# DIVISION 01

## GENERAL REQUIREMENTS

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# SECTION 01 11 00
SUMMARY OF WORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Location and Description of Work.
2. Contracts for this Project.
3. Sequence and Progress of Work.
4. Contractor's Use of Site.
5. Easements and Rights-of-Way.
6. Partial Utilization by Owner.
7. Utility Owners.
8. Tree Trimming, Clearing, and Tree Removal.
9. Fences.

### 1.2 LOCATION AND DESCRIPTION OF WORK

A. The Work is located south of the City of Ashland, Oregon, near Ashland Creek coming from Horn Creek Rd. The new address of this treatment plant is 1111 Granite Street, Ashland, OR 97520.

B. The Work to be performed under this Contract includes constructing the Work broadly described below, in accordance with the Contract Documents, with all related appurtenances. Work shown on the Drawings, or indicated in the Specifications, or indicated elsewhere in the Contract Documents is part of the Work, regardless of whether indicated below. The Work includes, but is not limited to, the following:
1. Constructing raw water and finished water conveyance piping and associated valves starting at the connection locations of the existing infrastructure to the entrance gate of the treatment plant site.
2. Road and site grading and finished grading of the existing access road.
3. Construction of the new access road to the treatment plant starting at the entrance gate to the new site including site grading and finish grading.
4. Construction of raw water and finished water conveyance piping, sewer piping, and other related site piping, electrical conduits and cables starting at the entrance gate to the new site of the new treatment plant.
5. Construction of all vaults and associated equipment.
6. Construction of a buried ozone contactor pipeline and associated vaults with injection equipment.
7. Site preparation, security fence, and finish grading.
8. Construction of an Operations Building that houses administration, maintenance, laboratory, elevator, electrical equipment, chemical storage, dual media filtration tanks, ballasted flocculation tanks, filter effluent clearwell and associated pumps, air compressors, and blowers.
9. Construction of a Pre-Treatment Building, Ozone Generation Building, Crowson Pump Station, backwash tank, clearwell tank and associated piping and equipment.
10. Purchase and installation of ballasted flocculation equipment.
11. Purchase and installation of ozone system equipment.
12. Construction of chemical storage and feed systems and associated transfer and feed pumps.
13. Construction of the raw water pipeline to bypass the existing water treatment plant including draining the existing water line, dewatering the excavated trench, and disposing of excess water.

14. Construction of miscellaneous sample sump pumps, sample sump pipelines, and analytical instruments and accessories.
15. Construction of all associated mechanical, electrical, instrumentation and control, and general sitework items including installation of a new electrical service entrance integrated power assembly and standby power engine generator.
16. Purchase and installation of the solar array including site preparation, grading, electrical metering, photovoltaic modules and support structures, inverters and other equipment, raceways, conduit, wiring and grounding, controls, and connection to water treatment plant electrical distribution and associated equipment.
17. Completing installation of a battery energy storage system including a pre-assembled conditioned outdoor enclosures, power conversion system, surge suppression, and concrete pad for maintenance access, metering, transformers, raceways, conduit, wiring and grounding, controls and connection to water treatment plant electrical distribution and associated equipment.

C. Contracting Method: The Project will be constructed under a single prime construction contract.

## 1.3 CONTINUITY OF PLANT OPERATIONS

A. General: Construct work to allow for Owner's continuous occupancy and for uninterrupted treatment of water during construction. Coordinate construction schedule and operations with the Owner. The Contractor shall plan, schedule, and coordinate his construction operations and activities in a manner that will facilitate the progress of the work included in these Contract Documents. Since there is considerable interfacing with the Owner's plant operating staff, it is imperative that the Contractor work closely with the plant operating staff in preparing the schedule.

B. Contractor shall not close any lines, open valves, or take any other action which would affect the operation of existing systems. Modifications of operations of existing systems will be performed by Owner's operations staff only. Such actions will be considered by the Owner, upon 7 calendar days written notice to the Owner.

C. Any existing plant equipment, facilities, and appurtenances such as water lines, gas lines, electrical conduits or cables, residuals lines, structures, vehicles, etc., which are damaged by the Contractor during construction, even though inadvertently, will be repaired immediately by Contractor at his own expense.

D. During the Contract, Contractor is responsible for adapting his construction and schedule in order to allow the Owner to maintain the existing level of water treatment consistent with applicable permit requirements, laws and regulations, and standard practices. In performing such Work, it may be necessary for the Contractor to plan, design and provide various temporary services, utilities, connections, temporary piping and heating, working other than during normal working hours, access and the like which will need to be included within the Contract Price.

E. VIOLATION OF TREATMENT LIMITS:
1. Violation of Treatment Limits is prohibited at all times. In the event of violation due to the activities of the Contractor, the Owner shall immediately be entitled to employ others to stop the violation. Penalties imposed on the Owner as a result of any violation of Treatment Limits caused by the actions of the Contractor, his employees, or subcontractors shall be borne in full by the Contractor, including legal fees and other expenses to the Owner resulting directly or indirectly from the violation.

F. SUBMITTALS:
1. OUTAGES: In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for each operation which will make it necessary to remove a tank, pipeline, channel, electrical circuit, instrument loop, piece of equipment, or structure from service. The number of outages shall be minimized through planning and use of isolation valves and terminal boxes. The outage schedule shall be coordinated with the overall construction schedule and shall meet the restrictions and conditions specified in this

section. The detailed plan shall describe the Contractor's method for preventing bypassing of other treatment units. Systems or individual equipment items shall be isolated, dewatered, decommissioned, de-energized, or depressurized by plant staff in accordance with the detailed outage plan and schedule. The Engineer shall be notified in writing at least 7 calendar days in advance of any planned outage in any area for coordination with plant staff.

2. TEMPORARY PIPING: The Contractor shall provide a formal submittal on the temporary piping arrangement for yard piping displaced by construction, as described below. The submittal shall be in accordance with Section 01 33 00, and shall consist of the following items:
   a. Piping arrangement drawings.
   b. Complete material list.
   c. Number and type of bypass pumps, if necessary.
   d. Piping connections.
3. TIE-INS: Tie-ins to existing process piping are subject to the following constraints:
   a. The allowable downtime for piping connections not otherwise specified is 4 hours.
   b. A plan and schedule for process piping tie-ins, must be approved by Engineer and Owner prior to beginning any tie-in work.
   c. Owner's isolation valves may not be bubble tight. Contractor shall be prepared to install necessary temporary plugs.
   d. Prior to installing any buried piping, Contractor must verify elevation of existing piping and provide fittings to install piping around existing piping.

## 1.4 SEQUENCE AND PROGRESS OF WORK

A. Work sequencing. The work includes general work and sequenced work as defined below:
   1. GENERAL WORK: General work includes work that can be accomplished at any time during the contract duration, provided that appropriate permits are in place and coordination with plant operations has been completed. Contractor shall coordinate all general work elements with the Owner and Engineer, and shall submit Deactivation Request Forms prior to working in areas where temporary conditions, tie-ins, and shut-downs are required. Construction of the GENERAL WORK facilities may commence at any time after formal Notice to Proceed.
   2. SEQUENCED WORK: Sequenced work includes work that requires completion of prerequisite work or establishing prerequisite conditions. Contractor shall coordinate all sequenced work elements with the Owner and Engineer, and shall submit Deactivation Requests prior to working in areas where temporary conditions, tie-ins, and shut-downs are required.

B. Coordinate construction schedule and operations with the Owner. The Contractor shall plan, schedule, and coordinate his demolition and construction operations and activities in a manner that will facilitate the progress of the work included in these Contract Documents. Since there is considerable interfacing with the Owner's staff, it is imperative that the Contractor work closely with the owner and the engineer in preparing his schedule.

C. Following are general work sequence constraints or time critical work elements for the construction of critical work items in each of the major areas of Work, specific schedule constraints are provided in bold lettering. Work elements shown are not necessarily on a critical path and may be done simultaneously. Critical work elements shown are not necessarily complete and others may occur as the Work proceeds. The Contractor shall submit a detailed work sequence schedule to accomplish the Work in accordance with the Construction Progress Schedule. Shutdown periods are consecutive 7-day weeks, 24-hour periods, workday hours, or otherwise shown. The Owner will perform activities that are underlined. All other activities shall be performed by the Contractor as part of the approved work sequence schedule. Installation of equipment shall include all electrical and control systems, and startup activities as specified in Section 01 75 00. Refer to Section 01 30 00 – Special Conditions for detailed special conditions associated with each major area of work:
   1. Water Treatment Plant:

a. Install permanent fence around the treatment site as appropriate to provide site security measures and temporary fencing as appropriate.
b. Provide temporary floor drain storage/infiltration pond and associated piping as required for construction activities.
c. Extension of existing fiber optic line to the Water Treatment Plant.
d. Excavation as required for the new buildings, clearwell, and below grade piping as required by the geotechnical investigation and Contract Documents may commence immediately.
e. Yard Piping - Construct pipelines from the existing access road to new Water Treatment Plant. Temporary thrust protection will be required to test and operate the pipelines.
f. Construction of new Operations Building with associated water treatment, chemical facilities, wastewater systems, and associated laboratory, administration and maintenance facilities. Construction of other on site buildings. Contractor shall be responsible for operation of their own on-site sewage facilities until completion of the entire work.
g. Construction of the clearwell access road, below grade piping, and clearwell tank.
h. Following completion of the buildings and treatment systems, complete installation of the filter media per AWWA requirements.
i. Clean all installed piping, structures and construction area to ensure no damage to equipment due to latent debris from construction.
j. Complete all system installation, commissioning and checkout. Coordinate all services of Equipment Manufacturers in accordance with Section 01 75 00 and individual equipment specification sections.
k. Complete system testing, hydraulic leakage tests, and thorough cleaning of all piping and strainer systems. All systems shall be thoroughly cleaned with potable water prior to disinfection activities.

2. Electrical Service Entrance and Standby Generator System: The following construction sequencing for the electrical service entrance is anticipated:
   a. Install the new conduits from the connection location of the existing electrical infrastructure to the new transformers. Install transformers and connect the power to the transformers. Establish the new service.
   b. Install the new conduits per utility requirements, utility transformer vault per utility requirements, Utility Metering section per utility requirements, and cables from the transformers to the new treatment site.
   c. Install standby generator and associated electrical conduits and cables.
   d. Establish the new service.
   e. Establish the electrical connections between the exterior service equipment and the new building as completed.
3. Existing Water Treatment Plant
   a. Construction of the raw water pipeline to bypass the existing water treatment plant.
   b. Draining the existing water line.
   c. Dewatering the excavated trench.
   d. Disposing of excess water.
   e. Complete bypass piping connections to existing piping per drawings.

D. Contractor is responsible for all temporary connections required to maintain existing raw water and treated water flows. Sequences other than those specified will be considered by Engineer and Owner, provided they afford equivalent continuity.

E. The Contractor shall schedule and coordinate his operations, and shall make all necessary temporary connections.

F. The Contractor shall work continuously during critical connections and changeovers, as required to prevent interruption of water service at no additional cost to the Owner. Provide written notice two weeks in advance of work to Owner and Engineer.

## 1.5 CONTRACTOR'S USE OF SITE

A. Contractors will have full use of the Site for storage and operations of workers related to the Project.

B. Owner and engineer will occupy the Site jointly with Contractor during construction for performance of Owner's typical operations. Coordinate with Owner in all construction operations to minimize conflicts between Contractor and Owner's employees and others under Owner's control. If the Site is a treatment facility or other production facility, Owner will have Owner's suppliers for deliveries of chemicals and other items accessing the Site from time to time, possibly on a daily basis.

## 1.6 EASEMENTS AND RIGHTS-OF-WAY

A. Easements and Rights-of-Way - General:
   1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by Owner in accordance with the General Conditions and Supplementary Conditions.
   2. Confine construction operations within Owner's property, public rights-of-way, easements obtained by Owner, and limits shown, and property for which Contractor has made arrangements directly with property owner(s). Contractor shall provide documentation for any arrangement made between Contractor and private property owners for storage of materials and equipment.
   3. Use care in placing construction tools, machinery and equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
   4. Do not enter private property outside the construction limits without permission from the owner of the property.

## 1.7 PARTIAL UTILIZATION BY OWNER

A. The Contractor shall schedule activities for completion of portions of the Work, as designated under Sequence of Work, for the Owner's occupancy prior to Substantial Completion of the entire Work.

B. Owner will occupy new facilities for the purpose of conducting normal operations.

C. Immediately prior to Owner occupancy of new facilities, Engineer shall issue a certificate of Partial Utilization, designating a date of occupancy and defining the area occupied:
   1. Contractor's responsibilities:
      a. Allow access for Owner's personnel.
      b. Allow operation of equipment and processes to remain in service during the course of the work.
   2. Owner's responsibilities:
      c. Assume responsibility for property insurance on occupied areas.
      d. Assume responsibility for security in occupied areas, but not extending to protection of Contractor's materials and equipment in occupied areas.
      e. Operate and maintain equipment and processes to remain in service during the course of the work.
   3. Other conditions of occupancy:
      a. The correction period for the occupied Work shall commence at the date of occupancy.

D. Prior to Substantial Completion of the entire Work under the Contract, substantially complete the Work as follows:
   1. Work indicted for Milestones (if any).
   2. Correction of all state, local, and other regulatory agencies defective Work lists.
   3. Submittals have been received and approved by the Engineer including, but not necessarily limited to, the following:

a. Record and test documents.
b. Pipe and structure water tightness test submittals.

4. All additional warranty or insurance coverage requirements have been provided.
5. Verify that all chemical handling, storage, and metering equipment is 100% complete and all punch list items have been addressed.
   a. Owner will not order chemicals until chemical handling, storage, and metering equipment punch list items have been addressed.

E. Final completion of total project: Additional work elements that shall be completed include:
1. Any required repairs to Contractor staging and storage areas and access road restoration if damaged during construction.
2. Fencing that has been damaged during construction needs to be repaired.
3. Clean up.
4. Items outlined within Section 00 72 13, Article 15 and Section 01 77 19.

## 1.8 UTILITY OWNERS

A. Utilities known to Engineer who may have facilities (Underground Facilities or otherwise) in the vicinity of the Work are as follows:
1. Electric Utility
   Ashland Municipal Electric Utility
   90 N Mountain Ave, Ashland, OR 97520
   Phone: 541-488-5357
   Email: electric@ashland.or.us
2. Fiber Utility
   Ashland Fiber Network
   90 N Mountain Ave, Ashland, OR 97520
   Phone: 541-552-2222
   Email: info@ashlandfiber.net
3. Water/Sewer
   City of Ashland
   20 E Main St., Ashland, OR 97520
   Phone: 541-488-5353
4. Natural Gas
   Avista
   1411 E Mission Ave, Spokane, WA 99252
   Phone: 800-227-9187

## 1.9 TREE TRIMMING, CLEARING, AND TREE REMOVAL

A. Provide all required labor and equipment for trimming, clearing, and tree removal as shown on the Drawings.

## 1.10 FENCES

A. All fences affected by the Work shall be maintained by the Contractor until completion of the Work. Fences disturbed by the Work shall be restored by Contractor to their original or better condition and to their original location unless otherwise indicated.

# PART 2 - PRODUCTS - (NOT USED)

# PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 01 21 00
ALLOWANCES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for:
      a. Contingency allowances.

B. Related Requirements:
   1. Include but are not necessarily limited to the following:
      a. Section 01 29 73 - Schedule of Values.
      b. Section 01 32 16 - Construction Progress Schedule.

### 1.2 REFERENCES

A. Terminology:
   1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the following meanings:
      a. "Allowance authorization" or "authorization", whether singular or plural, are Owner's written and signed approval for using a specific allowance item, in a specific authorized amount, for a specific construction task or activity. Allowance authorizations include all associated attachments at the time of Owner's signature and as delivered to Contractor.
      b. "Contingency allowance" is a stipulated amount included in the Contract Price, controlled by Owner, for Owner's sole use to cover unanticipated costs and costs for Work authorized by Owner that is not part of any other bid/pay item in the Contract.

### 1.3 ALLOWANCES – GENERAL

A. This Article applies to all allowance types and all authorized allowance Work performed in accordance with the Contract Documents.

B. All allowances in the Contract are Owner-controlled and for Owner's sole use. Contractor has no right or entitlement to any allowance or part thereof without express, written authorization from Owner.

C. Authorization of Allowances:
   1. Only Owner can authorize use of an allowance. No other entity, including Engineer, Resident Project Representative (RPR, if any), Owner's Site Representative (OSR, if any), or others may authorize use of allowances in place of Owner.
   2. Allowance Authorization Mechanism:
      a. To be binding and enforceable, allowance authorizations must be in writing, signed by the Public Works Director or Designee.
      b. Allowance authorization form is attached to this Section.
      c. Allowance authorizations issued in accordance with the procedures set forth in this Section, are binding and enforceable under the Contract, unless promptly contested in writing by Contractor in accordance with this Section.
      d. Oral authorizations, authorizations without an appropriate signature, and authorizations not on the proper form, will not be binding or enforceable.
   3. Allowance authorizations duly signed by Owner's authorized person may be delivered to Contractor by Engineer, RPR, OSR, or other Owner-authorized representative, and shall be binding and enforceable when so delivered (unless properly contested).
   4. Do not perform Work presumed for compensation under an allowance without first obtaining Owner's allowance authorization.

5. Work presumed by Contractor to be under an allowance and performed without: (a) written authorization duly signed by Owner, or (b) Change Order, or (c) Work Change Directive, is not be eligible for payment.

D. Contract Times:
   1. Allowance authorizations do not have any effect on, and do not change, the Contract Times. The Contract Times can be changed only via a duly authorized Change Order.
   2. Should the Work included in an allowance authorization adversely affect Contractor's ability to comply with the Contract Times, promptly submit Change Proposal (including appropriate supporting documentation), in accordance with the Contract Documents, indicating the associated, specific, proposed effect on each of the Contract Times.

E. Payment for Work Under an Allowance Authorization:
   1. Work duly authorized by Owner under an allowance is eligible for payment upon performance of the associated Work, in accordance with the Contract Documents and the associated allowance authorization.
   2. When applying for payment for Work under an allowance authorization, the Application for Payment shall include a copy of the associated allowance authorization(s) signed by Owner.
   3. When requested by Owner or Engineer, amend the Schedule of Values to indicate Work authorized under contingency allowances or cash allowances.

F. Compensation for Bonds and Insurance:
   1. Contractor is not eligible for compensation under an allowance, or for an increase in the Contract Price, for costs associated with insurance, performance bond, payment bond, or warranty bond (when such bond is required by the Contract). Compensation for such costs is included elsewhere in the Contract Price, under other (non-allowance) bid/pay items.

G. Change Orders:
   1. A Change Order is not required for authorization of an allowance that is already included in the Contract.
   2. Prior to final payment, all allowances with funds remaining (not yet authorized) shall be reduced to the total amount authorized by Owner for that allowance item, via a Change Order.

## 1.4 CONTINGENCY ALLOWANCES

A. Provisions on contingency allowance(s) are set forth in the General Conditions, as may be modified by the Supplementary Conditions, and in this Section.

B. Owner may authorize use of all or part of a contingency allowance included in the Contract for Work not otherwise covered under one or more other bid/pay items already in the Contract.

C. Procedure for Using Contingency Allowances:
   1. Prior to Work being authorized under a contingency allowance, Contractor shall submit complete Change Proposal for the associated Work, in accordance with the Contract Documents.
   2. Compensation proposed via the Change Proposal for the contemplated allowance Work shall be complete and sufficient for the entire scope of the contemplated allowance Work, unless expressly indicated otherwise in the Change Proposal or an associated, Owner- or Engineer-issued Proposal Request.
   3. Compensation eligible under a contingency allowance includes:
      a. Materials and equipment furnished to Owner or incorporated into the Work; labor; construction equipment and machinery; services, incidentals, and related costs, in accordance with the Contract Documents' provisions for Contract modifications.
      b. Overhead and profit for the associated Work, for Contractor and Subcontractors.
      c. Other costs and expense mutually agreeable to Owner and Contractor.
   4. Excluded are costs not mutually agreeable to the parties and costs excluded in accordance with Article 1.3 of this Section.

5. Should Change Proposal indicate, and Owner accept that, change in the Contract Times is necessary, Owner (or Engineer, on Owner's behalf) will issue an appropriate Change Order for signature by the parties, upon mutual agreement to the changed Contract Times.
6. Upon receipt of contingency allowance authorization, when Contractor does not reject or disagree with the authorization, Contractor shall sign allowance authorization form indicating acceptance and return signed form to Owner and Engineer within two days of receipt.
7. Commence performing the allowance Work promptly upon receipt of allowance authorization.
8. Application for Payment for the associated Work may be made in accordance with Article 1.3 of this Section and the Contract's provisions governing progress payments.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 ATTACHMENTS

A. The following, bound after this Specifications Section's "End of Section" designation, are part of this Specifications Section:
   1. Forms:
      a. Allowance Authorization Form, (one page).

**END OF SECTION**

## ALLOWANCE AUTHORIZATION

| | | | |
|---|---|---|---|
| Project: | _____ | Authorization Number: | _____ |
| | _____ | From: | _____ |
| To: | _____ | Date: | _____ |
| | _____ | Engineer Project No.: | _____ |
| Re: | _____ | Contract For: | _____ |

Contractor is authorized to perform the following item(s) of Work and to be eligible to apply for payment under the designated Contract allowance(s) indicated below for the amount indicated below for each item:

1. Allowance Title / Title of Change:

| |
|---|
| |

This instrument is not a Change Order and does not modify the Contract Price, nor does it modify the Contract Times.

| | |
|---|---|
| Original Allowance | $ _____ |
| Allowance Expenditures prior to this Authorization | $ _____ |
| Allowance Balance prior to this Authorization | $ _____ |
| Allowance will be decreased by this Authorization | $ _____ |
| New Allowance Balance | $ _____ |

RECOMMENDED BY

HDR

_____
Engineer

_____
By Date

OWNER APPROVAL

_____
Owner

_____
By Date

CONTRACTOR ACCEPTANCE

_____
Contractor

_____
By Date

☐ Attachments

Copies: ☐ Owner ☐ Contractor ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ File

# SECTION 01 22 00
## MEASUREMENT AND PAYMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. General requirements applicable to all bid/pay items.
   2. General provisions on unit prices and quantities.
   3. General provisions on lump sums.
   4. Listing of the various bid/pay items in the Project, together with criteria for measuring Unit Price Work for payment.

B. Related Requirements:
   1. Include but are not necessarily limited to:
      a. Section 01 21 00 - Allowances.
      b. Section 01 23 00 - Alternates.
      c. Section 01 26 00 - Contract Modification Procedures.
      d. Section 01 29 73 - Schedule of Values.
      e. Section 01 29 76 - Progress Payment Procedures.
      f. Section 01 71 23 - Field Engineering.

### 1.2 REQUIREMENTS APPLICABLE TO ALL BID/PAY ITEMS

A. In this Section and elsewhere in the Contract Documents, the terms "bid item", "pay item", "bid/pay item", "Item" followed by a number designation, "this item", and the like all have the same meaning, and refer to one or more specific elements of the Contract, established for pricing and payment, as indicated in the Bid Form and in the Agreement (or exhibit to the Agreement) at the time the Contract was signed by the parties.

B. This Article applies to all bid/pay items in the Contract.

C. Prices – General:
   1. The bid/pay items listed starting with Article 1.4 of this Section refer to and are the same bid items listed in the Bid Form and included in the Contract, and constitute all bid/pay items for the Work at the time the Contract was signed by the parties.
   2. No direct or separate payment will be made, outside of the bid/pay items in the Contract, for the following: providing miscellaneous temporary or accessory materials or equipment, temporary works, temporary construction facilities, Contractor's project management, superintendence, and similar costs for Subcontractors or Suppliers; bonds and insurance; schedules and schedule updates; coordination (with: Owner's operations (including, but not limited to, lockout/tag-out procedures), other contractors, utility owners, owners of transportation facilities, adjacent property owners and occupants, authorities having jurisdiction, Subcontractors and Suppliers, and others with whom Contractor is to coordinate the Work); information technology systems required by the Contract Documents; Submittals; photographic documentation; Project meetings; Contractor's hazard communication program; Contractor's compliance with environmental procedures for Constituents of Concern (including spill control and countermeasures plans and implementation); professional services (required for Contractor's means and methods of construction, and for delegated designs required by the Contract Documents); obtaining and complying with permits and licenses; temporary utilities (including electric power, water supply and disposal, fuel, and communications); temporary lighting; temporary fire protection; temporary enclosures and HVAC; temporary sanitary facilities; temporary first-aid facilities and services; ; Contractor's field offices and sheds, Engineer's field offices (when required elsewhere in the Contract Documents); temporary vehicular access and

parking (including access to the Site, temporary access roads and parking, onsite traffic controls for construction traffic, and offsite haul routes); traffic control of non-construction vehicular and pedestrian traffic; temporary controls (including temporary erosion and sediment controls, noise control, control of storm water, surface water, and groundwater, pollution controls (including solid waste control, water pollution control, and control of atmospheric pollution), dust control, pest and rodent controls, odor controls, and other temporary controls required by the Contract Documents); temporary security for the Work; temporary barriers; Project signage (when required elsewhere in the Contract Documents); delivering, handling, and storing materials and equipment to be incorporated into the Work; layouts and surveys for the Work; construction equipment, machinery, tools, and vehicles; safety and protection; Site maintenance during construction; cleaning and removal and disposal of waste and debris; checkout and startup; testing and other quality control activities required by the Contract Documents; record documents, operation and maintenance data; warranties; spare parts and extra materials required by the Contract Documents; instruction of facility personnel as required by the Contract Documents; commissioning (when required elsewhere in the Contract Documents); Contractor's correction period, Contractor's general warranty and guarantee; Contractor's indemnification obligations; other labor, cost, or effort required by the General Conditions and Supplementary Conditions, Division 01 Specifications, and other requirements of the Contract Documents.

3. Price Escalation:
   a. Unless expressly indicated otherwise in the Contract Documents, Owner is not obligated to change the stipulated prices (including lump sums, unit prices, and allowances) that are all or part of the Contract Price because of escalation of costs when there is no corresponding change in the Contract Times.
   b. Changes in the Contract Times do not necessarily entitle Contractor to a change in Contract Price due to escalation.
4. Compensation for all services, labor, materials, and equipment shall be included in prices stipulated for the lump sum bid/pay items in the Contract.
5. Each lump sum in the Contract shall include an amount considered by Contractor as sufficient for all overhead and profit for each separately identified bid/pay item.

D. Contract Price, Payment Procedures, and Related Matters:
1. Contract Price: The Contract Price, as apportioned among bid/pay items in the Contract, is indicated in the Agreement and may be modified by Change Order.
2. Payments to Contractor: Refer to the General Conditions (as may be modified by the Supplementary Conditions), the Agreement (including provisions on retainage, if any), and Section 01 29 76 - Progress Payment Procedures, among other applicable Contract Documents.
3. Schedule of Values: Refer to the General Conditions (as may be modified by the Supplementary Conditions) and Section 01 29 73 - Schedule of Values.
4. Procedures for Changes in Contract Price: Refer to the General Conditions (as may be modified by the Supplementary Conditions) and Section 01 26 00 - Contract Modification Procedures.
5. Alternates: The scope and limits of alternates, when contemplated for or included in the Contract, may be addressed, in whole or in part, in Section 01 23 00 - Alternates.
6. Defective Work is not eligible for payment.

## 1.3 GENERAL PROVISIONS ON UNIT PRICES AND QUANTITIES

A. Quantities:
1. Quantities of Unit Price Work indicated in the Bid Form and in the Contract (at the time the Agreement was signed by the parties) are estimates for purposes of pricing and comparison of Bids.
2. Owner does not represent, either expressly or by implication, or agree that the nature of materials encountered below ground surface or in concealed areas, or actual quantities of

Unit Price Work required, will correspond with the quantities in the Contract at the time the Agreement was signed by the parties. Owner reserves the right to increase or decrease quantities, and to eliminate quantities, as Owner may deem necessary or as may be necessary due to Site conditions encountered.

3. Adjustment of Unit Prices Due to Variation in Quantities:
   a. Provisions, if any, regarding adjustment of unit prices due to variations in actual quantities (eligible for payment) from the estimated quantities in the Contract (including quantities at the time the Agreement was signed by the parties and as subsequently modified by Change Order) are in the General Conditions, as may be modified by the Supplementary Conditions.
      1) Engineer's review for possible unit price adjustment, when provision for such adjustment is expressly indicated in the Contract, will be at a time Engineer deems reasonable and proper.
      2) When the Supplementary Conditions establish that, to be eligible for an adjustment in the unit price, a pay item of Unit Price Work must have a total computed, extended price (at the time the Agreement was signed by the parties) equal to or greater than a specified percentage (stipulated in the Supplementary Conditions) of the total Contract Price (at the time the Agreement was signed by the parties), and the total extended price of such pay item does not exceed the stipulated percentage of the Contract Price, then the associated pay item will be paid at the unit price in the Contract without adjustment for variations in actual quantity.
4. Quantities eligible for payment will be actual quantities furnished and installed (as applicable) in accordance with the Contract Documents, within the pay limits shown or indicated, as measured by Engineer (or other entity so empowered in the Contract Documents), and recommended for payment by Engineer.
5. At Contractor's expense, Contractor may independently verify quantities measured by Engineer for payment. Should Contractor disagree with quantities measured and recommended for payment by Engineer, submit appropriate Change Proposal (appealing Engineer's measurements) indicating the specific reasons for Contractor's appeal, with detailed reasons therefor and associated calculations and estimates, in accordance with the Contract Documents.
6. Quantity Overruns:
   a. When the quantity of a pay item of Unit Price Work eligible for payment exceeds the pay item's quantity included in the Contract, Owner will pay for quantities that exceed those in the Contract only while the estimated total payments to Contractor under the Contract will not exceed the Contract Price. Otherwise, a Change Order is required to modify the associated quantity in the Contract, thus changing the Contract Price.
7. Except as may be established elsewhere in the Contract Documents, make no claim for anticipated profit, loss of profit, damages, or additional compensation arising from difference between quantities of Unit Price Work eligible for payment and the estimated quantities in the Contract.

B. Measuring for Payment:
   1. At Engineer's option, Engineer may delegate to Resident Project Representative (RPR) (if any), some or all of Engineer's responsibilities for measuring Unit Price Work eligible for payment.
   2. Unless expressly indicated otherwise in the Contract Documents, measurements will be in United States standard measurements.
   3. Unless indicated otherwise elsewhere in the Contract Documents, quantities of Unit Price Work eligible for payment will be rounded to the nearest whole number.
   4. In the event of conflict between this Section and the measurement criteria in the Specifications of Divisions 02-49, the measurement criteria in this Section will govern. Typical intent when measurement criteria are in both this Section and the associated Division 02-49 Specifications section, is for the criteria to be interpreted together.
   5. Assistance with Measurements:

a. Comply with Section 01 71 23 - Field Engineering.
b. Assist Engineer and Resident Project Representative (RPR) (if any), by providing measuring equipment, labor, and survey personnel necessary to measure quantities eligible for payment.

6. Quantities eligible for payment can be adjusted by Engineer to correct quantities included in Contractor's prior payment requests, and for incomplete or defective Unit Price Work. Such corrections are at Engineer's sole discretion.

### 1.4 GENERAL PROVISIONS ON LUMP SUM ITEMS

A. Progress payments for Work paid on a lump sum basis will based on Engineer's estimate of the Work (in accordance with the Contract Documents) performed through the end of the associated pay period, based on the Schedule of Values accepted by Engineer in accordance with the Contract Documents.

B. At its sole discretion, Engineer may correct amounts of lump sum Work included in prior payment requests based on improved data or information available to Engineer, or Engineer's knowledge or reasonable belief that Work is incomplete or defective.

### 1.5 BID/PAY ITEMS – GENERAL CONTRACT

A. Item 1 – General Construction:
1. Measurement: As set forth in the Contract's provisions regarding the Schedule of Values and progress payment procedures.
2. Payment: Lump sum payment for this item will be full compensation for completing the Work, as shown and indicated in the Contract Documents not included under other bid/pay items.

B. Item Lump Sum– Contingency Allowance:
1. Measurement: As indicated in the Agreement and Section 01 21 00 - Allowances, the Contract includes in this item a stipulated amount available as reserve for sole use by Owner, for costs authorized by Owner during construction, for Work not included under other bid/pay items.
2. Payment: Payment for Work authorized in accordance with Section 01 21 00 - Allowances, and performed under this item will be full compensation for providing all Work authorized under this allowance, complete as shown, indicated, or directed by Engineer in accordance with the associated allowance authorizations.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 01 23 00
## ALTERNATES

### 1.1 SUMMARY

A. Section Includes:
   1. Section identifies each alternate and describes the basic changes that shall be incorporated into the Work when that alternate is made part of the Work.

B. Scope:
   1. When alternate item(s) are included in the Work as awarded by Owner, the Contractor shall provide all labor, materials, equipment, tools, and incidentals required to provide the Work included under the alternate(s) so awarded.

### 1.2 ADMINISTRATIVE PROCEDURES

A. Coordination:
   1. Contractor shall coordinate related Work as required to complete the Work under each alternate included in the Work. Include as part of each alternate miscellaneous devices, accessories, and similar items incidental to or required for a complete installation whether or not shown or indicated as part of the alternate.
   2. Notification: Immediately following award of the Contract, notify in writing each Subcontractor and Supplier involved of the status of each alternate item. In such notice, indicate which alternate items have been accepted, rejected, or deferred for later consideration, and include complete description of negotiated modifications to alternates.

### 1.3 DESCRIPTION OF ALTERNATES

A. Alternate No. 1 – Add Solar Array
   1. Description:
      a. This additive item includes completing installation of the solar array including all equipment, site preparation, grading, electrical, controls and other appurtenant Work, as shown on the Drawings and as specified.
   2. Solar Array
      a. Provide photovoltaic modules, inverters and other equipment to attain the nominal maximum power rating (Pmax) DC capacity specified as determined by Contractor's module selection and the requirements in the Drawings.
      b. Provide photovoltaic module support structures.
      c. Provide Control System and integrate with Owner's SCADA system.
      d. Provide metering, raceways, conduit, wiring and grounding.
      e. Complete connection to water treatment plant electrical distribution and associated equipment.
   3. Refer to Section 26 99 00 – Photovoltaic Modules, 26 00 03 – Inverters, 26 99 04 – Meteorology Station System Description, 40 63 44 – SCADA Control System, and 48 14 10 - PV Module Support Structures..

B. Alternate No. 2 – Add Battery Energy Storage System
   1. Description:
      a. This additive item includes completing installation of a battery energy storage system including all equipment, electrical, controls and other appurtenant Work, as shown on the Drawings and as specified.
   2. Battery Energy Storage System
      a. Provide Battery Energy Storage System including a pre-assembled conditioned outdoor enclosures, power conversion system, surge suppression, and concrete pad for maintenance access.
      b. Complete connection to water treatment plant electrical distribution and associated equipment.

c. Provide Control System and integrate with Owner's SCADA system.
d. Provide metering, transformers, raceways, conduit, wiring and grounding.

3. Refer to Sections 40 63 44 – SCADA Control System and 48 17 00 – Battery Energy Electrical Power Generation Equipment.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

# SECTION 01 25 13
PRODUCT SUBSTITUTIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. The procedure for requesting the approval of substitution of a product that is not equivalent to a product which is specified by descriptive or performance criteria or defined by reference to one or more of the following:
      a. Name of manufacturer.
      b. Name of vendor.
      c. Trade name.
      d. Catalog number.
   2. Substitutions are not "or-equals."
   3. This Specification Section does not address substitutions for major equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

C. Request for Substitution - General:
   1. Base all bids on materials, equipment, and procedures specified.
   2. Certain types of equipment and kinds of material are described in specifications by means of references to names of manufacturers and vendors, trade names, or catalog numbers.
      a. When this method of specifying is used, it is not intended to exclude from consideration other products bearing other manufacturer's or vendor's names, trade names, or catalog numbers, provided said products are "or-equals," as determined by Engineer.
   3. Other types of equipment and kinds of material may be acceptable substitutions under the following conditions:
      a. Or-equals are unavailable due to strike, discontinued production of products meeting specified requirements, or other factors beyond control of Contractor; or,
      b. Contractor proposes a cost and/or time reduction incentive to the Owner.

### 1.2 QUALITY ASSURANCE

A. In making request for substitution or in using an approved product, Contractor represents they:
   1. Have investigated proposed product, and have determined that it is adequate or superior in all respects to that specified, and that it will perform function for which it is intended.
   2. Will provide same guarantee for substitute item as for product specified.
   3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.
   4. Waives all claims for additional costs related to substitution which subsequently arise.

### 1.3 DEFINITIONS

A. Product: Manufactured material or equipment.

### 1.4 PROCEDURE FOR REQUESTING SUBSTITUTION DURING BIDDING PERIOD

A. See Section 00 21 13 - Instructions to Bidders.

### 1.5 PROCEDURE FOR REQUESTING SUBSTITUTION AFTER AWARD OF CONTRACT

A. Substitution will only be considered under the conditions stated herein.

B. Written request through Contractor only.

C. Transmittal Mechanics:
   1. Follow the transmittal mechanics prescribed for Shop Drawings in Specification Section 01 33 00.
      a. Product substitution will be treated in a manner similar to "deviations," as described in Specification Section 01 33 00.
      b. List the letter describing the deviation and justifications on the transmittal form in the space provided under the column with the heading DESCRIPTION.
         1) Include in the transmittal letter, either directly or as a clearly marked attachment, the items listed in Paragraph D below.

D. Transmittal Contents:
   1. Product identification:
      a. Manufacturer's name.
      b. Telephone number and representative contact name.
      c. Specification Section or Drawing reference of originally specified product, including discrete name or tag number assigned to original product in the Contract Documents.
   2. Manufacturer's literature clearly marked to show compliance of proposed product with Contract Documents.
   3. Itemized comparison of original and proposed product addressing product characteristics including but not necessarily limited to:
      a. Size.
      b. Composition or materials of construction.
      c. Weight.
      d. Electrical or mechanical requirements.
   4. Product experience:
      a. Location of past projects utilizing product.
      b. Name and telephone number of persons associated with referenced projects knowledgeable concerning proposed product.
      c. Available field data and reports associated with proposed product.
   5. Data relating to changes in construction schedule.
   6. Data relating to changes in cost.
   7. Samples:
      a. At request of Engineer.
      b. Full size if requested by Engineer.
      c. Held until substantial completion.
      d. Engineer not responsible for loss or damage to samples.

## 1.6 APPROVAL OR REJECTION

A. Written approval or rejection of substitution given by the Engineer.

B. Engineer reserves the right to require proposed product to comply with color and pattern of specified product if necessary to secure design intent.

C. In the event the substitution is approved, the resulting cost and/or time reduction will be documented by Change Order in accordance with the General Conditions.

D. Substitution will be rejected if:
   1. Submittal is not through the Contractor with his stamp of approval.
   2. Request is not made in accordance with this Specification Section.
   3. In the Engineer's opinion, acceptance will require substantial revision of the original design.
   4. In the Engineer's opinion, substitution will not perform adequately the function consistent with the design intent.

E. Reimburse Owner for the cost of Engineer's evaluation whether or not substitution is approved.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

**EXHIBIT A**

# Substitution Request Form
## (One Item per each Form)

| Project: | | Date: |
|---|---|---|
| Substitution Requestor: | | |
| Contractor: | | |
| Specification Section No: | Paragraph No. (i.e. 2.1.A.1.c): | Specified Item: |
| | | |
| Proposed Substitution: | | |

Provide Product Data Sheets, Manufacturer's written installation instructions, drawings, diagrams, or any other information as an attached to this Form that will demonstrate the proposed substitution is an Approved Equal.

In the lines provided state differences between proposed substitutions and specified item. Differences include but are not limited to interrelationship with other items; materials, equipment, function, utility, life cycle costs, applied finished, appearances, and quality.

In the lines provided demonstrate how the proposed substitution is compatible with or modifies other systems, parts, equipment or components of the Project and Work under the Contract

In the lines provided, describe what effect the proposed substitution has on dimensions indicated on the Drawings and previously reviewed Shop Drawings?

In the lines provided, describe what effect the proposed substitution has on the Construction Schedule and Contract Time.

In the lines provided, describe what effect the proposed substitution has on the Contract Price. This includes all direct, indirect, impact and delay costs.

Manufacturer's guarantees of the proposed and specified items are:

☐ Same ☐ Different (explain on attachment)

The undersigned state that the function, utility, life cycle costs, applied finishes, appearance and quality of the proposed substitution are equal or superior to those of the specified item.

For use by Project Representative:

☐ Accepted ☐ Accepted as Noted

☐ Not Accepted ☐ Received Too Late

(Date)

(Telephone)

(Contractor's Signature)

(Contractor's Firm)

(Firms Address)

Comments:

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# SECTION 01 26 00
## CONTRACT MODIFICATION PROCEDURES

### 1.1 SUMMARY

A. Section Includes:
   1. This Specifications section expands upon provisions of the General Conditions, as may be modified by the Supplementary Conditions, and includes:
      a. Requests for interpretation.
      b. Written clarifications.
      c. Minor changes in the Work and Field Orders.
      d. Work Change Directives.
      e. Proposal Requests.
      f. Change Proposals.
      g. Change Orders.

### 1.2 GENERAL – APPLICABLE TO ALL PROVISIONS OF THIS SECTION

A. Submit Contract modification documents to Engineer, addressed to the contact person and contact information indicated in Section 01 33 00 - Submittal Procedures, and in accordance with Section 01 31 26 - Electronic Communication Protocols.

B. Retain at Contractor's office and at the Site complete copy of each Contract modification document, all interpretations and clarifications, related documents, and Engineer's response.

### 1.3 REQUESTS FOR INTERPRETATION

A. General.
   1. Transmit written requests for interpretation to Engineer. Contractor and Owner may prepare and transmit requests for interpretation.
   2. Prepare and transmit request for interpretation to obtain clarifications or interpretations of the Contract Documents. Report conflicts, errors, ambiguities, and discrepancies in the Contract Documents by requesting an interpretation.
   3. Do not transmit request for interpretation when other form of communication is appropriate, such as Submittals, requests for approvals of substitutes, notices, ordinary correspondence, or other form of communication. Improperly prepared or inappropriate requests for interpretation will be returned without response or action by Engineer.
   4. Do not submit request for interpretation or clarification when:
      a. answer may be obtained by observations at the Site; or.
      b. required information is clearly indicated in the Contract Documents; or.
      c. required information is included in industry standards referenced in the Contract Documents or Supplier's instructions that are consistent with the Contract Documents; or.
      d. are reasonably inferable from any of foregoing.
   5. Engineer will return requests for interpretation without response for any of the following reasons:
      a. Request is regarding one of the items addressed in Paragraphs 1.3.A.3 and 4 of this Specifications section.
      b. Request is unclear or incomplete.
      c. Request was answered in Engineer's response to a prior request for interpretation.
      d. Request is related to construction means, methods, techniques, procedures, or sequences of construction that are not required by the Contract Documents.
      e. Request is related to safety and protection matters that are solely Contractor's responsibility.
      f. Request resulted in whole or in part to lack of adequate coordination by Contractor, including coordination of Subcontractors and Suppliers.
      g. Requests that are otherwise frivolous or unnecessary.

6. Should requests be categorized by Engineer as within the limits of Paragraphs 1.3.A.3, 4, or 5 of this Specifications Section, Engineer may recommend and Owner may withhold from payments due Contractor under the Contract set-off(s) sufficient to cover Owner's costs of Contractor's submittal of invalid, frivolous, unnecessary, or inappropriate requests for interpretation or clarification.
7. Contractor shall have sole financial responsibility for Contractor's costs for requests for interpretation or clarification that are submitted late, out of sequence, or that are unnecessary.

B. Procedure.
1. Transmit requests for interpretation in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Include with each request for interpretation a separate letter of transmittal.
2. If Engineer requests additional information to make an interpretation, entity requesting the interpretation shall transmit the information requested within 10 days, unless Engineer allows additional time, via correspondence referring to request for interpretation number.
3. Engineer will review and respond to requests for interpretation with reasonable promptness. Allow sufficient time for review and response.
4. Engineer will maintain log of requests for interpretation. Upon request, copy of log will be transmitted to requestor.
5. Engineer's response to requests for interpretation will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Each response to a request for interpretation will include a separate letter of transmittal.
6. Engineer's response to each request for interpretation will be distributed to:
   a. Contractor.
   b. Owner.
   c. Resident Project Representative (RPR).
   d. Engineer.
7. If Contractor desires to appeal Engineer's interpretation or clarification, comply with the appeals procedure set forth in the General Conditions, as may be modified by the Supplementary Conditions.
8. Interpretations that One or Both Parties Believes Entails a Change to the Contract:
   a. If Contractor or Owner believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of Engineer's interpretation, so advise Engineer in writing before proceeding with the Work associated with the request for interpretation.
   b. If, after this initial communication, either Owner or Contractor believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.

C. Preparation of Requests for Interpretation:
1. Prepare each request for interpretation on the "Request for Interpretation" form included with this Specifications section, or other form acceptable to Engineer.
2. Number each request for interpretation as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First request for interpretation on the general contract for project titled, "Contract WWTP09" would be, "RFI No. WWTP09-GC-001".
3. In space provided on form, describe the interpretation requested. Provide additional sheets as necessary. Include text and sketches as required in sufficient detail to describe the need for interpretation.
4. When applicable, request for interpretation shall include Contractor's recommended resolution.

## 1.4 WRITTEN CLARIFICATIONS

A. General:

1. Written clarifications, when required, will be initiated and issued by Engineer.
2. Written clarifications do not change the Contract Price or Contract Times, and do not alter the Contract Documents.
3. Written clarifications will be issued as correspondence or using clarification notice form acceptable to Engineer, with additional information as required.

B. Procedure.
1. Engineer's written clarifications will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section.
2. Each written clarification will be distributed to:
   a. Contractor.
   b. Owner.
   c. Resident Project Representative (RPR).
   d. Engineer.
3. If Contractor desires to appeal Engineer's interpretation or clarification, comply with the appeals procedure set forth in the General Conditions, as may be modified by the Supplementary Conditions.
4. Written Clarifications that One or Both Parties Believes Entails a Change to the Contract:
   a. If Contractor or Owner believe that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of Engineer's written clarification, so advise Engineer in writing before proceeding with the Work associated with the written clarification.
   b. If, after this initial communication, either Owner or Contractor believes that change in the Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
5. If Engineer's written clarification is unclear, prepare and transmit a request for interpretation in accordance with the Contract Documents.

## 1.5 MINOR CHANGES IN THE WORK AND FIELD ORDERS

A. General:
1. Field Orders, when required, will be initiated and issued by Engineer.
2. Field Orders authorize minor changes in the Work but do not change the Contract Price or Contract Times.
3. Field Orders will be in the form of Engineers Joint Contract Documents Committee document EJCDC C-942, "Field Order".
4. Engineer will maintain a log of Field Orders issued. Copy of Engineer's log of Field Orders will be transmitted to Contractor or Owner upon request.

B. Procedure:
1. Field Orders will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Each Field Order will include a separate letter of transmittal.
2. Each Field Order will be distributed to the following:
   a. Contractor.
   b. Owner.
   c. Resident Project Representative (RPR).
   d. Engineer.
3. Field Orders that One or Both Parties Believes Entails a Change to the Contract Price or Contract Times:
   a. If Contractor or Owner believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of a Field Order, so advise Engineer in writing before proceeding with the Work associated with the Field Order.
   b. If, after this initial communication, Contractor believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
4. If the Field Order is unclear, submit request for interpretation.

5. If Owner disagrees with the Field Order, Engineer may issue a revised or amended Field Order, or a Change Order or Work Change Directive may be issued.

## 1.6 WORK CHANGE DIRECTIVES

A. General:
   1. Work Change Directives, when issued, order additions, deletions, or revisions to the Work. When issued, Contractor shall promptly implement the changes ordered in the associated work Change Directive.
   2. Work Change Directives do not change the Contract Price or Contract Times but are evidence that the parties to the Contract expect that the change ordered or documented by the Work Change Directive will be incorporated in subsequently issued Change Order following agreement by the parties as to the Work Change Directive's effect, if any, on the Contract Price, Contract Times, or both.
   3. Work Change Directives will be in the form of EJCDC C-940, "Work Change Directive".

B. Procedure.
   1. Work Change Directives signed by Owner and Engineer will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Each Work Change Directive will include a separate letter of transmittal. Signed Work Change Directives will be transmitted to:
      a. Contractor.
      b. Owner.
      c. Engineer.
      d. Resident Project Representative.
   2. Documentation of Costs:
      a. Promptly following receipt of the Work Change Directive:
         1) Advise Engineer and Owner in writing of the anticipated quantity and types of construction equipment and machinery required or anticipated for the associated Work.
         2) Advise Engineer and Owner in writing of which construction equipment and machinery is owned by the Contractor or Subcontractor and which is, or will be, rented from an equipment rental firm.
         3) When construction equipment and machinery is rented from a rental firm, transmit to Engineer and Owner copy of the associated rental agreements(s) pertinent to the Work ordered by the Work Change Directive.
         4) For all construction equipment and machinery, indicate to Engineer and Owner whether each item is required only for the Work ordered by the Work Change Directive and whether each item is being, or will be, used for other Work on the Project or other projects for Owner.
         5) Advise Engineer and Owner in writing of information on anticipated temporary materials (including items such as temporary support of excavations, scaffolding, temporary barriers, temporary plates covering excavations, and other temporary materials) to the same extent as that required for construction equipment and machinery.
      b. When basis of payment for Work ordered under a Work Change Directive will be paid as Cost of the Work plus a fee, or when otherwise required by Engineer, document for the Work performed under each separate Work Change Directive, for each day, the following:
         1) Number and labor classifications of workers employed and hours worked each day on the Work ordered via the Work Change Directive.
         2) Construction equipment used, including manufacturer, model, and year of manufacture, and number of hours such equipment was onsite and used each day for the Work under the Work Change Directive. Indicate where the equipment was used for other Work under the Contract and idle time.

3) Temporary materials; furnish the same information as required for construction equipment and machinery. Where rental costs of such items approaches the purchase cost of such item, or when otherwise requested by Engineer, furnish evidence, satisfactory to Engineer, of the purchase price of such temporary materials.
4) Consumables and similar materials used.
5) Suppliers' receipts, bills, or invoices for and descriptions of materials and equipment incorporated into the Work.
6) Invoices and labor and equipment breakdowns for Subcontractors.
7) Other information required by Owner or Engineer.
8) Transmit such documentation as a Change Proposal promptly after such documentation is available to Contractor. Actively pursue Subcontractors and Suppliers for required documentation to promptly furnish required documentation to Engineer.

c. Separately track and document Work performed in accordance with each Work Change Directive and Work performed under stipulated price methods of compensation (including lump sums and Unit Price Work).
d. Submit such information in a format acceptable to Engineer.

3. Documentation of Time:
a. General:
1) Contractor will be entitled to change of Contract Times Work ordered by a Work Change Directive in accordance with the requirements of the General Conditions, as may be modified by the Supplementary Conditions.
2) Contractor will be entitled to a change in Contract Times only when the Work ordered by the Work Change Directive is implemented promptly and affects the Contractor's ability to comply with the Contract Times.

b. Requirement Documentation: Submit the following as part of the Change Proposal documenting price-related impact of the Work ordered by the Work Change Directive:
1) Statement on whether the subject Work affected Contractor's ability to comply with the Contract Times.
2) If Contractor's ability to comply with the Contract Times was so affected, indicate the effect on each of the relevant Contract Times.
3) Document that Contractor acted promptly and properly upon receipt of the Work Change Directive to promptly implement the Work ordered thereby.
4) Time impact analysis for the affected Work, in accordance with Section 01 32 16 - Construction Progress Schedule.
5) Other time-related documentation required by Engineer.

## 1.7 PROPOSAL REQUESTS

A. General:
1. Proposal Requests may be initiated by Engineer or Owner.
2. Proposal Requests are for requesting the effect on the Contract Price and the Contract Times and other information relative to contemplated changes in the Work. Proposal Requests do not authorize changes or variations in the Work, and do not change the Contract Price or Contract Times or terms of the Contract.
3. Proposal Requests will be furnished using the "Proposal Request" form included with this Specifications section.

B. Procedure:
1. Proposal Requests will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Section. Each Proposal Requests will include a separate letter of transmittal.
2. Each signed Proposal Request will be transmitted to the following:
a. Contractor.
b. Owner.

c. Resident Project Representative (RPR).
d. Engineer.

3. Transmit request for interpretation to obtain clarification of conflicts, errors, ambiguities, and discrepancies in Proposal Request.
4. Upon receipt of Proposal Request, Contractor shall prepare and transmit to Engineer a Change Proposal, in accordance with the Contract Documents, for the proposed Work described in the Proposal Request.

## 1.8 CHANGE PROPOSALS

A. General:
1. Prepare and transmit written Change Proposal to Engineer in response to each Proposal Request; or when Contractor believes a change in the Contract Price, Contract Times, both, or other change to the terms of the Contract is required; or to appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract.

B. Procedure:
1. Prepare and transmit Change Proposals within time limits indicated in the General Conditions, as may be modified by the Supplementary Conditions.
2. Submit only one Change Proposal for each change issue, unless Engineer requires additional information or clarification. Do not submit repeated Change Proposals for the same change issue. Rather, when Contractor is dissatisfied with Engineer's decision on a Change Proposal, recourse is set forth in the General Conditions, as may be modified by the Supplementary Conditions, and elsewhere in this Article.
3. Transmit Change Proposals in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Include with each Change Proposal all required supporting documentation and a separate letter of transmittal.
4. Engineer's Review and Requests for Additional Information:
   a. Engineer will review and act on each Change Proposal in accordance with, and within the time limits indicated in, the General Conditions, as may be modified by the Supplementary Conditions.
   b. When, Engineer requests additional information to render a decision, submit required information within five days of receipt of Engineer's request, unless Engineer allows more time. Submit the required information via correspondence that refers to the specific Change Proposal number.
   c. Owner shall transmit to Engineer such comments, if any, that Owner has on the Change Proposal, within 10 days of Owner's receipt of the Change Proposal.
   d. Engineer will render a written decision on the Change Proposal or take other action in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
   e. Engineer's response to Change Proposals will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section, the General Conditions, and the Supplementary Conditions.
5. Engineer's response to each Change Proposal will be distributed to:
   a. Contractor.
   b. Owner.
   c. Resident Project Representative (RPR).
   d. Engineer.
6. If Change Proposal is recommended for approval by Engineer and is approved by Owner, a Change Order will be issued or, when applicable, an appropriate use of an allowance (already included in the Contract Price) will be authorized by Owner.

7. If parties do not agree on terms for the change, Owner or Contractor may file a Claim against the other, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.

C. Preparation of Change Proposals:
   1. Each Change Proposal shall be submitted on the "Change Proposal" form included with this Specifications section, or other form acceptable to Engineer.
   2. Number each Change Proposal as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First Change Proposal for the general contract for project named "Contract No. 8" would be, "Change Proposal No. 8-GC-001".
   3. In space provided on Change Proposal form:
      a. Describe scope of each proposed change. Include text and sketches on additional sheets as required to provide detail sufficient for Engineer's review and response. If a change item is submitted in response to Proposal Request, write in as scope, "In accordance with Proposal Request No." followed by the Proposal Request number. Submit written clarifications, if any, to scope of change.
      b. Submit justification for each proposed change. If change is in response to proposal request, write in as justification, "In accordance with Proposal Request No." followed by the Proposal Request number.
      c. Indicate the total change in the Contract Price and Contract Times for each separate change item included in the Change Proposal.
   4. Proposed Effect on Contract Price: Unless otherwise directed by Engineer, attach to the Change Proposal detailed breakdowns of pricing (Contractor's cost and Contractor's fee) including:
      a. List of Work tasks to accomplish the change.
      b. For each task, labor cost breakdown including labor classification, total hours per labor classification, and hourly cost rate for each labor classification. Where overtime is included, indicate the overtime hours, labor classifications, and associated overhead rates.
      c. Construction equipment and machinery to be used, including manufacturer, model, and year of manufacture, and number of hours for each. Indicate whether the construction equipment or machinery is owned by Contractor, Subcontractor, or leased from a rental firm; if leased, include with the Change Proposal a copy of the rental agreement. Indicate whether the construction equipment and machinery is already onsite and used for other activities, or whether it is required solely for the Work in the contemplated change. Indicate overtime hours budgeted, if any, and the associated cost rate for overtime compared with the straight-time rate.
      d. Indicate temporary materials required, including description of extent, scope, and quality, and associated cost. Temporary materials include items such as temporary sheeting for support of excavations, scaffolding, temporary plates to cover open excavations, temporary barriers, and other temporary items. Indicate ownership or source of such items. Include copy of rental agreement if rented from a third-party rental firm in which neither Contractor nor any Subcontractor has a financial interest. Indicate intended duration of use for such items and purchase cost of such items.
      e. Detailed breakdown of cost of materials and equipment to be incorporated into the Work, including quantities, unit costs, and total cost, with Supplier's written quotations. When requested by Engineer, submit quotes by multiple prospective Suppliers.
      f. Breakdowns of each Subcontractors' pricing, including labor, construction equipment and machinery, temporary materials, and materials and equipment incorporated into the Work, other costs, and Subcontractor fees (e.g., overhead and profit). Breakdown of Subcontractors' pricing shall be the same level of detail as that for Contractor.
      g. Breakdown of other costs eligible, in accordance with the General Conditions and the Supplementary Conditions under "Cost of the Work" provisions.
      h. Other information required by Engineer.

i. Contractor's fees (overhead and profit) applied to eligible Contractor costs and eligible Subcontractor costs.

5. Proposed Effect on Contract Times: Unless otherwise directed by Engineer, attach to the Change Proposal detailed information substantiating the proposed change in Contract Times, including:
   a. Time impact analysis required by Section 01 32 16 - Construction Progress Schedule.
   b. Indication of whether the Work associated with the contemplated change will affect Contractor's ability to comply with the Contract Times.
   c. Other time-related information requested by Engineer.

### 1.9 CHANGE ORDERS

A. General:
   1. Change Orders will be recommended by Engineer (when required by the General Conditions) and will be signed by Owner and Contractor (subject to the General Conditions related to a party withholding its signature from a contractually-required Change Order)), to authorize additions, deletions, or revisions to the Work, changes to the Contract Price, changes in the or Contract Times, changes to the terms of the Contract, or a combination thereof.
   2. Change Orders will be in the form of EJCDC C-941, "Change Order".

B. Procedure.
   1. Change Orders for signature by Contractor will be transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section. Each Change Order will include a separate letter of transmittal.
   2. Contractor shall promptly sign each original Change Order and, within five days of receipt, deliver all originals to Engineer.
   3. Engineer will sign each original Change Order and forward them to Owner.
   4. After approval and signature by Owner, original Change Orders will be distributed as indicated below.
   5. Original, signed Change Orders will be distributed as follows:
      a. Contractor: One original.
      b. Owner: One original.
      c. Engineer: One original.
      d. Resident Project Representative (RPR): One copy.
   6. Upon Contractor's receipt of the fully-signed Change Order, promptly perform the Work ordered thereby in accordance with the Contract Documents and the Progress Schedule accepted by Engineer.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 ATTACHMENTS

A. The forms listed below and bound following this Specifications section's "End of Section" designation, are part of this Specifications section:
   1. Request for Interpretation form (one page).
   2. Proposal Request form (one page).
   3. Change Proposal form (one page).

**END OF SECTION**

## REQUEST FOR INTERPRETATION

Owner: _____

Project Name: _____

Contractor: _____ RFI No. [_____]

Date Transmitted: _____ Date Received: [_____]

Date Response Requested: _____ Date Response Transmitted: [_____]

Subject: _____ [_____]

Specification Section and Paragraph: _____

Drawing References: _____

---

**INTERPRETATION REQUESTED**:

Signature: _____ Date: [_____]

---

**ENGINEER'S RESPONSE**:

Signature: _____ Date: [_____]

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## PROPOSAL REQUEST

Owner: _____

Project Name: _____

Proposal Request No.: _____ Date: [_____]

Contract Name and No.: _____

Contractor: _____

Other Contracts Involved in Proposed Change: _____

*TO CONTRACTOR*: Please submit a complete Change Proposal for the proposed modifications described below. If the associated Change Proposal is approved, a Change Order or allowance authorization will be issued to authorize adjustment so the Contract. This Proposal Request is not a Change Order, Work Change Directive, Field Order, or an authorization to proceed with the proposed Work described below.

### SCOPE OF PROPOSED CHANGE(S) IN THE WORK:

1. *[Title 1]*:
2. *[Title 2]*:
3. *[Title 3]*:

Attachments to this Proposal Request:

1. [None].

Proposal requested by: _____
HDR (Engineer)

Signature of Requestor: _____

## CHANGE PROPOSAL

Owner: _____

Project Name: _____

Change Proposal No.: _____ Date: [_____]

Submitted in Response to Proposal No.: _____

Contractor Name and No.: _____

Contractor: _____

Subject: _____

_____

The following changes to the Contract are proposed:

**SCOPE OF PROPOSED CHANGE TO CONTRACT:** *(attach supporting information as required)*

1. *[Title 1]*:
2. *[Title 2]*:

**JUSTIFICATION:**

1. *[Title 1]*:
2. *[Title 2]*:

**PROPOSED CHANGES IN CONTRACT PRICE AND CONTRACT TIMES:**

We propose that the Contract Price and Contract Times be changed as follows:

*For Contract Price, attach detailed cost breakdowns for Contractor and Subcontractors, Supplier quotations, and other information required.*

*For the Contract Times, state increase, decrease, or no change to Contract Times for Substantial Completion, readiness for final payment, and Milestones, if any. If increase or decrease, state specific number of days for changes to the Contract Times. Submit supporting data, including time impact analysis for the Progress Schedule.*

| | | Contract Times (days) | |
|---|---|---|---|
| **Description** | **Amount** | **Substantial** | **Final** |
| 1. [Title 1] | $0.00 | 0 | 0 |
| 2. [Title 2] | $0.00 | 0 | 0 |
| **Total This Change Proposal** | **$0.00** | **0** | **0** |

Changes to Milestones, if any: [_____] [_____]

Contractor represents that supporting data attached to this Change Proposal are accurate and complete. The requested time or price adjustment indicated in this Change Proposal is the entire adjustment to which Contractor believes it is entitled as a result of the proposed change(s) indicated herein.

Change Proposal by: _____

Signature of Proposer: _____

# SECTION 01 29 73
SCHEDULE OF VALUES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for the Schedule of values.

B. Scope:
   1. Contractor shall prepare and submit to Engineer for acceptance a Schedule of Values that allocates cost to each item of the Work. Schedule of Value list of line items shall correspond to each aspect of the Work, establishing in detail the portion of the Contract Price allocated to each component of the Work.
   2. Upon request of Engineer, promptly furnish data and information that substantiates and supports the amounts indicated in the Schedule of Values.
   3. Submit preliminary Schedule of Values to Engineer for initial review. Contractor shall incorporate Engineer's comments into the Schedule of Values and resubmit to Engineer. Engineer may require corrections and re-submittals until Schedule of Values is acceptable.
   4. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.

### 1.2 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Submit to Engineer the Schedule of Values in the form and quantity required in Section 01 33 00 – Submittals.
   2. Content of Schedule of Values Submittals shall be in accordance with Article 1.3 of this Specifications section.
   3. Timing of Submittals:
      a. Submit preliminary Schedule of Values within time limit indicated in the General Conditions.
      c. Submittal of the Schedule of Values for acceptance by Engineer shall be in accordance with the General Conditions. Engineer will not accept Applications for Payment without an acceptable Schedule of Values.
      d. When required by Engineer, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price.

### 1.3 SCHEDULE OF VALUES FORMAT AND CONTENT

A. Organization and Major Elements of Schedule of Values.
   1. Organization in Accordance with Specification Sections:
      a. Within each work area, organize the Schedule of Values by the various Specifications section numbers and titles included in the Contract Documents.
      b. Label each row in the Schedule of Values with the appropriate Specifications section number. Include an amount for each row in the Schedule of Values.
      c. List sub-items of major materials, equipment, or systems, as appropriate or when requested by Engineer.

B. Requirements for preliminary Schedule of Values Submittal and the Schedule of Values Submittal for acceptance by Engineer are:
   1. Subcontracted Work:
      a. Line items for Work to be performed by each Subcontractor shall include the word, "(SUBCONTRACTED)" and the name of the Subcontractor once the associated subcontract is signed and effective.

2. Apportionment between Materials and Equipment, and Installation: Schedule of Values shall include separate apportionment of costs for:
    a. Cost of materials and equipment to be incorporated into the completed construction.
    b. Cost of delivery, handling, and storage of materials and equipment to be incorporated into the completed construction.
    c. Cost of temporary materials (such as excavation supports, scaffolding, and other temporary materials), and their associated delivery, handling, and storage costs, if any.
    d. Cost of rentals of construction equipment and machinery, whether owned by Contractor or Subcontractor or leased from a third-party equipment rental entity.
    e. Cost of installing materials and equipment.
    f. Travel and subsistence costs, if any.
    g. Other costs used in preparing the Bid by Contractor and each Subcontractor.
3. Sum of individual line item amounts indicated on the Schedule of Values shall equal the total of associated bid/payment item. Sum of bid/payment item totals in the Schedule of Values shall equal the total lump sum component of the Contract Price.
4. Overhead and Profit:
    a. Include in each line item a directly proportional amount of Contractor's overhead and profit in the Contract Price.
    b. Do not include overhead and profit as separate line item(s).
5. Allowances: Include separate line item for each allowance.
6. Bonds and Insurance Costs:
    a. Include line item for bonds and insurance in payment item, in amount not exceeding 2.0 PCT of the Contract Price.
    b. When greater than the amount stipulated immediately above is proposed by Contractor in the Schedule of Values, submit to Engineer documentation substantiating the proposed amounts. Submit to Engineer such documentation when otherwise requested by Engineer.
    c. When Contractor has furnished bonds and evidence of insurance acceptable to Owner and in accordance with the Contract Documents, entire amount for bonds and insurance may be applied for in the first Application for Payment.
7. "Site Overhead" and Administrative Cost Elements:
    a. Include in the Schedule of Values relevant line items and amounts for work and services required by the General Conditions and specific Division 01 Specifications sections, such as:
        1) Superintendence and supervision costs and other costs.
        2) Itemized list of Work by work area, as applicable, for costs associated with coordination with the Owner's operations, including required sequencing, as set forth in the Contract Documents.
        3) Construction Progress Schedule and scheduling, schedule updates, time impact analyses, and preparation of recovery schedules.
        4) Construction photographic documentation.
        5) Permits (when applicable).
        6) Temporary utilities and temporary facilities.
        7) Field offices (monthly rental and maintenance) and storage facilities (excluding costs of establishment and removal, which are part of mobilization and demobilization).
        8) Site maintenance, such as temporary controls (dust, air pollution, water pollution, solid waste control, pest and rodent control, temporary erosion and sediment controls, and others), snow and ice removal, and similar activities.
        9) Field engineering and surveying.
        10) Progress cleaning and cleaning for Substantial Completion.
        11) Record documents (preparation, maintenance, and submittal).
            a) If adequate record documents are maintained, up to 50 PCT of the value of the record documents line item will be eligible for payment, spread evenly over those progress payments in which construction at the Site is performed.

b) Remainder of Project record documents line item will be eligible for payment when complete record documents are submitted in accordance with the Contract Documents. If record documents submitted are unsatisfactory to Engineer, amount may be reduced via set-offs in accordance with the Contract Documents.

12) Other items required by Engineer.

b. Include such items in Applications for Payment on payment schedule acceptable to Engineer

c. Such line items in the Schedule of Values shall exclude any and all costs associated with Contractor's permanent place(s) of business, personnel stationed at permanent office(s), salaries and bonuses of executive and administrative personnel not directly performing work on the Project, and general business expenses, all of which are part of Contractor's overhead costs.

8. Mobilization and Demobilization:
   a. Include separate line items under each appropriate lump sum bid/payment item for mobilization and demobilization.
   b. Document for Engineer the activities included in mobilization and demobilization line items.
   c. Mobilization includes: obtaining permits; negotiating, preparing, and signing subcontracts and purchase orders, attending preconstruction conference(s) and initial scheduling conference(s); establishing temporary utilities and temporary facilities; establishing field offices, storage sheds, and staging and laydown areas; establishing major temporary equipment and machinery at the Site; establishing temporary access roads and parking; preparing and initial implementation of spill prevention control and countermeasures plans; initial establishment of temporary environmental controls, including initial temporary erosion and sediment controls; and similar work required for Contractor to mobilize for Work at the Site, not included under other line items of the Schedule of Values. Obtain Engineer's concurrence for other costs included under mobilization.
   d. Mobilization will be limited to 5 percent of the Contract Price, and will be paid in 4 payments, each of 25 percent of total amount for mobilization. Should Contractor propose mobilization in an amount greater than the limit indicated in this paragraph or on an alternative schedule from that indicated in this paragraph, submit to Engineer for acceptance information and documentation sufficient to support and substantiate the proposed amount and payment schedule for mobilization.
   e. Demobilization includes: closing out permits obtained by Contractor; final closeout of remaining subcontracts and purchase orders, attending the final inspection; terminating temporary utilities; removing remaining temporary facilities; removing field offices, storage sheds, and staging and laydown areas and performing final restoration of such areas; removing major temporary equipment and machinery from the Site; removing temporary access roads and parking; and similar work required for Contractor to fully demobilize from the Site, not included under other line items of the Schedule of Values.
   f. Demobilization shall be not less than 2 percent of the Contract Price and shall be included with the Application for Payment following Substantial Completion, or other schedule acceptable to Engineer.
9. Costs for Submittals, field quality control activities, and training of operations and maintenance personnel shall be as follows, unless otherwise accepted by Engineer:
   a. Submittals: Up to 8.0 PCT of cost (including all associated overhead and profit) of each equipment item, exclusive of transportation and installation costs associated therewith, may be allocated to preparation of Shop Drawings, Samples ,and other Submittals required for release for purchase, fabrication, or delivery (as applicable) and may be included in the Application for Payment following Engineer's approval of Shop Drawings (and acceptance of other Submittals, as applicable) required for fabricating or purchasing for that item for the Work.

b. Field Quality Control: Up to 3.0 PCT of total cost of each item (including all associated overhead and profit), including materials and equipment, and installation, may be apportioned to specified or required field quality control activities (including required testing and inspections) and included in the Application for Payment following Engineer's acceptance of the associated written field quality control report Submittal(s).
c. O&M Manual Submittals and Training: Up to a total of 4.0 PCT of equipment cost (including all associated overhead and profit), exclusive of transportation and installation costs, may be apportioned to operations and maintenance manuals and training of operations and maintenance personnel, which may be included in the Application for Payment following completion of training for the associated item.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 01 29 76
## PROGRESS PAYMENT PROCEDURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for Contractor's progress payments.

B. Scope:
   1. Contractor's requests for payment shall be in accordance with the Agreement, General Conditions and Supplementary Conditions, and the Specifications.
   2. Form: Applications for Payment shall be the Engineers Joint Contract Documents Committee (EJCDC) document EJCDC C-620, "Contractor's Application for Payment" (2018 edition or later) or other form acceptable to the Owner and Engineer.

### 1.2 CONTENT AND PROCEDURE FOR REQUESTING PROGRESS PAYMENTS

A. Procedure:
   1. Review with Resident Project Representative (RPR) quantities and the Work proposed for inclusion in each progress payment request. Application for Payment shall cover only the Work and quantities recommended by the RPR.
   2. Contractor will review with Engineer or RPR the status of Project record documents, in connection with Engineer's review of each Application for Payment. Failure to maintain record document current will be cause for Engineer to recommend a reduction in payment for record documents in accordance with Section 01 29 73 - Schedule of Values, and will entitle Owner to set-offs in accordance with the Contract Documents.
   3. Submit to Engineer1 electronic copy of Application for Payment, with Contractor's signature and other documents to accompany the Application for Payment. Transmit Application for Payment in accordance with Section 01 31 26 - Electronic Communication Protocols, and requirements of this Specifications section.
   4. Engineer will act on request for payment in accordance with the General Conditions and Supplementary Conditions.

B. Content: Each request for payment shall include:
   1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have the same level of detail as the Schedule of Values.
   2. Documentation for Stored Materials and Equipment:
      a. For materials and equipment not incorporated in the Work but suitably stored, submit documentation in accordance with the General Conditions and Supplementary Conditions.
      b. UCC-1 Financial Statement:
         1) For each lot or delivery of stored materials and equipment for which payment is requested prior to installation of the item(s) at the Site, complete UCC-1, "Financial Statement" form. On UCC-1 form, indicate Owner as "security party"; indicate Supplier as "debtor" when stored item(s) are in Supplier's custody, and indicate Contractor as "debtor" when stored item(s) are in Contractor's custody; and clearly indicate in detail all stored item(s) included in the filing as "collateral" on the form. Include attachments to the form when necessary to clearly and fully indicate in detail the associated "collateral".
         2) File completed UCC-1 form with the secretary of state in the state where the subject item(s) are stored.

3) Include with Application for Payment the completed UCC-1 form together with evidence of filing with the required state(s). Submit UCC-1 form and related documentation once for each lot or delivery of stored items.

c. Photographs of the stored items at the storage location, in accordance with requirements for progress photographs in Section 01 42 00 - References. Submit photographs sufficient to clearly indicate each stored item, clearly showing marking of Owner's property in accordance with Paragraph 1.3.C of this section. Such photographs do not count as photographs required under Section 01 42 00 - References. For each month that such item(s) are stored, take and submit monthly new photographs of each stored item, with date-stamp on each photograph.

d. Legibly indicate on invoice or bill of sale the specific stored materials or equipment included in the payment request and corresponding bid/payment item number for each and the Supplier price for each item.

3. For Payment on the Basis of Cost of the Work plus a Fee:

a. When Work included in an Application for Payment will be compensated on the basis of Cost of the Work plus a fee, whether when the entire Contract is compensated on the basis of Cost of the Work plus a fee or when the Application for Payment includes Change Order Work to be compensated on the basis of Cost of the Work plus a fee, the Application for Payment shall include documentation of the costs, including not less than the following:

1) Number of and labor classifications of workers employed and hours worked. Separately indicate overtime and holiday hours, when applicable.

2) Construction equipment used including manufacturer, model, and year of manufacture, and number of hours such equipment was onsite and used for the Work compensated on the basis of Cost of the Work. Where such equipment was used on overtime, separately indicate overtime hours.

3) Consumables and similar materials used.

4) Receipts, bills, or invoices for, and descriptions of, materials and equipment incorporated into the Work.

5) Invoices and breakdowns of labor, construction equipment, and materials and equipment incorporated into the Work by Subcontractors, and Suppliers' onsite time, if any.

6) Invoices or receipts for other expenses included in the Application for Payment, such as travel and subsistence expenses, costs for bonds and insurance, and all other eligible costs and expenses for which compensation is sought in the subject Application for Payment on the basis of Cost of the Work.

7) Other information and documents required by Owner or Engineer,

b. Costs for which progress payment is requested on the basis of Cost of the Work plus a fee and for which documentation acceptable to Engineer is not submitted will not be eligible for payment.

4. Listing of Subcontractors and Suppliers:

a. In accordance with the General Conditions, submit not less than monthly updated listing of all Subcontractors and Suppliers known to Contractor, whether or not such entities have a contract directly with Contractor.

b. Submit complete information using the form attached to this Specifications section.

5. Allowance Work:

a. For payment requests that include payment for Work under an allowance, include with the progress payment request copy of Owner's authorization of the associated allowance Work, in accordance with Section 01 21 00 - Allowances.

6. Partial Release or Reduction of Retainage:

a. For each Application for Payment where Contractor requests partial release or reduction of retainage in any amount (other than request for final payment), submit with associated progress payment request consent of surety to partial release or reduction of retainage, duly completed by Contractor and surety.

b. Acceptable form includes AIA G707A, "Consent of Surety to Reduction in or Partial Release of Retainage" (1994 or later edition), or other form acceptable to Owner.
c. For payment requests that include reduction in or payment of retainage in an amount greater than that required by the Contract Documents, obtain Owner's concurrence for partial release or reduction in retainage prior to submitting such Application for Payment.

C. Final Payment:
1. Requirements for request for final payment are in the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 19 - Closeout Requirements.

### 1.3 ADDITIONAL PROCEDURES FOR PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Observation of Stored Materials and Equipment as Condition Precedent to Eligibility for Payment:
1. General:
a. Prior to materials or equipment suitably stored but not yet incorporated into the Work can be eligible for payment, Engineer or Resident Project Representative (RPR) shall visit the storage location and verify the extent, condition, and storage environment of the stored items.
b. When the same material or equipment item is stored for more than two months, such visits to storage location shall be not less than once every two months.
2. Cost Responsibility for Observations:
a. When storage location is less than 20 miles from the Site or less than 20 miles from Engineer's office, Contractor is not responsible for reimbursing Owner for cost of Engineer's time and expenses for observing stored materials and equipment.
b. When storage location is more than 20 miles from the Site and more than 20 miles from Engineer's office, Contractor shall reimburse Owner, via a set-off under the Contract Documents, for reasonable cost of Engineer's time and expenses, including travel time, to visit the storage location and observe the stored materials and equipment.

B. Other Requirements for Stored Items: Regardless of storage location, perform the following for stored materials and equipment for which payment is sought:
1. Clearly mark each stored container, crate, or item as follows: "Property ofthe City of Ashland" using permanent marking. Such marking shall not blemish or deface the finish of items that will be exposed to view after installation at the Site.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 ATTACHMENTS

A. The forms listed below, following this Specifications section's "End of Section" designation, are part of this Specifications section:
1. List of Subcontractors and Suppliers form (two pages).

**END OF SECTION**

## LIST OF SUBCONTRACTORS AND SUPPLIERS

Owner: [_____] [_____]
Project Name: [_____] [_____]

Contractor: _____ Date: [_____]
Contract Designation: _____

*Indicate below complete information for each Subcontractor and Supplier known to Contractor, regardless of whether the firm has a direct contract with Contractor. Include all lower-tier Subcontractors and associated Suppliers. Copy and paste the paragraphs below as required to indicate all Subcontractors and Suppliers.*

---

## SUBCONTRACTORS

1. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

2. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

3. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

**Total of Subcontract Prices for all subcontracts equals approximately [_____] percent of the Contract Price** *(Contractor to fill in blank monthly)*

---

## SUPPLIERS

1. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

2. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

3. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

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# SECTION 01 30 00
SPECIAL CONDITIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for:
      a. Indication of applicable building codes and related codes.
      b. Project signs.
      c. Contractor's field office.
      d. Engineer's field office.
      e. Project photographic documentation.
      f. Adjacent properties and facilities.

### 1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. References in the Contract Documents to local code(s) means the following:
      a. 333-061-0030; 0031 Maximum Contaminant Levels and Action Levels; and Maximum Residual Disinfectant Levels
      b. 333-061-0032 Treatment Requirements and Performance Standards for Surface Water, Groundwater Under Direct Influence of Surface Water, and Groundwater
      c. 333-061-0034 Treatment Requirements and Performance Standards for Corrosion Control
      d. 333-061-0050; 0055 Construction Standards and Waivers from Construction Standards
      e. 333-061-0060 Plan Submission and Review Requirements
      f. 2019 Oregon Structural Specialty Code (OSSC):
         1) As amended by 2021 Ashland Municipal Code.
      g. 2019 Oregon Fire Code (OFC).
      h. 2019 Oregon Mechanical Specialty Code (OMSC).
      i. 2017 Oregon Plumbing Specialty Code (OPSC).
      j. 2014 Oregon Energy Efficiency Specialty Code (OEESC).
      k. 2017 Oregon Electrical Specialty Code.

### 1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Project Signage: Location, materials, mounting hardware or mounting method, layout, and colors of required Project signage.
      b. Engineer's Field Office: Proposed location, type of construction, size, and layout of Engineer's field office.
   2. Project Data:
      a. Manufacturer's published literature and product data for Engineer's field offices:
         1) Furniture and furnishings.
         2) Office equipment.
         3) Safety items and first-aid kit.
         4) Proposed communications service(s).

B. Informational Submittals: Submit the following:
   1. Project Photographic Documentation:
      a. Preconstruction photographic documentation.
      b. Progress photographic documentation, submitted at the frequency indicate in this Specifications section.

c. Final photographic documentation.

## 1.4 PROJECT SIGNS

A. Within 10 days after date the Contract Times start to run provide and maintain a Project sign in accordance with this Specifications section. Signage other than the required Project sign and traffic/site access control signage is not allowed without Owner's written approval.

B. Project Sign Materials:
   1. Project sign shall be:
      a. Furnished by an experienced professional sign company.
      b. Structurally adequate and suitable for exterior application.
      c. Sign panels shall be constructed using a 4 FT and 8 FT, 3/4 IN new A-B Grade, exterior type, APA MDO plywood both sides.
      d. Materials shall be new and of good quality.
   2. Paint shall be exterior quality, as specified in the Specifications of Division 09 or as a minimum, primer and finish coat: exterior, semi-gloss, enamel. Colors for the sign and structure, framing, sign surfaces, and graphics shall be as shown on the Drawings.
   3. Prior to furnishing the sign, submit the Project sign layout Submittal required in this section. Sign layout Submittal shall indicate sign text, font, arrangement, logo(s (if any), and colors of text, logos, and sign background.

C. Information to be indicated on the Project sign includes:
   1. Site name.
   2. Project name (including Owner's project number or contract designation).
   3. Owner's name.
   4. Engineer's company name.
   5. Contractor's company name.
   6. Name(s) of funding and financing entities.

D. Installation of Project Sign:
   1. Install sign as shown in the Drawings.
      a. Coordinate Project Sign location(s) and mounting with the Owner prior to installation.
   2. Mount sign to resist wind loads as required by authorities having jurisdiction and other loads reasonably imposed on the sign, but not less than sustained wind velocity of 50 MPH with gusts of 75 MPH.
   3. Prior to installing sign, submit mounting design to Engineer.
   4. Install sign level and plumb. Unless otherwise required by the Contract Documents, all angles shall be at 90 DEG.

E. Maintenance and Removal:
   1. Keep Project sign clean and legible until the sign is removed from the Site.
   2. Repair sign when necessary.
   3. Remove Project sign entirely from the Site following Substantial Completion and prior to requesting final inspection.
   4. Remove signs, framing, supports, and foundations to a depth of at least 2 FT below finished grade at the sign.
   5. Restore area of sign to condition as required by the Contract Documents. If not expressly required otherwise, restore landscaping and pavement and site improvements to condition equal to or exceeding that at the time the Contract Times started to run.

## 1.5 CONTRACTOR'S FIELD OFFICE

A. Establish at the Site the Contractor's field office, structurally sound and in accordance with Laws and Regulations, sufficient for Contractor's needs at the Site.

B. Equipment: Telephone, copier/scanner, and (as deemed necessary by Contractor) appropriate computer equipment.

C. Contractor's personnel will be reasonably present at Contractor's office during working days.

D. At Contractor's field office, maintain complete file of the Contract Documents, Submittals approved or accepted (as applicable) by Engineer, interpretations and clarifications issued by Engineer, copies of Contractor's daily field reports, all necessary and required safety data sheets, copies of documents comprising Contractor's safety program, record documents required by the Contract Documents including the General Conditions), and other files of field operations deemed appropriate by Contractor and as required by the Contract Documents.

E. Remove field office from Site following Substantial Completion of all the Work and prior to final inspection of the completed Work.

## 1.6 ENGINEER'S FIELD OFFICE

A. Separate from Contractor's field office.

B. General Construction:
   1. New or reconditioned mobile office trailer as manufactured by Acton or equal.
   2. Baked enamel aluminum siding.
   3. 3-1/2 IN foil-backed fiberglass insulation throughout.
   4. Interior paneling.
   5. Vinyl tile flooring.
   6. 8 FT high acoustic tile ceiling.
   7. Two private office areas, one at each end of trailer, one reception-conference room area, and private washroom.
   8. Windows:
      a. Minimum two per room, excepting washroom, with one each on opposing walls.
      b. Combination screen-storm windows.
      c. Provide horizontal louver blinds on each window.
   9. Nominal 60 FT long and 14 FT wide.
   10. Two exterior doors (with cylinder deadbolt locks) with outer screens, exterior lights and exterior stairs and railings.
   11. A sketch of interior configuration with up to four doors will be provided by the Engineer.
   12. Trailers, once sited, must be securely tied down and grounded.

C. Electrical System:
   1. All fixtures, outlets, and wiring of Underwriters Laboratories, Inc. (UL) approved devices.
   2. All circuits protected by circuit breakers; fuses are not acceptable.
   3. Electrical system shall meet requirements of the latest National Electric Code (NEC).
   4. System suitable for 220 V, 3 PH service.
   5. Any transformers or other devices required to match this supply to the mobile office shall be provided and connected.
   6. Provide a circuit breaker for the incoming service.
   7. Each interior room except the washroom shall have at least four, 110 V duplex electrical convenience outlets.

D. Central Combination Electric Heating, Air-Conditioning System:
   1. Fan-forced air.
   2. Thermostatically controlled.
   3. Individual room units are not acceptable.
   4. Freeze protect and insulate all piping.
   5. System sized to maintain 75 DEGF constant temperature in each room.

E. Lighting System:
   1. LED lighting producing 100 foot-candles at desk top height.
   2. Ample ceiling fixtures provided to ensure adequate lighting throughout.

F. Standard Washroom:
   1. Flush toilet, sink, hot and cold running water.
   2. Electric water heater.
   3. Mirror.

4. Electric ceiling or wall vent.
5. Sound insulated partitions.

G. Furnishings:
1. One desk 36 x 72 IN long with locking lap drawer.
2. One plan table 39 x 72 x 36 IN wide, with one locking equipment drawer.
3. One L-shaped secretary desk with main desk 36 x 72 x 36 IN high with locking lap drawer, side drawer, and hanging file drawer.
4. Two 30 x 72 IN folding tables.
5. One 48 x 60 IN liquid marking board with minimum four-color set of compatible markers.
6. One 48 x 60 IN cork bulletin board.
7. Four four-drawer legal size filing cabinets.
8. Two cushioned swivel arm chairs.
9. Two conference chairs.
10. 12 folding chairs.
11. Two nominal 3 FT plan racks that hold a 30 IN minimum of six, 200 sheet sets of 30 x 42 IN Drawings.
12. Three sets of bookcases, each composed of three shelves 36 IN long and 12 IN wide.
    a. The units shall be a minimum of 3 FT high.
13. Three standard size waste paper baskets.
14. One Emerson Model OR300A, 2.7 CUFT refrigerator.

H. Communications:
1. Provide telephone service including four lines and four sets.
2. High-speed internet service.

I. Field Office Equipment:
1. One all-in-one printer-copier-scanner.
2. One three-hole punch, Master Products Series 25.
3. One stapler, Swingline 113.
4. Three Acco 20 staplers.
5. Three scotch tape dispensers.
6. Six wire in and out baskets.
7. Three two-hole punch, Wilson-Jones Model 202B.
8. One Eagle Zepher 84 date stamp.
9. Electric pencil sharpener, Panasonic Model KP-77.
10. Exterior boot wash station.

J. Safety Equipment:
1. One 10 LB ABC dry powder fire extinguisher, upright and fully charged, in an easily accessible location.
2. One OSHA, "Employee Right to Know" Poster, prominently displayed.
3. One first aid kit.
4. One weather radio.

K. Maintenance:
1. Provide all maintenance and upkeep of trailer and equipment.
    a. Equipment breakdowns shall be repaired promptly by Contractor.
2. Janitorial service.
    a. Weekly:
        1) Floor sweeping using dust suppressing compound.
        2) Wet mopping with floor detergent.
    b. Inclement weather: Conduct weekly requirements on daily basis.
    c. Monthly: Wash windows and clean window blinds.
3. Pay all utilities costs.
4. Maintain at least until acceptance of the entire work by the Owner or until otherwise suspended by the Engineer.

L. Removal of Engineer's Field Office:
   1. Remove field office from the Site following Substantial Completion and prior to final completion.
   2. Jointly agree with Engineer and Resident Project Representative (RPR) on the date for closure of Engineer's field office, disconnection of utilities, removal of field office equipment, and physical removal of the field office and restoration of the field office area.
   3. Completely remove Engineer's field office, all appurtenances, and associated site work such as walkways or sidewalks to the field office, temporary parking areas, temporary utilities serving the field office, and field office structure.
   4. Restore area of the field office to conditions required by the Contract Documents. If not expressly required by the Contract Documents, restore area of field office to condition equal to or better than that at the time the Contract Times started to run.

## 1.7 PROJECT PHOTOGRAPHIC DOCUMENTATION

A. Contractor shall furnish photographic documentation as required and as directed by Engineer or Resident Project Representative (if any). Required under this Article is "still" photographs only.

B. Types of Construction Photographic Documentation Required:
   1. Preconstruction photographs, sufficient to document preconstruction conditions of the site, buildings, and structures, and facilities. Obtain and submit to Engineer prior to performing any mobilization or Work at the Site.
   2. Construction progress photographs. Obtain at frequency of not less than weekly. Obtain not less than twenty photographs each time the photographer is onsite for the purpose of obtaining construction progress photographic documentation. Submit to Engineer within five days of the date the associated progress photograph was taken.
   3. Final photographs, all taken after completion of the Work and demobilization from the Site, and prior to submittal of Contractor's final Application for Payment.

C. Construction Photography - General:
   1. Photographer Qualifications:
      a. Prior to obtaining any required construction photographic documentation, indicate to Engineer in writing the name and qualifications of the proposed photographer.
      b. Use the same photographer for the entire Project. Do not replace photographer without notifying Engineer and submitting qualifications of the proposed new photographer. Engineer may reject the qualifications of a proposed photographer.
   2. Obtain required photographic documentation using a digital camera of not less than 16 megapixel resolution.
   3. Photographs shall be digital and submitted to Engineer. Each photograph shall be JPG, TIFF, or PNG files. Each electronic file of a photograph shall be titled with the date and brief description of the view; for example: "2019-10-25 - Blower Building South Façade.jpg".
   4. All photographs shall be in color, properly lit and illuminated, and adequately framed to fully illustrate the subject of the photograph.
   5. Schedule and coordinate photographer with Engineer, RPR, and OSR, as applicable. Locations at which photographs are taken and view shall be mutually agreeable to Contractor and Engineer, RPR, or OSR as applicable.

## 1.8 ADJACENT PROPERTIES AND FACILITIES

A. Contractor shall be obtain and pay for any and all waivers or alternate arrangements necessary for transporting materials and equipment to the Site.

B. Access, Traffic Control, and Parking:
   1. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.
   2. Do not permit driving across or transporting materials or equipment across areas outside the construction limits shown on the Drawings.

3. Provide traffic control devices and personnel necessary to ensure a safe interface of construction traffic with business traffic to and from adjacent sites.
4. Provide access routes for emergency vehicles at all times.
5. Provide daily sweeping of hard-surface roadways to remove soils tracked onto roadway.
6. Provide on-site parking for all staff to limit interference with adjacent properties and businesses.

C. Work at the existing water treatment plant:
   1. CONTRACTOR must coordinate excavation activities associated with the raw water pipeline bypassing the existing plant to ensure chemical deliveries can be completed as regularly scheduled.
   2. CONTRACTOR must provide OWNER approved means of access for all vehicles that may access the Hosler Dam facilities.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

**END OF SECTION**

# SECTION 01 31 19
PROJECT MEETINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Preconstruction, progress and other project meetings.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 PRECONSTRUCTION MEETING

A. Meet with the Owner and Engineer for a pre-construction conference at a time mutually agreed upon after the contract is awarded, but before any work is performed,

B. The Engineer will schedule a meeting of the Owner, Contractor, Contractor's Subcontractors, and their respective representatives.
   1. The purpose of the meeting will be to clarify construction contract administration procedures, to establish lines of authority and communication and identify duties and responsibilities of the parties.

C. The Engineer will schedule the pre-construction conference after receipt of the Contractor's draft proposed schedule.

D. The agenda for the meeting shall cover at least the following items:
   1. Use of site and special concerns regarding adjacent properties.
   2. Organization of the Contractor's forces and personnel, including all subcontractors, and materials suppliers.
   3. Channels and procedures for communication.
   4. Contractor's construction schedule, including sequence of critical work.
   5. Contract documents, including distribution of required copies and revisions.
   6. Processing of shop drawings and other data.
   7. Processing of Requests for Information (RFI), Construction Change Directives (CCD) and Change Orders and distribution of related forms.
   8. Rules and regulations applicable to the performance of the work, such as quality control, testing and startup.
   9. Contractor's site safety and security protocols.
   10. Procedures for quality control, housekeeping and related matters.

E. The Engineer will compile meeting minutes from the transcribed record of the meeting and electronically distribute copies to all participants. Recording of meetings using AI and use of AI for meeting summary generation shall not be allowed.

F. Pre-construction conference submittals:
   1. The names and telephone numbers of Contractor's Superintendent and Office Manager.
   2. List of personnel authorized to sign change orders and receive progress payments.
   3. The name, address and telephone numbers of two or more persons employed by the Contractor who can be reached at any time of the day or night to handle emergency matters.
   4. A list of all subcontractors that will work on the project, a description of work they will perform, and a contact list for each subcontractor with phone numbers and address.
   5. A draft proposed Construction Schedule.
   6. Material Safety Data Sheets for all hazardous chemical products to be used by the Contractor on this project.
   7. Temporary Erosion and Sediment Controls Plan.

8. Traffic Control Plan.

## 1.3 PROGRESS MEETINGS

A. Weekly progress meetings will be held at a location determined by the Engineer, unless otherwise arranged.

B. Attendees will include the Owner, Engineer, Contractor, subcontractors, and suppliers' representatives as may be needed, other Contractors working at the site, and other interested or affected parties.

C. The specific purpose of the weekly meetings is to coordinate the efforts of all concerned so that the project progresses without delay to completion, with the least inconvenience.

D. Bring a three week look ahead schedule to each weekly meeting, including the following items:
   1. Work completed last week.
   2. Work anticipated for the next two weeks ("Look Ahead").
   3. Subcontractors on site the prior week.
   4. Subcontractors scheduled on site for the next two weeks.
   5. Contract document deficiencies or questions noted during prior week.
   6. Anything that could impede the progress of the work or affect the critical path on the project schedule.
   7. Corrective measures and procedures planned to regain planned schedule, cost or quality assurance, if necessary.
   8. Report of any accidents, and any site safety issues that need to be addressed.

E. Other Agenda items to be discussed:
   1. Review and revise as necessary and approve minutes of previous meetings.
   2. Status of submittals of equipment and shop drawings.
   3. Identify problems that impede planned progress.
   4. Other current business.

F. Revision of Minutes:
   1. Unless published minutes are challenged in writing prior to the next regularly scheduled progress meeting, they will be accepted as properly stating the activities and decisions of the meeting.
   2. Persons challenging published minutes shall reproduce and distribute copies of the challenge to all indicated recipients of the particular set of minutes.
   3. Challenge to minutes shall be settled as priority item of "old business" at the next regularly scheduled meeting.

G. Minutes of Meeting:
   1. The Engineer will compile minutes of each project meeting and will furnish electronic copies to the Contractor.
   2. Recording of meetings and use of AI for meeting summary generation shall not be allowed.

## 1.4 OTHER MEETINGS

A. Other meetings will be required to facilitate progress of the Work. These include, but are not limited to the following:
   1. Pre-Installation Conferences:
      a. Coordinate and schedule with Engineer for each piece of major equipment listed in Section 00 43 33.
         1) Conferences to be held prior to initiating installation, but not more than two weeks before scheduled initiation of installation.
         2) Conferences may be combined if installation schedule of multiple components occurs within the same two week interval.
         3) Review manufacturers recommendations and Contract Documents Specification Sections.
   2. Facility Startup Planning and Coordination Meeting. See Section 01 75 00.

3. Owner reserves the right to call additional meetings and require attendance of Contractor's Project Manager and other supporting staff as needed.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

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# SECTION 01 31 26
## ELECTRONIC COMMUNICATION PROTOCOLS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Procedures with which Users will comply regarding transmission or exchange of Electronic Documents for the Project.

B. Related Requirements:
   1. Refer to the General Conditions, as may be modified by the Supplementary Conditions, regarding transmitting Electronic Documents by Electronic Means.
   2. In addition to the requirements of this Specifications Section, comply with the requirements for Electronic Documents in the following Specifications:
      a. Section 01 42 00 - References.
      b. Section 01 32 16 - Construction Progress Schedule.
      c. Section 01 33 00 - Submittals.
      d. Section 01 33 04 – Operation and Maintenance Manuals.
      e. Section 01 78 39 - Project Record Documents.

### 1.2 DEFINITIONS

A. The following terms are defined for use in this Specifications Section and are indicated herein using initial capital letters. The terms have the associated meaning regardless of whether indicated in singular or plural.
   1. Electronic Documents Protocol (abbreviated as "EDP"): Procedures and requirements set forth in this Specifications Section for the exchange of Electronic Documents by Electronic Means.
   2. Project Website: An internet-based software platform, such as a website or other project management information system (PMIS) designated by Contract or mutual consent of Users as the means of exchanging Electronic Documents during the Project.
   3. System Infrastructure: Hardware, operating system(s) software, internet access, e-mail service and software, security software, and large-file transfer functions.
   4. Users: Owner, Contractor, Engineer, and others exchanging Electronic Documents on the Project in accordance with the EDP.

### 1.3 ADMINISTRATIVE REQUIREMENTS.

A. Coordination:
   1. Contractor shall require all Subcontractors and Suppliers to comply with the EDP established in the Contract Documents.

### 1.4 GENERAL PROVISIONS OF ELECTRONIC DOCUMENT PROTOCOL

A. EDP – General:
   1. To the fullest extent practical, Users agree to and will transmit and accept Electronic Documents transmitted by Electronic Means in accordance with the requirements of this Specifications Section. Use of the Electronic Documents and any information contained therein is subject to requirements of this Specifications Section and other provisions of the Contract Documents governing transmittal of Electronic Documents.
   2. Content of Electronic Documents will be the responsibility of transmitting User.
   3. Unless otherwise provided in: (1) the EDP, (2) elsewhere in the Contract Documents, or (3) or other agreement between two or more Users governing use of Electronic Documents, Electronic Documents exchanged in accordance with the Contract Documents may be used in the same manner as paper or other printed versions of the same documents exchanged

using other than Electronic Means, subject to the same governing requirements, limitations, and restrictions set forth in the Contract Documents.

4. Except as otherwise explicitly indicated in the EDP, the terms of this EDP will be incorporated into any other agreement or subcontract between a party and a third party for a portion of the Work or Project-related services, where such third party is, either directly or indirectly, required to exchange Electronic Documents with Owner, Contractor, or Engineer. Nothing in this EDP modifies the requirements of the Contract Documents regarding communications between and among Owner, Contractor, and Engineer Subcontractors, Suppliers, consultants, and others for which each is responsible.
5. When transmitting Electronic Documents, transmitting User makes no representations regarding long-term compatibility, usability, or readability of the items resulting from the receiving User's use of software applications or System Infrastructure differing from those established in this EDP.
6. This EDP does not negate or mitigate any obligation: (1) in the Contract Documents to create, provide, or maintain an original paper record version of Drawings and Specifications, signed and sealed in accordance with Laws or Regulations; (2) to comply with Laws and Regulations governing signing and sealing of design documents or signing and electronic transmission of other documents; or (3) to comply with notice requirements of the General Conditions (as. May be modified by the Supplementary Conditions).
7. Modifications to EDP:
    a. When modifications to the EDP are necessary to address issues affecting System Infrastructure, Users shall cooperatively resolve the issues.
    b. If resolution within a reasonable time is not achieved, Owner is empowered to require reasonable and necessary changes to the EDP consistent with the original intent of the EDP.
    c. If such changes result in additional cost or delay to Contractor, not reasonably anticipated under the original EDP, Contractor may seek an adjustment in the Contract Price, Contract Times, or both in accordance with the Contract Documents.

B. System Infrastructure and Systems for Exchanging Electronic Document:
1. Each User will provide System Infrastructure (as defined in this EDP) at its own cost and sufficient for complying with EDP requirements. Except for minimum standards set forth in this EDP and explicit system requirements specified by attachment to this EDP, it is the obligation of each User to determine, for itself, such User's own System Infrastructure.
    a. Maximum size of e-mail file attachment under this EDP is 25 megabytes (MB). Attachments larger than the maximum size indicated in this paragraph shall be exchanged via secure electronic transfer using method mutually acceptable to Owner, Engineer, and Contractor.
    b. Each entity transmitting or receiving Electronic Documents has full responsibility for its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, and otherwise enabling its System Infrastructure for use in accordance with this EDP.
    c. Each User will provide its own printing facilities and will be responsible for its own costs of printing Electronic Documents.
2. Each User is responsible for its own system operations, security, back-up, archiving, audits, and other technology and resources for operations of its System Infrastructure during the Project, including coordination with the User's individual(s) or subcontractor(s) responsible for managing its System Infrastructure and capable of addressing communications and other technology issues affecting exchange of Electronic Documents.
3. Security:
    a. Each User will operate and maintain industry-standard, industry-accepted, ISO standard, commercial-grade security software and systems to protect against threats including software viruses and other malicious software including worms, trojans, adware; data breaches; loss of confidentiality; and other threats in transmission to, or storage of, Electronic Documents from other Users, including transmission of

Electronic Documents by physical media including flash drives/thumb drives, hard drives, compact discs (CD), digital video discs (DVD), and other portable devices, whether connected physically or wirelessly.

b. To the extent that a User maintains and operates such security software and appropriate System Infrastructure, such User will not be liable to other Users participating in the Project for breach of system security.

4. Archiving and Electronic Document Backup:
   a. Each User is responsible for its own back-up and archive of Electronic Documents and data transmitted and received during the Project, unless this EDP establishes a Project Electronic Document archive, either as a mandatory Project Website or other communications protocol, upon which Users may rely for Electronic Document archiving for the duration of the Project Website or archiving system established in this EDP.
   b. Each User is solely responsible for its own post-Project back-up and archive of Electronic Documents after the Project is complete or after termination of the Project Website or other Project archive (as applicable), for the longer of: (1) required by the Contract Documents, (2) required by Laws and Regulations, and (3) as each User deems necessary for its purposes.
5. Receipt of Damaged, Incomplete, or Corrupt Electronic Documents: When a receiving User receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving User will advise the transmitting User of the incomplete transmission and transmitting User will retransmit the Electronic Document.
6. Completion of Transmittals: Users will bring non-conforming Electronic Documents into compliance with the EDP. Users will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the transfer of the Electronic Documents.
7. Principal means of exchanging Electronic Documents will be e-mail and files attached to e-mail, in accordance with the EDP.
8. Project Website:
   a. Contractor will establish, operate, and maintain a Project Website (as defined in this EDP) for use of Owner, Engineer, Contractor, and other Users as appropriate during the Project, for exchanging and storing Project Electronic Documents.
   b. Unless otherwise provided in the Contract Documents, use of Project Website by Owner, Contractor, and Engineer is mandatory for exchanging Project documents as set forth in the EDP.
   c. Project Website Conditions and Standards:
      1) Software Platform: As determined by Contractor and Approved by Owner and Engineer.
      2) Duration of Project Website Availability and Reliance by Users: 6 months after final payment.
   d. Address of Project Website will be furnished to Owner, and Project Website will be available to Owner, at least10 days prior to transfer of submittals.

C. General Requirements and Limitations for Software for Electronic Document Exchange:
1. Software and file formats for exchange of Electronic Documents shall be as indicated in Article 1.5 of this Specifications Section.
2. Software Versions:
   a. Each User will acquire the software and associated licenses necessary to create, transmit, receive, read, and us Electronic Documents for the Project, using the software and file formats indicate in Article 1.5 of this Specifications Section.
   b. Prior to using any updated version of the software required in the EDP for Electronic Document(s) transmitted to other User(s), the originating User will first notify and either (1) receive concurrence from receiving User(s) for use of the updated version, or (2) adjust its transmission to comply with the EDP.
3. Preservation of Intellectual Property and Confidentiality of Electronic Documents:

a. Users agree to not intentionally edit, reverse-engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes Electronic Documents, and information and data contained therein, transmitted in a file format, including portable document format (PDF), intended by transmitting User to not be modified, unless the receiving User (1) obtains permission from owner of the Electronic Document and intellectual property contained therein, or (2) is expressly allowed by the EDP to edit or modify the Electronic Document.
b. Where modifying, editing, decryption, or reverse-engineering is allowed by the EDP, such use is conferred only for the Project.
c. The EDP does not transfer any ownership or rights of any sort regarding use outside of the Project of Electronic Documents.
d. Users shall not cite or quote excerpts of Electronic Documents for purposes outside of the Project unless required to do so by Laws and Regulations.

D. Contractor's Requests for Electronic Documents in Other Formats:
1. Release of Electronic Documents in format(s) other than those indicated in in Article 1.5 of this Specifications Section and elsewhere in the Contract Documents will be at the discretion of Owner and subject to terms and conditions required by the owner of such files and documents, and the provisions indicated below.
2. To extent determined by Owner, in its sole discretion, to be appropriate, release of Electronic Documents in alternative format(s) requested by Contractor ("Request") are subject to provisions of Owner's response to the Request and to the following:
a. Contractor's Request shall be in writing. Owner and others, as appropriate, will consider and respond to Request promptly, but neither Owner nor Engineer will be responsible for any time or cost impacts on Contractor associated with timing of the Request, or with Owner's decision associated therewith.
b. When Engineer is the owner of the Electronic Documents requested by Contractor in native format, prior to Engineer transmitting such Electronic Documents to Contractor, Contractor shall sign and deliver to Engineer, without modifying or amending, Engineer's "Electronic Media Release" agreement.
c. Content included in Electronic Documents created by Engineer and furnished in response to the Request was prepared by Engineer as an internal working document for Engineer's purposes solely and, when provided to Contractor, is on an "as-is" basis without warranties of any kind, including, but not limited to any implied warranties of fitness for purpose. Contractor acknowledges that content of Electronic Documents furnished in response to the Request may not be suitable for Contractor's purpose(s), or may require substantial modification and independent verification by Contractor. Content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other shown or indicated information that may affect subsequent use by Contractor or others for whom Contractor is responsible.
d. Electronic Documents containing text, graphics, metadata, or other types of data furnished by Engineer in response to the Request are only for Contractor's convenience and any and all conclusions or information obtained or derived from such Electronic Documents will be at Contractor's sole risk and expense. Contractor waives any and all claims against Engineer, Owner, or both arising from Contractor's use of Electronic Documents furnished in response to the Request.
e. Contractor shall indemnify and hold harmless Owner, Engineer, and their respective consultants and subconsultants from any and all claims, damages, losses, and expenses, including attorneys' fees and defense costs, fees and costs of engineers, architects, geologists, accountants, and other professionals, and any and all other costs, direct and indirect, resulting from Contractor's use, adaptation, or distribution of Electronic Document(s) furnished in response to the Request.

f. Contractor shall not sell, copy, transfer, forward, give away or otherwise distribute the Electronic Documents (in source format or modified file format) to any third party without direct written authorization of Engineer or other entity that owns the Electronic document(s), unless such distribution is specifically indicated in the Request and is limited to Subcontractors and Suppliers. Contractor warrants that subsequent use by Subcontractors and Suppliers complies with terms and conditions of the Contract Documents, Owner's response to the Request, and release agreement(s) (if any) by owner of the Electronic Documents (including Engineer, where applicable).

3. When the Request is for Electronic Documents in a format not other than that indicated in the Contract Documents, and Owner (and others, as applicable) decide to comply with the Request, and when the requested Electronic Documents are not easily available in the format(s) requested, Contractor shall reimburse Owner for costs incurred by Owner, either directly or indirectly, to furnish Electronic Documents in accordance with the Request at a rate of $100 per labor-hour to furnish the requested format(s). In compensation, Owner may retain such amount(s) as set-off(s) under the Contract Documents.

## 1.5 EXCHANGE OF ELECTRONIC DOCUMENTS

A. Comply with the Electronic Document formats, transmission methods, and permitted uses set forth in Table 01 31 26-A, Exchange of Electronic Documents, below, when transmitting or using Electronic Documents on the Project. Where a row in the table has no indicated means of transmitting Electronic Documents, use for such documents only paper copies transmitted to the receiving party via appropriate delivery method.

**TABLE 01 31 26-A – EXCHANGE OF ELECTRONIC DOCUMENTS**

| Electronic Document Type | Format | Transmitting User | Transmission Method | Receiving User | Allowed Uses | Notes |
|---|---|---|---|---|---|---|
| 1.5.A.1. Project communications | | | | | | |
| General communications & correspondence | EM, PDF | O, E, C | EM, EMA | O, E, C | R | |
| Meeting notices and agendas | EM, PDF | E | EM, EMA | O, C | R | |
| Meeting minutes | PDF | E | EM, EMA | O, C | R | |
| 1.5.A.2. Contractor's Submittals to Engineer | | | | | | |
| Shop Drawings | PDF | C | EMA | E | M (1) | (1) |
| Product data Submittals, delegated design Submittals, and other action Submittals (except Samples) | PDF | C | EMA | E | M (1) | (1) |
| Informational and closeout Submittals: | PDF | C | EMA | E | M (1) | (1) (6) |
| Documentation of delivery of maintenance materials submittals | PDF | C | EMA | E | M (1) | |
| 1.5.A.3. Engineer's return of reviewed Submittals to Contractor | | | | | | |
| Shop Drawings | PDF | E | EMA | O., C | R | |
| Product data Submittals, delegated design Submittals, and other action Submittals | PDF | E | EMA | O., C | R | |
| Informational and closeout Submittals: | PDF | E | EMA | O., C | R | (6) |
| Documentation of delivery of maintenance materials submittals | PDF | E | EMA | O. C | R | |

| Electronic Document Type | Format | Transmitting User | Transmission Method | Receiving User | Allowed Uses | Notes |
|---|---|---|---|---|---|---|
| 1.5.A.4. Contract Modifications Documents | | | | | | |
| Requests for interpretation to Engineer | PDF | C, O | EMA | E | M (1) | (1) |
| Engineer's interpretations (RFI responses) | PDF | E | EMA | C, O | R | |
| Engineer's clarifications to Contractor | EM, PDF | E | EM, EMA | C, O | R | |
| Engineer's issuance of Field Orders | PDF | E | EMA | C, O | R | |
| Proposal Requests | PDF | E, O | EMA | C | R | |
| Change Proposals – submitted to Engineer | PDF | C | EMA | O, E | S | |
| Change Proposals – Engineer's response | PDF | E | EMA | C, O | | |
| Work Change Directives (for Contractor signature) | PDF | E | EMA | C | R | (2) |
| Change Orders (for Contractor signature) | PDF | E | EMA | C | R | (2) |
| 1.5.A.5. Applications for Payment | | | | | | (3) |
| 1.5.A.6. Claims and other notices | | | | | | (4) |
| 1.5.A.7. Closeout Documents | | | | | | |
| Record drawings | DWG and PDF | C | EMA | E, O | M (5) | (5) |
| Other record documents | PDF | C | EMA | E, O | M (5) | (5) |
| Contract closeout documents | | | | | | |

1. Key to Table 01 31 26-A:
   a. Data Format:
      1) EM: .msg, .htm, .txt, .rtf, e-mail text.
      2) W: .docx, Microsoft Word 2013 or later.
      3) EX: .xlsx, Microsoft Excel 2013 or later.
      4) PDF: .pdf. portable document format.
      5) DWG: .dwg. Autodesk AutoCAD 2014 drawing.
   b. Transmitting User:
      1) O: Owner.
      2) C: Contractor.
      3) E: Engineer.
   c. Transmission Method:
      1) EM: Via e-mail.
      2) EMA: Attachment to e-mail transmission.
      3) PORT: Delivered via portable media such as flash drive/thumb drive, CD, or DVD
      4) PW: Posted to Project Website.
      5) FTP: FTP transfer to receiving FTP server.
   d. Receiving User:
      1) O: Owner.
      2) C: Contractor.
      3) E: Engineer.

e. Permitted Uses:
   1) S: Store and view only.
   2) R: Reproduce and distribute.
   3) I: Integrate (incorporate additional electronic data without modifying data received)
   4) M: Modify as required to fulfill obligations for the Project.

f. Notes:
   1) Modifications by Engineer to Contractor's Submittals and requests for interpretations are limited to marking-up and adding comment sheets.
   2) May be distributed only to affected Subcontractors and Suppliers. Sign document with electronic signature and return originals to Engineer.
   3) Submit Applications for Payment with electronic signatures.
   4) Submit notices, including Claims, in accordance with the notice provisions of the General Conditions, as may be modified by the Supplementary Conditions.
   5) Submit record drawings in native CAD format indicated when Contractor has signed Engineer's standard agreement for release of electronic media. In addition, always submit record drawings as PDF files. Comply with Contract Documents requirements for Project record documents.
   6) For operation and maintenance data, also submit paper copies as required by Section 01 33 04 - Operations and Maintenance Manuals.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

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# SECTION 01 32 16
## CONSTRUCTION PROGRESS SCHEDULE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Specific requirements for the preparation, submittal, updating, and status reporting of the construction Progress Schedule.

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

C. Review of the CPM Schedule:
   1. In so far as the Contractor is solely responsible for its means and methods and the CPM schedule represents in part its means and methods, the review of the CPM schedules (preliminary, baseline, updates, revisions, etc.) is for compliance with the requirements as defined in the contract documents.
   2. The review of the CPM schedule is not intended to be complete or exhaustive or check every activity and its relation to the work.
   3. The Engineer will provide comments on the CPM schedule compliance with those contract requirements and anomalies that might appear to the Engineer.
   4. If the Contractor fails to include contract requirements (e.g. specified cure times, commissioning periods) in the CPM schedule, or the Engineer fails to notify the Contractor of anomalies the Contractor is not relieved of the contract requirements.
   5. Acceptance of the CPM schedule does not imply that the Owner has approved or accepted the Contractor's means and methods or sequence for performing the work to construct the project.
   6. If the Contractor has questions or concerns about comments, the Contractor and Engineer shall meet to resolve those issues prior to issuance of future updates or revisions.

### 1.2 QUALITY ASSURANCE

A. The person preparing, updating and revising the construction Progress Schedule shall be experienced in the preparation of schedules of similar complexity.

B. Project Scheduler Qualifications:
   1. Minimum five years of relevant experience in construction, planning, scheduling, expediting and tracking the progress of the work for projects of a similar nature, size, and complexity.
   2. Adhere to all requirements of this schedule specification, participate in all job progress review/update meetings, and other requested meetings regarding the project schedules.
   3. If the Engineer notifies the Contractor that the scheduler does not meets the minimum requirements, provide the qualifications of another scheduler that meets the requirements.
   4. If the Contractor changes schedulers after the Engineer determines the scheduler meets these requirements, follow this same process outlined above to substitute schedulers.

### 1.3 DEFINITIONS

A. The following definitions shall apply to this Specification Section:
   1. Preliminary Schedule: Establishes the Contractor's plans to execute the first actions associated with the project and to establish a tool by which the progress of the project can be monitored during the period when the baseline project schedule is being developed. The Preliminary Schedule shall include a detailed plan for the first 90 days of the project and summary activities of the work to achieve the Substantial Completion Date, Final Acceptance Date, and any project Milestones defined in the Contract Documents.

2. Baseline Schedule: Establishes the Contractor's plans to execute the project. The Baseline Schedule shall include preconstruction activities, submittals, Engineer's reviews, fabrication, and delivery; construction activities with durations not to exceed 20 days and whose progress can be reasonably measured; Milestones, and constraints defined in the Contract Documents; post construction activities, O&M Manual production, testing, commissioning, and project closeout.
3. Schedule Update: The initially accepted Baseline Schedule, or subsequently approved Revised Baseline Schedules, updated each month to reflect actual start and finish dates of each schedule activity and the remaining duration of activities that began during the period.
4. Current Schedule: The current schedule is either the Baseline Schedule or Revised Baseline Schedule including and incorporating Schedule Updates.
5. Revised Schedule: Updated schedule that include changes agreed on by the Engineer and the Contractor. The Revised Schedule shall be developed after the Schedule Update is completed. The Revised Schedule will become the Current Schedule that will subsequently be utilized for Schedule Updates.
6. Recovery Schedule: A Recovery Schedule shall be prepared when the Current Schedule forecasts the Work completing at least 10 working days or more in meeting a contract milestone or the contract completion date. The Recovery Schedule shall show how the Contractor intends to complete the Work within the Contract Time. Do not incorporate unapproved changes in the Recovery Schedule.
7. Short Interval Schedule: A schedule prepared by the Contractor reflecting the work planned for the current and subsequent two weeks and the work completed in the week prior to the current week. This is also known as a Look-Ahead Schedule.
8. Resources: Hours for each worker on the project, materials, and permanent equipment incorporated into the work, construction equipment, or budgeted dollars.
9. Time Impact Analysis (TIA): A schedule used to quantify the effects of an unplanned event which can have an impact on the work scope and Contract Time.

## 1.4 SUBMITTALS

A. Project Schedule Preparation:
   1. Within five days from Execution of the Contract, Submit a statement of qualifications for the person responsible for the preparation, maintenance, updating and revision of all schedules. The statement of qualifications shall demonstrate that the scheduler meets the minimum qualifications for a scheduler outlined herein.

B. Preliminary Schedule:
   1. Submittal and review:
      a. Submit within 10 calendar days after the Effective Date of the Contract.
      b. The Engineer will review and provide comments to the Contractor within 10 working days after receipt of the schedule.
      c. The Contractor will review and modify the Preliminary Schedule and return the schedule within five working days. If there are concerns about the comments provided, the Engineer and Contractor will meet to review and resolve those concerns.
   2. Submittal package:
      a. CPM time-scaled network diagram in PDF.
      b. Tabular Report.
      c. Preliminary Schedule Report.
      d. Electronic Data Files: The Contractor with provide the Engineer with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

C. Baseline Schedule and Narrative Report:
   1. Submittal and review:
      a. Submit within 30 days after Effective Date of the Contract or Notice to Proceed, whichever is earlier.

b. The Engineer shall review the Baseline Schedule and provide comments to the Contractor within 10 working days after receipt of the schedule.
c. After receiving comments, the Contractor and Engineer shall meet to review the comments within five working days.
d. After the meeting, the Contractor will modify the schedule as agreed and resubmit the Baseline Schedule within five working days.
e. After the Engineer confirms that the Contractor has made the changes as agreed, the schedule will become the Baseline Schedule.

2. Submittal package:
   a. As listed in 1.4 B. above.

D. Schedule Updates:
1. Submittal and Review:
   a. Provide Schedule Updates five days after the last working day of the month as agreed to with the Engineer.
   b. If the Engineer identifies anomalies the Engineer shall provide comments to the Contractor on the Schedule Update.
   c. Unless directed by the Owner to resubmit the schedule update within five working days, incorporate the Engineer comments into the next Schedule Update.
   d. Do not include any changes to the existing logic, activity durations, add new activities, or delete activities within the Monthly update during the monthly updating process. Should the Contractor wish to make any changes to the existing logic, activity durations, add new activities, or delete activities, the proposed changes to the schedule will be submitted to the Engineer for review. If the Engineer determines the change(s) are not consistence with the contract document, the Engineer shall notify the Contractor of its determination and maintain the current schedule. If the Engineer determines the changes are consistent with the contract document, the changes can be put into the current update following the procedures described below under Sections F below.
2. Submittal Package:
   a. As listed in 1.4 B. above.

E. Revised Schedule:
1. Submittal and Review:
   a. Provide a Revised Baseline Schedule to reflect approved Change Orders as requested by the Engineer.
   b. Submit 10 working days after the Updated Schedule.
   c. Activities will be added or the durations modified to reflect the work approved in change orders.
   d. The Engineer will review and provide comments to the Contractor on the Revised Baseline Schedule within five working days.
   e. Incorporate the Engineer comments into the Revised Baseline Schedule.
   f. After acceptance by the Engineer the Revised Baseline Schedule, use for future Schedule Updates.
2. Submittal Package:
   a. As listed in 1.4 B. above.

F. Recovery Schedule:
1. Unless otherwise directed in writing by the Engineer, when the activities on the critical path or the completion milestones appear to be beyond the contract time, provide a Recovery Schedule demonstrating how the Contractor will recover the lost time so that the Work will be completed within the Contract Time.
   a. Do not incorporate unapproved changes in the Recovery Schedule.
   b. The Contractor's refusal, failure or neglect to take appropriate recovery action or to submit a written recovery statement shall constitute reasonable evidence that the Contractor is not prosecuting the Work, or separable part, with the diligence that will insure its completion within the applicable Contract Time and shall constitute sufficient

basis for the Engineer to recommend to withhold any payment or portion thereof otherwise due, or identify and order alternate recovery actions on the basis of the information in the Contract Schedule.

2. Submittal and Review.
   a. Provide the Recovery schedule within 10 working days after requested by the Engineer.
   b. Activities will be added or the durations modified to reflect the changes to the work.
   c. The Engineer will review and provide comments to the Contractor on the Recovery Schedule within five working days.
   d. The Contractor will incorporate the Engineer comments into the Recovery Schedule.
   e. The Recovery Schedule shall be used for subsequent Schedule Updates.
3. Submittal Package:
   a. As listed in 1.4 B. above.

G. Short Interval Schedule:
1. Submittal and Review:
   a. Provide a two week rolling look-ahead Short Interval Schedule each week during the Contract Time by Friday noon prior to the first working day of the schedule.
   b. If the Engineer provides comments, the Contractor will revise and resubmit the schedule.

## 1.5 SCHEDULE REQUIREMENTS

A. General:
1. The above listed project schedules shall be used for evaluating all issues related to time for this Contract. The Project Schedules shall be updated in accordance with the requirements of this Specification to reflect the actual progress of the Work and the Contractor's current plan for the timely completion of the Work. The Project Schedules shall be used by the Engineer and Contractor for the following purposes as well as any other purpose where the issue of time is relevant:
   a. To communicate to the Engineer the Contractor's current plan for carrying out the Work.
   b. To identify work paths that are critical to the timely completion of the Work.
   c. To identify upcoming activities on the critical path(s).
   d. To evaluate the best course of action for mitigating the impact of unforeseen events.
   e. As the basis of progress payments to the Contractor.
   f. As the basis for analyzing the time impact of changes in the Work.
   g. As a reference in determining the cost associated with increases or decreases in the Work.
   h. To prioritize the Engineer's review of submittals.
   i. To document the actual progress of the Work.
   j. To evaluate resource requirements of the Contractor and the Engineer.
   k. To integrate the Work with the operational requirements of the Owner's facilities.
   l. To facilitate efforts to complete the Work in a timely manner.
2. The Project Schedules provide a basis for Owner decisions that may impact the Work under this Contract, as well as other concurrent or future Work. As such, the Contractor understands that time is of the essence in the performance of all Work under this Contract including but not limited to providing the necessary schedule information required by this Specification.
   a. The project schedules shall at all times accurately reflect the Contractor's current plan for the Work and shall be updated as required by this Specification.
   b. This Specification requires the Contractor to submit the Project Schedules in a specific format. Failure to meet the full requirements of this Specification will adversely affect the Owner and Engineer's ability to administer this and other Contracts.
   c. Be responsible for all impacts to the Work on this Contract as well as the Work on other Contracts and any cost incurred resulting from the Contractor's failure to meet the requirements of this Specification.

d. The monthly accepted Schedule Update, showing updated activities and status in accordance with the requirements of this Section shall be a condition precedent to the start of the progress payment cycle.

B. Schedule Detail:
   1. The CPM Schedule shall contain sufficient pre-construction, construction, and testing & commissioning and closeout activities to represent the Work, with a means to monitor and follow progress of all phases of Work; comply with limits imposed by the scope of Work, with contractually specified interim milestones and completion dates; and with constraints, restraints, or sequences included in the Contract. The CPM Schedules shall include, but are not limited to the following:
      a. Include a well-defined activity coding structure that allows Project activities to be sorted by type of Work, location of Work, work breakdown structure (WBS), or as mutually agreed to by the Contractor and the A/E, Owner, CM. Activity coding shall be assigned consistently and uniformly among all similar activity types.
      b. Activities will be sorted by milestones, area, trades, and subcontractors as agreed on with the A/E, Owner, CM.
      c. Construction start dates (Award date, Notice(s) to Proceed date).
      d. Preparation of submittals, submittal reviews and approvals, manufacture, tests, delivery, installation activities, critical materials and equipment shall be represented in the CPM Schedule. Description of the activity shall include sufficient detail to identify the unique scope of that activity.
      e. Materials and Equipment Procurement: Include the following activity sequence for critical and long lead materials and equipment procurement or any activity that may be requested by the A/E, Owner, CM:
         1) Submittal Preparation.
         2) Review and Approval.
         3) Fabricate and Deliver.
      f. If the contract permits and the Contractor plans to request payment for materials and/or equipment prior to installation, a separate activity shall be included in the CPM schedule for each item for which the Contractor plans to request payment. This section does not supersede or take precedence over any other contract provision regarding such payment.
      g. The CPM schedule shall include required review times for any Submittals and Approvals by regulatory agencies or other Parties as defined in the contract.
      h. Milestones or access restraints for completion of certain portions of the Work or access and availability to Work areas.
      i. Identification of interfaces and dependencies with preceding, concurrent, and follow-on Contractors, other agencies and utilities, typically shown as milestone type of activities.
      j. Other activities can include shutdowns, utility tie-ins, plant tie-ins, traffic changes and closings, inspections and hold points, receipt of operations and maintenance (O&M) manuals, start-up of equipment, testing of equipment and systems, and commissioning.
      k. Water curing of concrete after placement for all structures.
      l. Planning for phased or total handover to the Owner.
      m. Cost Loading: Allocation of the monetary value for each activity in the CPM Schedule. The sum of all values shall match the total Contract value. The A/E, Owner, CM reserves the right to accept or reject any value and allocation to the activity.
      n. Identification of manpower by trade, material, or equipment restrictions, as well as any activity requiring unusual shift work, such as two shifts, six day weeks, specified overtime, or work at times other than regular days or hours.
      o. Resource Loading: Resource allocation for each activity in the CPM Schedule identifying the hours by trade, the physical quantity of material to be installed (Cubic yards of concrete, linear feet of pipe, etc.). The A/E, Owner, CM reserves the right to accept or reject any value and allocation of the man-hours and/or the materials. The unit of measure shall be reviewed and approved by the A/E, Owner, CM.

2. Calendars:
    a. Develop activity calendars commensurate with the Contractor's workweek plan. Calendars shall include all non-working days, such as weekends, holidays, or other periods when the Contractor plans not to work. Calendar(s) shall be reviewed and accepted by the A/E, Owner, CM as part of the CPM schedule submittal and will be monitored using the most updated schedule.
    b. The planning unit for the Contract shall be days;
    c. Calendars shall contain all Owner holidays;
    d. Every activity shall be assigned a calendar that takes into account when the activity is planned to occur and/or when it is contractually permitted to occur.
    e. Contract times are expressed in calendar days, the CPM Schedule shall be calculated in working days.
3. Logic and Durations:
    a. Logic and activity durations shall be established by the Contractor consistent with the Contract requirements and shall reflect coordination between trades, definitive resource planning and on-site work conditions.
    b. Logic shall show how the start of a given activity is dependent on the completion of preceding activities, and its completion restricts the start of following activities. Except for fabrication activities shall not have duration greater than 20 working days.
    c. Except the first activity and completion milestone(s), each activity on the CPM schedule shall have a predecessor and successor activity.
    d. Preferential Logic sequencing shall not be allowed in the schedule.
4. Restraints, Constraints and Milestones:
    a. The start date of the CPM Schedule shall be the Contract Notice to Proceed.
    b. The completion date of the CPM Schedule shall be the Contract Final Completion date.
    c. All intermediate restraints and milestones required in the Contract shall be shown in proper logical sequence and properly constrained.
    d. The CPM Schedule shall include all Work constraints indicated in the Contract or as added with a Contract modification. Other activity Constraints shall not be used unless approved by the A/E, Owner, CM.
5. Schedule Dates: Whenever the term "schedule" or "scheduled date" is used, it shall mean the "early start" and "early finish" dates in the CPM Schedule. The "late" dates are for purposes of calculating float and do not represent the schedule dates.
6. Activity Descriptions:
    a. Activities shall be described such that the Work is readily identifiable for assessment of start and completion, as well as intermediate status.
    b. Descriptions shall utilize identifiers for physical locations such as column lines, stations, and elevations where possible to define the Work.
    c. The activity description shall identify the scope of the activity.
    d. There shall not be any two activities with the same activity description. If the Contractor wants to change the description of an activity, it will delete the activity and then add a new one with the new activity description.

C. Float:
1. The total float of an activity is the maximum time that its actual completion date can extend beyond its early finish date and not affect the Contract Time.
2. Float is not for exclusive use or benefit of either the Owner, Engineer, or the Contractor but is an expiring resource available to both parties. Float is used by any party, as needed, to meet the contract milestones and the contract completion dates, or to cover changes to the Contract. However the Contractor is expected to execute the work according to the Early Dates of the schedule.
3. Float Suppression: Pursuant to float sharing requirements of this Section, use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity durations are prohibited. Approval of any Schedule

Submission by the A/E, Owner, CM shall not preclude later correction of float suppression techniques or of any other deficiency by the A/E, Owner, CM.

4. Early Completion Schedule: Recognizing that the Owner developed the project duration based on its needs and resources, if the Contractor proposes an early completion schedule, such schedule shall be subject to the acceptance of the A/E, Owner, CM. Any time between the early completion of a contract milestone, including substantial completion, schedule proposed by the Contractor and that contract milestone will be considered float.

D. CPM Time-Scaled Network Diagram:
   1. A printed logic diagram and PDF that include the following information:
      a. Unique activity number/identifier; numeric, alpha or combination of numeric/alpha.
      b. Activity description.
      c. Activity duration.
      d. Early start and early finish for each activity.
      e. Late start and late finish for each activity.
      f. Total float (TF) for each activity.
      g. Bar showing the early start and completion dates of each activity.
      h. The activities will be sorted by area, trades, and subcontractors as agreed on with the A/E, Owner, CM.
      i. Print the CPM time-scaled network diagram on minimum sheet size of 11 IN x 17 IN.
      j. Provide electronic data in accordance with the Early Completion paragraph in the GENERAL REQUIREMENTS Article.

E. Tabular Reports:
   1. Provide a Tabular Report with each schedule submittal that includes the following information;
      a. Activity number/identifier.
      b. Activity description.
      c. Activity duration.
      d. Early start and early finish for each activity.
      e. Late start and late finish for each activity.
      f. Total float (TF) for each activity.
      g. Predecessor activities.
      h. Successor activities.
      i. Cost/budget to perform the work in the activity.
      j. Resources needed to perform the activity.

F. Schedule Reports: Provide reports with each of the schedule submittals. As a minimum, the reports shall contain the following information:
   1. Preliminary Schedule Report.
      a. Executive Summary explaining how the Contractor plans to execute its plan to construct the project.
      b. Critical activities needed to start construction.
      c. Description of what the Contractor sees as the critical activities.
      d. Constraints that will be included the schedule.
   2. Baseline Schedule Report.
      a. Executive Summary explaining how the Contractor plans to execute its plan to construct the project.
      b. Assumptions used to develop the schedule.
      c. Constraints included in the schedule as defined by the Contract Documents.
      d. The critical path and near critical path activities with an explanation of why those activities are included on those paths.
      e. Number of planned working days per week including shifts per day.
      f. Manpower plan including craft on site per day.
      g. Production rates assumptions.
      h. Major equipment planned for the project and durations for their use.

i. Resource constraints.
j. Identification of unusual conditions or restrictions regarding labor, equipment or material.
k. Calendar(s) used in the contract and how the multiple calendars are used.
l. Holidays observed during construction.

3. Schedule Updates Progress Reports:
   a. Provide a report with each Schedule Update detailing the work completed during the month, any changes to the schedule logic, any changes to activity durations, any changes to the critical path, and any changes to its assumptions for constructing the Work, including assumed constraints included in the schedule as defined by the Contract Documents, permits, or the Contractor.
   b. Identify the current critical path activities.
   c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.
4. Revised Schedule Report:
   a. Provide a report with each Revised Schedule detailing the work completed during the month, any changes to the schedule logic, any changes to activity durations, any changes to the critical path, and any changes to its assumptions for constructing the Work, including assumed constraints included in the schedule as defined by the Contract Documents, permits, or the Contractor.
   b. Identify the current critical path activities.
   c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.
5. Recovery Schedule Report:
   a. Provide a report with an explanation of the changes in logic and/or activity durations.
   b. Identify the current critical path activities.
   c. Indicate reasons the Contractor made the changes to logic, durations, activities, and/or the critical path.

G. Electronic Data Files:
   1. The Contractor with provide the A/E, Owner, CM with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.

H. Weather delays:
   1. Include an activity on the critical path of the schedule with a duration of five working days per year for delays due to adverse weather on the project. When the A/E, Owner, CM and Contractor agree that a weather day affects the work, it will reduce the remaining duration of the weather day activity by the agreed on weather days.
      a. Adverse weather is considered when the temperature and/or precipitation exceeds the average temperature, precipitation and/or other weather event by 15 PCT as measured by the National Oceanic and Atmospheric Administration (NOAA) at the closest weather station to the project site and the adverse weather impacts the Contractor's delivery of material, availability of labor, or production of work. If the adverse weather does not affect delivery of material, availability of labor, or production of work, then it will not be considered adverse weather.
      b. The adverse weather must effect the work on the critical path at the time the adverse weather occurs.
      c. Any time not used in a calendar year may be carried over to the next year or considered float.

I. CPM Scheduling Software:
   1. Unless otherwise agreed to with the A/E, Owner, CM, use the latest version of Oracle Primavera P6 to develop and maintain the schedules listed above for this project.

1) Provide data files that can be read using the latest version of Oracle Primavera P6. Do not employ any methods for locking data or preventing the A/E, CM. Owner from reading the data using the latest version of Oracle Primavera P6.

2. If the Contractor proposes to use a different scheduling software package for this project, provide up to three licenses for the software to the Owner and A/E, CM and provide on-going training on the use of that software.

## 1.6 START-UP, DEMONSTRATION, TRAINING, AND FINAL COMPLETION

A. The Baseline Schedule must include broad-based activities for start-up, operator training, and final completion.
   1. The Baseline Schedule may not necessarily contain sufficient detail on all activities listed in Specification Section 01 75 00 for start-up and demonstration.
   2. At least 90 days prior to any activities, submit a detailed schedule in conformance with the requirements of Specification Section 01 75 00:
      a. Identify task for the substantial completion notification.
      b. Pre-demonstration period:
         1) Identify equipment start-up for all major equipment.
      c. Identify all operator trainings required by individual Specification Sections.
      d. Complete submission of all required submittals.
      e. Demonstration period: Identify for each project classified system.

## 1.7 TIME IMPACT ANALYSIS (TIA)

A. Provide a TIA to support all requests for increases to the Contract Time.

B. Use the Current Schedule to develop the TIA.
   1. The TIA must be attached to any change order proposal prior to approval of any change to time or cost when requesting additional time.
   2. Submit a written narrative report to the A/E, Owner, CM with each request for adjustment to the Contract Time, or when Contractor or A/E, Owner, CM consider that an approved or anticipated change may impact the critical path or progress of the work.
      a. Include a description of delaying factors and their impact with an explanation of corrective actions taken or proposed.
      b. The TIA shall illustrate the impacts of each change or delay on the current scheduled completion date or internal milestone, as appropriate.
      c. The analysis shall start by using the schedule that has a data date closest to and prior to the event or change.
      d. The analysis shall identify the activities on the critical path prior to the event or change, the activities added or extended as a result of the event or change, and the impact of those changes on the critical path activities.
      e. The analysis shall identify the impacts that the Contractor attributed to the change or Owner, those impacts that are the result of the Contractor's actions and those impacts that are considered concurrent.
      f. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the accepted CPM Schedule, the difference between scheduled completion dates of the two schedules shall be equal to the adjustment of Contract Time.

C. Submit a TIA within 15 working days of receiving a written request for a TIA from the A/E, Owner, CM or after the event.
   1. Allow the A/E, Owner, CM 30 days after receipt to approve or reject the submitted TIA.
   2. All approved TIA schedule changes shall be shown on the next Schedule Update.

D. Rejections of a TIA:
   1. If a TIA submitted by the Contractor is rejected by the A/E, Owner, CM, meet with the A/E, Owner, CM to discuss and resolve issues related to the TIA.

2. If agreement is not reached, the Contractor will be allowed 10 working days from the meeting with the A/E, Owner, CM to give notice.
3. The A/E, Owner, CM will withhold a portion of the progress payment if a TIA is requested by A/E, Owner, CM and not submitted by Contractor within 15 working days.
4. The payment will resume on the next estimate after the requested TIA is submitted and accepted by the A/E, Owner, CM.

E. Any delay by the Contractor that is in parallel with another delay not caused by the Contractor shall be considered a concurrent delay for which the Contractor will not be entitled to impactable/compensable time regardless if on the critical path or not.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

# SECTION 01 33 00
SUBMITTALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Mechanics and administration of the submittal process for:
      a. Shop Drawings.
      b. Samples.
      c. Informational submittals.
   2. General content requirements for Shop Drawings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Construction Progress Schedule submittal requirements are specified in Specification Section 01 32 16.
   4. Operations and Maintenance Manual submittal requirements are specified in Specification Section 01 33 04.
   5. Technical Specification Sections identifying required submittals.

### 1.2 DEFINITIONS

A. Action Submittals:
   1. Action Submittals require an explicit, written approval or other appropriate action by Engineer before Contractor may release the associated item(s) for raw materials procurement, fabrication, production, and shipment.
   2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
      a. Shop Drawings.
      b. Product data.
      c. Samples.
      d. Testing plans for quality control activities required by the Contract Documents.
      e. Delegated Designs: Design drawings, design specifications, calculations, reports, and other instruments of service sealed and signed by design professional retained by Contractor, Subcontractor, or Supplier for a portion of the completed Work as part of the completed Project. Engineer's approval or other appropriate action on such delegated design Submittals will be only for the limited purposes set forth in the General Conditions.

B. Informational Submittals:
   1. Informational Submittals are Submittals, other than Action Submittals, required by the Contract Documents. Explicit response from Engineer is not required when such Submittal is acceptable and Engineer's acceptance thereof will be indicated in the Engineer's Submittals log. When Informational Submittal does not indicate full compliance with the Contract Documents, Engineer will indicate the non-compliance in a written response to Contractor.
   2. Representative types of informational submittal items include but are not limited to:
      a. HVAC test and balance reports.
      b. Installed equipment and systems performance test reports.
      c. Manufacturer's installation certification letters.
      d. Instrumentation and control commissioning reports.
      e. Warranties.
      f. Service agreements.

g. Construction photographs.
h. Survey data.
i. Work plans.
j. Shop Drawings, product data, Samples, and testing plans, submitted as a requirement of for delegated designs, bearing the Submittal approval stamp of associated design professional retained by Contractor, Subcontractor, or Supplier.

3. For-Information-Only submittals upon which the Engineer is not expected to conduct review or take responsive action may be so identified in the Contract Documents.

## 1.3 SUBMITTAL SCHEDULE

A. Schedule of Shop Drawings:
1. Submitted and approved within 20 days of receipt of Notice to Proceed.
2. Account for multiple transmittals under any specification section where partial submittals will be transmitted.

B. Shop Drawings: Submittal and approval prior to 30 PCT completion of project.

C. Informational Submittals:
1. Reports and installation certifications submitted within seven days of conducting testing, installation, or examination.
2. Submittals showing compliance with required qualifications submitted 20 days prior to any work beginning using the subject qualifications.

D. The submittal schedule shall include the following columns as a minimum:

| Submittal Section | Submittal Description | Planned Submittal Date | Submittal Need Date | Actual Submittal Date | Actual Return Date | Disposition |
|---|---|---|---|---|---|---|
| | | | | | | |

## 1.4 PREPARATION OF SUBMITTALS

A. General:
1. All submittals and all pages of all copies of a submittal shall be completely legible.
2. Submittals which, in the Engineer's sole opinion, are illegible will be returned without review.
3. Minimize extraneous information for equipment and products not relevant to the submittal.
4. Contractors or vendors written comments on the submittal drawings shall be in green

B. Shop Drawings, Product Data, and Samples:
1. Scope of any submittal and letter of transmittal:
a. Limited to one Specification Section.
b. Submittals with more than one Specification section included will be rejected.
c. Do not submit under any Specification Section entitled (in part) "Basic Requirements" unless the product or material submitted is specified, in total, in a "Basic Requirements" Specification Section.
2. Numbering letter of transmittal:
a. Include as prefix the Specification Section number followed by a series number, "-xx", beginning with "01" and increasing sequentially with each additional transmittal for that Specification Section.
b. If more than one submittal under any Specification Section, assign consecutive series numbers to subsequent transmittal letters.
3. Describing transmittal contents:
a. Provide listing of each component or item in submittal capable of receiving an independent review action.
b. Identify for each item:

1) Manufacturer and Manufacturer's Drawing or data number.
2) Contract Document tag number(s).
3) Unique page numbers for each page of each separate item.

c. When submitting "or-equal" items that are not the products of named manufacturers, include the words "or-equal" in the item description.

4. Contractor certification of review and approval:
   a. Contractor's review and approval certification stamp shall be applied either to the letter of transmittal or a separate sheet preceding each independent item in the submittal.
      1) Stamp shall be electronically embedded.
      2) Clearly identify the person who reviewed the submittal and the date it was reviewed.
      3) Shop Drawing submittal stamp shall read "(Contractor's Name) has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval as stipulated in the General Conditions."

OR

   b. Execute Exhibit AA, Contractor's Submittal Certification form, to indicate Contractor has reviewed and approved the submittal contents.
      1) Clearly identify the person who reviewed the submittal and the date it was reviewed."
   c. Submittals containing multiple independent items shall be prepared with each item listed on the letter of transmittal or on an index sheet for all items listing the discrete page numbers for each page of each item, which shall include Contractor's review and approval stamp.
      1) Each independent item shall have a cover sheet with the transmittal number and item number recorded.
         a) Provide clear space of 3 IN SQ for Engineer stamping.
      2) Individual pages or sheets of independent items shall be numbered in a manner that permits the entire contents of a particular item to be readily recognized and associated with Contractor's certification.
5. Resubmittals:
   a. Number with original Specification Section and series number with a suffix letter starting with "A" on a (new) duplicate transmittal form.
   b. Do not increase the scope of any prior transmittal.
   c. Provide cover letter indicating how each "B", "C", or "D" Action from previous submittal was addressed and where the correction is found in the resubmittal.
   d. Account for all components of prior transmittal.
      1) If items in prior transmittal received "A" or "B" Action code, list them and indicate "A" or "B" as appropriate.
         a) Do not include submittal information for items listed with prior "A" or "B" Action in resubmittal.
      2) Indicate "Outstanding-To Be Resubmitted At a Later Date" for any prior "C" or "D" Action item not included in resubmittal.
         a) Obtain Engineer's approval to exclude items.
6. Do not use red color for marks on transmittals.
   a. Duplicate all marks on all copies transmitted, and ensure marks are photocopy reproducible.
   b. Engineer will use red marks or enclose marks in a cloud.
7. Transmittal contents:
   a. Coordinate and identify Shop Drawing contents so that all items can be easily verified by the Engineer.
   b. Provide submittal information or marks defining specific equipment or materials utilized on the Project.
      1) Generalized product information, not clearly defining specific equipment or materials to be provided, will be rejected.

c. Identify equipment or material project use, tag number, Drawing detail reference, weight, and other Project specific information.
d. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
e. Do not modify the manufacturer's documentation or data except as specified herein.
f. Submit items such as equipment brochures, cuts of fixtures, product data sheets or catalog sheets not exceeding 11 x 17 IN pages.
    1) Indicate exact item or model and all options proposed by arrow and leader.
g. When a Shop Drawing submittal is called for in any Specification Section, include as appropriate, scaled details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout Drawings, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data in addition to information specifically stipulated in the Specification Section.
    1) Arrange data and performance information in format similar to that provided in Contract Documents.
    2) Provide, at minimum, the detail specified in the Contract Documents.
h. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

8. Samples:
    a. Identification:
        1) Identify sample as to transmittal number, manufacturer, item, use, type, project designation, tag number, Specification Section or Drawing detail reference, color, range, texture, finish and other pertinent data.
        2) If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
    b. Include application specific brochures, and installation instructions.
    c. Provide Contractor's review and approval certification stamp or Contractor's Submittal Certification form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
    d. Resubmit revised samples of rejected items.

C. Informational Submittals:
    1. Prepare in the format and detail specified in Specification requiring the informational submittal.

## 1.5 TRANSMITTAL OF SUBMITTALS

A. Shop Drawings and Samples:
    1. Transmit all submittals to:

HDR
1050 SW 6th Avenue, Suite 1800
Portland, OR 97204
Attn: Pierre Kwan

    2. Utilize attached Exhibit A to transmit all Shop Drawings and samples.
    3. All submittals must be from Contractor.
        a. Submittals will not be received from or returned to subcontractors.

B. Informational Submittals:
   1. Transmit under Contractor's standard letter of transmittal or letterhead.
   2. Submit as specified in individual Specification Section.
   3. Transmit to:

      HDR
      1050 SW 6th Avenue, Suite 1800
      Portland, OR 97204
      Attn: Pierre Kwan

C. Electronic Transmission of Submittals:
   1. Transmittals shall be made electronically.
      a. Use email for transmittal.
      b. Protocols and processes will be determined at the Pre-Construction Conference.
   2. Provide documents in Portable Document Format (PDF).
   3. Do not password protect or lock the PDF document.
   4. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
      a. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 DPI or greater.
      b. Required signatures may be applied prior to scanning for transmittal.
   5. Electronic drawings shall be formatted to be at full-scale (or half-scale when printed to 11x17).
      a. Do not reduce drawings by more than 50 PCT in size.
      b. Reduced drawings shall be clearly marked "HALF-SIZE" and shall scale accurately at that size.
   6. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
   7. Create bookmarks in the bookmarks panel for the cover, the Table of Contents, and each major section of the document.
   8. File naming conventions:
      a. File names shall use the convention (XXXXXX-YY-Z.PDF) where XXXXXX is the Specification Section number, YY is the Shop Drawing number and Z is an ID number used to designate the associated volume.
   9. Labeling:
      a. As a minimum, include the following labeling on all electronic media:
         1) Project Name.
         2) Equipment Name and Project Tag Number.
         3) Project Specification Section.
         4) Manufacturer Name.
         5) Vendor Name.
   10. Binding:
      a. Include labeled electronic media in a protective case.
         1) Bind protective case in three-ring binder, inserted at the front of the Final paper copy submittal.
         2) Protective case(s) to have means for securing electronic media to prevent loss (e.g., zip case, flap and strap, or equivalent).

## 1.6 ENGINEER'S REVIEW ACTION

A. Shop Drawings and Samples:
   1. Items within transmittals will be reviewed for overall design intent and will receive one of the following actions:
      a. A - FURNISH AS SUBMITTED.
      b. B - FURNISH AS NOTED (BY ENGINEER).

c. C - REVISE AND RESUBMIT.
d. D - REJECTED.
e. E - ENGINEER'S REVIEW NOT REQUIRED.

2. Submittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp.
   a. Submittals not stamped by the Contractor or stamped with a stamp containing language other than that specified herein will not be reviewed for technical content and will be returned rejected.
3. In relying on the representation on the Contractor's review and approval stamp, Owner and Engineer reserve the right to review and process poorly organized and poorly described submittals as follows:
   a. Submittals transmitted with a description identifying a single item and found to contain multiple independent items:
      1) Review and approval will be limited to the single item described on the transmittal letter.
      2) Other items identified in the submittal will:
         a) Not be logged as received by the Engineer.
         b) Be removed from the submittal package and returned without review and comment to the Contractor for coordination, description and stamping.
         c) Be submitted by the Contractor as a new series number, not as a re-submittal number.
   b. Engineer, at Engineer's discretion, may revise the transmittal letter item list and descriptions, and conduct review.
      1) Unless Contractor notifies Engineer in writing that the Engineer's revision of the transmittal letter item list and descriptions was in error, Contractor's review and approval stamp will be deemed to have applied to the entire contents of the submittal package.
4. Submittals returned with Action "A" or "B" are considered ready for fabrication and installation.
   a. If for any reason a submittal that has an "A" or "B" Action is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal.
   b. Destroy or conspicuously mark "SUPERSEDED" all documents having previously received "A" or "B" Action that are superseded by a resubmittal.
5. Submittals with Action "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected) will be individually analyzed giving consideration as follows:
   a. The portion of the submittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference).
      1) One copy or the one transparency of the "C" or "D" Drawings will be marked up and returned to the Contractor.
         a) Correct and resubmit items so marked.
   b. Items marked "A" or "B" will be fully distributed.
   c. If a portion of the items or system proposed are acceptable, however, the major part of the individual Drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" Action.
      1) This is at the sole discretion of the Engineer.
      2) In this case, some Drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package."
      3) Distribution to the Owner and field will not be made (unless previously agreed to otherwise).
6. Failure to include any specific information specified under the submittal paragraphs of the Specifications will result in the submittal being returned to the Contractor with "C" or "D" Action.
7. Calculations required in individual Specification Sections will be received for information purposes only, as evidence calculations have been stamped by the professional as defined in

the specifications and for limited purpose of checking conformance with given performance and design criteria. The Engineer is not responsible for checking the accuracy of the calculations and the calculations will be returned stamped "E. Engineer's Review Not Required" to acknowledge receipt.

8. Furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
9. Transmittals of submittals which the Engineer considers as "Not Required" submittal information, which is supplemental to but not essential to prior submitted information, or items of information in a transmittal which have been reviewed and received "A" or "B" action in a prior submittal, will be returned with action "E. Engineer's Review Not Required."
10. Samples may be retained for comparison purposes.
    a. Remove samples when directed.
    b. Include in bid all costs of furnishing and removing samples.
11. Approved samples submitted or constructed, constitute criteria for judging completed work.
    a. Finished work or items not equal to samples will be rejected.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

**EXHIBIT A** # Shop Drawing Transmittal No. _____ - _____

**(Spec Section) (Series)**

| | | | |
|---|---|---|---|
| Project Name: | | Date Received: | |
| Project Owner: | | Checked By: | |
| Contractor: | HDR Engineering, Inc. | Log Page: | |
| Address: | Address: | HDR No.: | |
| | | Spec Section: | |
| | | Drawing/Detail No.: | |
| Attn: | Attn: | 1st. Sub | ReSub. |
| Date Transmitted: | Previous Transmittal Date: | | |

| Item No. | No. Copies | Description | Manufacturer | Mfr/Vendor Dwg or Data No. | Action Taken* |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Remarks:

* The Action designated above is in accordance with the following legend:

A - Furnish as Submitted

B - Furnish as Noted

C - Revise and Submit
1. Not enough information for review.
2. No reproducibles submitted.
3. Copies illegible.
4. Not enough copies submitted.
5. Wrong sequence number.
6. Wrong resubmittal number.
7. Wrong spec. section.
8. Wrong form used.
9. See comments.

D - Rejected

E - Engineer's review not required
1. Submittal not required.
2. Supplemental Information. Submittal retained for informational purposes only.
3. Information reviewed and approved on prior submittal.
4. See comments.

Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

Comments:

By Date

Distribution: Contractor | File | Field | Owner | Other

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**EXHIBIT AA**

# Contractor's Submittal Certification

Shop Drawing Transmittal No.: _____

Contract/Project Name: _____

_____

Company Name: _____

has

1. reviewed and coordinated this Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

3. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

☐ This Submittal **does not** contain any variations from the requirements of the Contract Documents.

☐ This Submittal **does** contain variations from the requirements of the Contract Documents. A separate description of said variations and a justification for them is provided in an attachment hereto identified as:

"Shop Drawing Transmittal No. _____Variation and Justification Documentation"

Insert picture file or electronic signature of Authorized Representative

_____ _____

Authorized Representative Date

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# SECTION 01 33 04
## OPERATION AND MAINTENANCE MANUALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administration of the submittal process for Operation and Maintenance Manuals.
   2. Content requirements for Operation and Maintenance Manuals.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. General submittal requirements are specified in Specification Section 01 33 00 - Submittals.
   4. Technical Specification Sections identifying required Operation and Maintenance Manual submittals.

### 1.2 DEFINITIONS

A. Equipment Operation and Maintenance Manuals:
   1. Contain the technical information required for proper installation, operation and maintenance of process, electrical and mechanical equipment and systems.

B. Building Materials and Finishes Operation and Maintenance Manuals:
   1. Contain the information required for proper installation and maintenance of building materials and finishes.

### 1.3 SUBMITTALS

A. List of all the Operation and Maintenance Manuals required by the Contract as identified in the Technical Specification Sections. These may be referred to as "Operation and Maintenance Data" submittals.

B. Operation and Maintenance Manuals:
   1. Draft and final electronic copies.
   2. Final paper copies: Five.

### 1.4 SUBMITTAL SCHEDULE

A. List of Required Operation and Maintenance Manuals:
   1. Submit list with Specification Section number and title within 90 days after Notice to Proceed.

B. Draft Operation and Maintenance Manuals:
   1. Submit approvable draft manuals in electronic format (PDF) within 30 days following approval of the respective Shop Drawing.
      a. Include placeholders or fly sheet pages where information is not final or is missing from the draft manual.
   2. All Draft Operation and Maintenance Manuals shall be received by no later than 90 days prior to equipment startup and starting training of operation and maintenance personnel, or 60 days prior to field quality control testing at the Site.

C. Final Operation and Maintenance Manuals:
   1. Final approval of Operation and Maintenance Manuals in electronic format (PDF) must be obtained 45 days prior to equipment start-up and starting training of operation and maintenance personnel, or 14 days prior to field quality control testing at the Site.

2. Provide 5 paper copies and two USB flash drives of approved final Operation and Maintenance Manuals in electronic format (PDF), a minimum of 30 days prior to equipment start-up.
3. Issue addenda to Final Approved Operation and Maintenance Manual to include:
    a. Equipment data that requires collection after start-up, for example but not limited to HVAC balancing reports, electrical switchgear, automatic transfer switch and circuit breaker settings.
    b. Equipment field testing data.
    c. Equipment start-up reports.

## 1.5 PREPARATION OF SUBMITTALS

A. General:
1. All pages of the Operation and Maintenance Manual submittal shall be legible.
    a. Submittals which, in the Engineer's sole opinion, are illegible will be rejected without review.
2. Identify each equipment item in a manner consistent with names and identification numbers used in the Contract Documents, not the manufacturer's catalog numbers.
3. Neatly type any data not furnished in printed form.
4. Operation and Maintenance Manuals are provided for Owner's use, to be reproduced and distributed as training and reference materials within Owner's organization.
    a. This requirement is:
        1) Applicable to both paper copy and electronic files.
        2) Applicable to materials containing copyright notice as well as those with no copyright notice.
5. Notify supplier and/or manufacturer of the intended use of Operations and Maintenance Manuals provided under the Contract.

B. Operation and Maintenance Manual Format and Delivery:
1. Draft electronic submittals:
    a. Provide manual in Adobe Acrobat Portable Document Format (PDF), latest version.
    b. Create one (1) PDF file for each equipment Operation and Maintenance Manual.
    c. Do not password protect or lock the PDF document.
    d. Scanned images of paper documents are not acceptable. Create the Operation and Maintenance Manual PDF file from the original source document.
    e. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
    f. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 DPI or greater.
    g. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
    h. Create bookmarks in the bookmarks panel for the Operation and Maintenance Manual cover, the Table of Contents and each major section of the Table of Contents.
    i. Using Adobe Acrobat Standard or Adobe Acrobat Professional, set the PDF document properties, initial view as follows:
        1) Select File →Properties→Initial View.
        2) Select the Navigation tab: Bookmarks Panel and Page.
        3) Select the Page layout: Single Page Continuous.
        4) Select the Magnification: Fit Page.
        5) Select Open to page: 1.
        6) Set the file to open to the cover page of the manual with bookmarks to the left, and the first bookmark linked to the cover page.
        7) Window Options: Check the "Resize window to initial page" box.
    j. Set the PDF file "Fast Web View" option to open the first several pages of the document while the rest of the document continues to load.
        1) To do this:

a) Select Edit→Preferences→ Documents→Save Settings.
b) Check the "Save As optimizes for Fast Web View" box.

k. PDF file naming convention:
1) Use the Specification Section number, the manufacturer's name and the equipment description, separated by underscores.
2) Example: 46 51 21_Sanitaire_Coarse_Bubble_Diffusers.pdf.
3) Do not put spaces in the file name.

2. Final electronic submittals:
a. Submit two copies in PDF file format on two USB flash drives, each secured in a protective case.
b. Labeling:
1) Provide the following printed labeling on all electronic media:
a) Project name.
b) Specification Section.
c) Equipment names and summary of tag(s) covered.
d) Manufacturer name.
e) Date (month, year).
c. Binding:
1) Include labeled electronic media in a protective case.
a) Bind protective case in three-ring binder, inserted at the front of the Final paper copy submittal.
b) Protective case(s) to have means for securing electronic media to prevent loss (e.g., zip case, flap and strap, or equivalent).

3. Final paper copy submittals:
a. Quantity: Provide five copies.
b. Paper: 8.5 x 11 IN or 11 x 17 IN bright white, 20 LB paper with standard three-hole punching.
c. 3-Ring Binder:
1) Provide D-ring binder with clear vinyl sleeves (i.e. view binder) on front and spine.
2) Insert binder title sheet with the following information under the front and spine sleeves:
a) Project name.
b) Specification Section.
c) Equipment names and summary of tag(s) covered.
d) Manufacturer name.
e) Date (month, year).
3) Provide plastic sheet lifters prior to first page and following last page.
d. Drawings:
1) Provide all drawings at 11 x 17 IN size, triple folded and three-hole punched for insertion into manual.
2) Where reduction is not practical to ensure readability, fold larger drawings separately and place in three-hole punched vinyl envelopes inserted into the binder.
3) Identify vinyl envelopes with drawing numbers.
e. Use plastic coated dividers to tab each section of each manual in accordance with the Table of Contents.

C. Equipment Operation and Maintenance Manual Content:
1. Provide a cover page as the first page of each manual with the following information:
a. Manufacturer(s) Name and Contact Information.
b. Vendor's Name and Contact Information.
c. Date (month, year).
d. Project Owner and Project Name.
e. Specification Section.
f. Project Equipment Tag Numbers.
g. Model Numbers.

h. Engineer's Name.
i. Contractor's Name.

2. Provide a Table of Contents for each manual.
3. Provide Equipment Record sheets as follows:
   a. Printed copies of the Equipment Record (Exhibits B1, B2 and B3), as the first tab following the Table of Contents.
      1) For Instrumentation and Control equipment, International Society of Automation (ISA) Data Sheets will be acceptable in lieu of the Equipment Record sheets.
   b. Exhibits B1-B3 are available as Fillable PDF Form documents from the Engineer.
   c. Each section of the Equipment Record must be completed in detail; simply referencing the related equipment Operation and Maintenance Manual sections for nameplate, maintenance, spare parts or lubricant information is not acceptable.
   d. For equipment involving separate components (for example, a motor and gearbox), a fully completed Equipment Record is required for each component.
   e. Submittals that do not include the Equipment Record(s) will be rejected without further content review.
4. Provide a printed copy of the Manufacturer's Field Services report as required by Specification Section 01 75 00 following the Equipment Record sheets.
5. Provide the following detailed information, as applicable:
   a. Use equipment tag numbers from the Contract Documents to identify equipment and system components.
   b. Equipment function, normal and limiting operating characteristics.
   c. Instructions for assembly, disassembly, installation, alignment, adjustment, and inspection.
   d. Operating instructions for start-up, normal operation, control, shutdown, and emergency conditions.
   e. Maintenance instructions, including lubrication instructions if applicable
   f. Troubleshooting guide.
   g. Mark each sheet to clearly identify specific products and component parts and data applicable to the installation for the Project; delete or cross out information that does not specifically apply to the Project.
   h. Parts lists:
      1) A parts list and identification number of each component part of the equipment.
      2) Exploded view or plan and section views of the equipment with a detailed parts callout matching the parts list.
      3) A list of recommended spare parts.
      4) List of spare parts provided as specified in the associated Specification Section.
      5) A list of any special storage precautions which may be required for all spare parts.
   i. General arrangement, cross-section, and assembly drawings.
   j. Electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, and interconnection diagrams.
   k. Factory and field test data and performance curves (if applicable).
   l. As-constructed fabrication or layout drawings and wiring diagrams.
   m. Copy of the equipment manufacturer's warranty meeting the requirements of the Contract.
   n. Copy of any service contracts provided for the specific piece of equipment as part of the Contract.
6. Additional information as required in the associated equipment or system Specification Section.
7. Include in Submittal the final, configured control setpoints and similar configurable parameters provided in the equipment.

D. Building Materials and Finishes Operation and Maintenance Manual Content:
   1. Provide a cover page as the first page of each manual with the following information:
      a. Manufacturer(s) Name and Contact Information.

b. Vendor's Name and Contact Information.
c. Date (month, year).
d. Project Owner and Project Name.
e. Specification Section.
f. Model Numbers.
g. Engineer's Name.
h. Contractor's Name.

2. Provide a Table of Contents for each manual.
3. Building products, applied materials and finishes:
   a. Include product data, with catalog number, size, composition and color and texture designations.
   b. Provide information for ordering custom manufactured products.
4. Necessary precautions:
   a. Include product MSDS for each approved product.
   b. Include any precautionary application and storage guidelines.
5. Instructions for care and maintenance:
   a. Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
6. Moisture protection and weather exposed products:
   a. Include product data listing, applicable reference standards, chemical composition, and details of installation.
   b. Provide recommendations for inspections, maintenance and repair.
7. Additional requirements as specified in individual product specifications.

E. National Fire Protection Association 70 (National Electrical Code) Documentation:
1. Assemble documented calculations of Arc-Fault Current, Equipment Available Fault Current and Short Circuit Current Rating (SCCR) provided as part of equipment submittals into one O&M manual volume.

## 1.6 TRANSMITTAL OF SUBMITTALS

A. Operation and Maintenance Manuals.
1. Transmit all submittals to:
   a. The address specified in Specification Section 01 33 00 - SUBMITTALS.
2. Transmittal form: Use Operation and Maintenance Manual Transmittal, Exhibit A.
3. Transmittal numbering:
   a. Number each submittal with the Specification Section number followed by a series number beginning with "-01" and increasing sequentially with each additional transmittal, followed by "-OM" (for example: 43 23 14-01-OM).
4. Submit draft and final Operation and Maintenance Manual in electronic format (PDF) to Engineer, until manual is approved.

## 1.7 ENGINEER'S REVIEW ACTION

A. Draft Electronic (PDF) Submittals:
1. Engineer will review and indicate one of the following review actions:
   a. A - ACCEPTABLE
   b. B - FURNISH AS NOTED
   c. C - REVISE AND RESUBMIT
   d. D - REJECTED
2. Submittals marked as Acceptable or Furnish As Noted will be retained; however, the transmittal form will be returned with a request for the final paper and electronic documents to be submitted.
3. Copies of submittals marked as Revise and Resubmit or Rejected will be returned with the transmittal form marked to indicate deficient areas.
4. Resubmit until approved.

5. For components or equipment that are expected to have additional data added to the O&M manual after startup, such as field testing and startup reports, Engineer shall note this with submittal response.

B. Final Paper Copy Submittals:
   1. Engineer will review and indicate one of the following review actions:
      a. A - ACCEPTABLE
      b. D - REJECTED
   2. Submittals marked as Acceptable will be retained with the transmittal form returned as noted.
   3. Submittals marked as Rejected will be returned with the transmittal form marked to indicate deficient areas.
   4. Resubmit until approved.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

**EXHIBIT A** **Operation and Maintenance Manual Transmittal _____ - _____ - OM**
**(Spec Section) (Series)**

Project Name:

Date Received:

Project Owner:

Checked By:

Contractor:

Owner:

Log Page:

Address:

Address:

HDR No.:

Attn:

Attn:

1st. Sub. ReSub.

Date Transmitted:

Previous Transmittal Date:

| No. Copies | Description of Item | Manufacturer | Dwg. or Data No. | Action Taken* |
|---|---|---|---|---|
| | | | | |
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Remarks:

To:

From:
*HDR Engineering, Inc.*

Date:

* The Action designated above is in accordance with the following legend:

A - Acceptable, provide five (5) paper copies and two (2) electronic copies on USB flash drives for final review.

B - Furnish as Noted

C - Revise and Resubmit
This Operation and Maintenance Manual Submittal is deficient in the following area:

1. Equipment Records.
2. Functional description.
3. Assembly, disassembly, installation, alignment, adjustment & checkout instructions.
4. Operating instructions.
5. Lubrication & maintenance instructions.
6. Troubleshooting guide.
7. Parts list and ordering instructions.
8. Organization (binder, binder titles, index & tabbing).
9. Wiring diagrams & schematics specific to installation.
10. Outline, cross section & assembly diagrams.
11. Test data & performance curves.
12. Tag or equipment identification numbers.
13. Inclusion of all components & subcomponents.
14. Other - see comments.

D - Rejected

Comments:

By Date

Distribution: Contractor | File | Field | Owner | Other

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**EXHIBIT B1**

# Equipment Record

## Equipment Data and Spare Parts Summary

| | | | | |
|---|---|---|---|---|
| Project Name | | | | Specification Section: |
| Equipment Name | | | | Year Installed: |
| Project Equipment Tag No(s). | | | | |
| Equipment Manufacturer | | | | Project/ Order No. |
| Address | | | | Phone |
| Fax | Web Site | | E-mail | |
| Local Vendor/Service Center | | | | |
| Address | | | | Phone |
| Fax | Web Site | | E-mail | |

### MECHANICAL NAMEPLATE DATA

| | | | | |
|---|---|---|---|---|
| Equip. | | | Serial No. | |
| Make | | | Model No. | |
| ID No. | Frame No. | HP | RPM | Cap. |
| Size | TDH | Imp. Sz. | CFM | PSI |
| Other: | | | | |

### ELECTRICAL NAMEPLATE DATA

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Equip. | | | | Serial No. | | | | |
| Make | | | | Model No. | | | | |
| ID No. | Frame No. | HP | V. | Amp. | HZ | PH | RPM | SF |
| Duty | Code | Ins. Cl. | Type | NEMA | C Amb. | Temp. Rise | Rating | |
| Other: | | | | | | | | |

### SPARE PARTS PROVIDED PER CONTRACT

| Part No. | Part Name | Quantity |
|---|---|---|
| | | |
| | | |
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### RECOMMENDED SPARE PARTS

| Part No. | Part Name | Quantity |
|---|---|---|
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EXHIBIT B2

# Equipment Record

## Recommended Maintenance Summary

| Equipment Description | Project Equip. Tag No(s). | |
|---|---|---|
| | | |

| RECOMMENDED BREAK-IN MAINTENANCE (FIRST OIL CHANGES, ETC.) | INITIAL COMPLETION * FOLLOWING START-UP | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D | W | M | Q | S | A | RT | Hours |
| | | | | | | | | |
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| RECOMMENDED PREVENTIVE MAINTENANCE | PM TASK INTERVAL * | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D | W | M | Q | S | A | RT | Hours |
| | | | | | | | | |
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* D = Daily W = Weekly M = Monthly Q = Quarterly S = Semiannual A = Annual Hours = Run Time Interval

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EXHIBIT B3

# Equipment Record

## Lubrication Summary

| Equipment Description | Project Equip. Tag No(s). |
|---|---|
| | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | | | | | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | | | | | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | | | | | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | | | | | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | | | | | |

| Lubricant Point | | | | | | |
|---|---|---|---|---|---|---|
| Lubricant Type | | Manufacturer | Product | AGMA # | SAE # | ISO |
| | 1 | | | | | |
| | 2 | | | | | |
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# SECTION 01 35 73
## DELEGATED DESIGN PROCEDURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. General provisions for delegated design services.
   2. Coordination of delegated designs with other Work.
   3. Qualifications requirements for delegated design professionals.
   4. Limitations on Engineer's review of delegated design Submittals.
   5. Responsibilities of delegated design professionals.

B. Scope:
   1. Where delegated design is specifically Contractor's responsibility in accordance with the Contract Documents, Contractor shall provide labor, services, other effort, and pay all costs necessary and required to perform delegated design services for Work that will be part of the completed Project as a functioning whole.
   2. Perform delegated design Work in accordance with the Contract Documents, delegated design Action Submittals approved by Engineer, and Shop Drawings, product data Submittals, and Samples approved by the associated delegated design professional.
   3. Contractor's correction period, general warranty and guarantee, and obligations for safety and protection apply to delegated design Work to the same extent such provisions apply to all other Work under the Contract.
   4. Specifications requiring delegated design services include, but are not necessarily limited to, the following:
      a. Section 03 15 19 - Anchorage to Concrete.
      b. Section 05 50 00 - Metal Fabrications.
      c. Section 05 52 02 - Aluminum Railings.
      d. Section 13 34 19 - Metal Building Systems.
      e. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
      f. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
      g. Section 26 05 48 - Electrical Seismic Restraint Systems.
      h. Section 31 66 16 Special Foundation Walls
      i. Section 33 05 16 Precast Concrete Utility Structures.
      j. Section 33 16 25 Welded Steel Water Storage Tank.
      k. Section 40 05 07 - Pipe Support Systems.
   5. Not Delegated Design: The following are not delegated design and are not covered by this Section:
      a. Contractor's use of design professionals for: (1) temporary construction or temporary facilities not part of the completed Project as a functioning whole, or (2) Contractor's means, methods, procedures, techniques, and sequences of construction and safety and protection measures incident thereto. Requirements applicable to such professional services are in Section 01 71 23 - Field Engineering.
      b. Certain final designs that, in accordance with commonly accepted practice, are typically prepared by unlicensed, unregistered individuals, including for manufactured or fabricated systems, components or assemblies, not acting under the supervisory control of the design professional in responsible charge, but who commonly possess appropriate certification from a relevant industry organization, together with appropriate training and experience.

C. Related Requirements:
   1. Section 01 71 23 - Field Engineering.
   2. Sections of Divisions 02-49 where delegated design Work is required.

## 1.2 REFERENCES

A. Terminology:
   1. Terminology indicated below are not defined terms and are not indicated with initial capital letters but, when used in this Section and Specifications of Division 02-49 where delegated design Work is required, have the meaning indicated below:
      a. "Delegated design" means preparing the final design of part of the completed, permanent Work by one or more delegated design professionals, in accordance with the Contract Documents. The terms "delegated design", "delegated design services", "delegation of design responsibility", and similar or derivative terms have the same meaning.
      b. "Delegated design professional" means the licensed and registered engineer, architect, geologist, or other design professional retained by or employed by Contractor, Subcontractor, or Supplier to perform delegated design services for delegated design Work and possessing appropriate experience and qualifications for such delegated design services..
      c. "Delegated design Work" means delegated design services, associated construction, and related Work.
      d. "Instruments of service", relative to delegated designs, means delegated design professional's: (1) certifications (including delegated design professional's certification of compliance, as required in this Section, and other certifications required of delegated design professional), (2) reports (where required), (3) design drawings, (4) design specifications, (5) other documents specifically indicated as delegated design professional's "instruments of service" in the Contract Documents, and (6) documents modifying a delegated design (after Engineer's approval of the original delegated design Submittals). "Instruments of service" are to be sealed, signed, and dated by delegated design professional and expressly required as Submittals. Shop Drawings sealed and signed by delegated design professional are delegated design professional's "instruments of service".

## 1.3 GENERAL PROVISIONS CONCERNING DELEGATED DESIGN SERVICES

A. Delegated Designs - General:
   1. This Section augments the requirements of the General Conditions, as may be amended by the Supplementary Conditions, and other provisions of the Contract Documents regarding Contractor's responsibilities for delegated design Work.
   2. Delegated design professionals or their employer shall furnish professional liability insurance. Provisions on professional liability insurance are set forth in the Supplementary Conditions. Submit through Contractor appropriate documentation of professional liability insurance.

## 1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination - General:
      a. Contractor shall coordinate the services of delegated design professionals with all other elements of the Work.
      b. Contractor has full responsibility for scheduling delegated designs and all related Work.
      c. Allow sufficient time in Progress Schedule for performance of delegated design services, including requests for interpretation or clarification between delegated design professional and Contractor and between Contractor and Engineer.
   2. Coordination of Delegated Design Work's Connections to Other Work:
      a. Where delegated design Work connects to other Work designed by Engineer, existing construction, or both, the delegated design Work shall be consistent with the other Work and existing construction to which delegated design Work connects, and adjacent construction.

b. Submit details, loading, anchorage, and other coordinating information necessary to for the delegated design Work to properly interface with Work designed by Engineer.
c. Changes in the Work, whether designed by Engineer, designed by delegated design professional, or existing construction, necessary as a result of the delegated design are ineligible for increase in Contract Price or Contract Times, unless: (1) otherwise agreed by both Engineer and Owner, or (2) expressly indicated otherwise elsewhere in the Contract Documents for the associated delegated design Work.
d. Changes requiring extra compensation, time, or both arising from delegated design aspects needed for convenience of Contractor, Subcontractor, or Supplier, are not grounds for increase in Contract Price or Contract Times.

3. Coordination of Submittals, Fabrication, Production, and Shipment:
   a. Do not release for raw materials procurement, fabrication, production, and shipment to the Site materials, equipment, or systems designed by delegated design professional until the associated delegated design professional has reviewed and approved all associated Shop Drawings, product data, Samples, and (relative to shipment) source quality control Submittals, and such Submittals have been delivered to and accepted by Engineer.
   b. Allow sufficient time in the Progress Schedule for required Submittals and required actions by delegated design professionals and Engineer.

## 1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Delegated Design Professionals:
      a. Each delegated design professional shall possess not less than the minimum qualifications set forth in this provision. Where the Specifications for the associated delegated design Work establish more-stringent qualifications requirements, comply with the more-stringent requirements.
      b. Each delegated design professional shall comply with all of the following:
         1) Legally qualified, as both an individual and as a business entity, to practice the associated design discipline(s) in the jurisdiction where the Site is located, including possessing current, valid license and registration for the design discipline(s) for which the delegated design professional will render its services on the Project.
         2) Possess not less than five years of experience in the subject design discipline(s).
         3) Served as design professional in responsible charge on not less than five other designs similar in scope and complexity to the Work for which delegated design professional is retained on the Project; construction of such prior projects shall be complete by the start of the Project's construction.
      c. Summary of Qualifications: Submit to Engineer summary of delegated design professional's experience and qualifications, including:
         1) Evidence of coverage under appropriate professional liability insurance in accordance with the Contract Documents.
         2) Evidence of delegated design professional's ability to legally conduct business as a design professional in the same jurisdiction as the Site, as a business entity.
         3) Copy of delegated design professional's current, valid personal design professional license and registration for the same jurisdiction as the Site. Such documents shall indicate the individual's name, license or registration number, and dates for which the license or registration is valid.
         4) Other information reasonably requested by Engineer.

## 1.6 GENERAL PROVISIONS FOR DELEGATED DESIGN SUBMITTALS

A. Under the Division 02-49 Specifications section(s) where delegated design Work is required, furnish to Engineer Submittals such as:
   1. Action Submittals:
      a. Delegated design professional's instruments of service Submittals.

2. Informational Submittals:
    a. When delivered to Engineer, the following must bear delegated design professional's Submittal approval stamp:
        1) Shop Drawings, product data Submittals, Samples, testing plans.
        2) Results of source quality control and field quality control activities.
    b. Delegated design professional's calculations.
    c. Other Informational Submittals required for the subject delegated design Work.

B. Limitations of Engineer's Review of Delegated Design Submittals:
1. Delegated Design Professional's Instruments of Service Submittals:
    a. Engineer's review of delegated design instruments of service Submittals is for the limited purposes indicated in this Section's "General Provisions Concerning Delegated Designs" Article.
    b. The following disclaimer applies to Engineer's responses to delegated design professional's instruments of service Submittals:
        1) Engineer's review and approval of delegated design instruments of service is only for the limited purpose of verifying that performance and design criteria given in the Contract were used in the delegated design and checking for compliance with the Engineer's design concept expressed in the Contract Documents.
        2) Contractor is solely responsible for complying with the Contract Documents, Subcontractor and Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations.
        3) Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the Work of all trades.
        4) Engineer is not responsible for the effects of resubmittals or tracking progress of resubmittals.
2. Delegated Design Informational Submittals:
    a. Other provisions of the Contract Documents notwithstanding, Engineer's review of delegated design Informational Submittals is limited to only:
        1) Verifying the Submittal was furnished as required; and
        2) Submittal generally appears complete (except for calculations); and
        3) Submittal bears delegated design professional's approval stamp; or, for calculations prepared by or for delegated design professional, that such calculations bear delegated design professional's seal, signature, and date; or, for delegated design professional's reports of visits to the Site, that such report is legible, and bears delegated design professional's signature with date.
    b. Engineer receives such Submittals, including delegated design professional's calculations, on behalf of Owner, for Owner's records.
    c. Engineer, Owner, and others involved in the Project have the right to rely on delegated design professional's approval stamp as meaning that the delegated design professional has performed and appropriate review of the Submittal and determined it to be complete, in accordance with delegated design professional's instruments of service approved by Engineer, in accordance with delegated design professional's design intent, and in accordance with the Contract Documents.
3. Engineer's Other Comments on Delegated Design Submittals:
    a. Despite the limitations of Engineer's review of Submittals for delegated design Work, should Engineer become aware of, or reasonably suspect existence of, potential of associated delegated design Work to adversely affect health, safety, or welfare of persons, or pose reasonable potential for damage to the Work, work of other contractors, or adjacent property, Engineer will advise Contractor in writing of general nature of Engineer's concern.

b. Such advisory by Engineer, if issued, is rendered in good faith and does not in any way constitute:
   1) Engineer's review of all aspects of the delegated design.
   2) Any sharing by Engineer of any of delegated design professional's responsibilities or professional liability.
   3) Any responsibility imposed, in any way, on Engineer for any aspect of the delegated design professional's services or design, beyond the limited purposes of Engineer's review as set forth in the Contract Documents.
c. Contractor and its Subcontractors and Suppliers, including delegated design professionals, shall immediately investigate Engineer's concern indicated in such advisory and remedy as necessary and required.
d. Neither Engineer nor Owner, nor their respective consultants and subcontractors, is obligated to review any Submittal for delegated design Work beyond the limited review required by the Contract Documents. No such advisory, if issued, entitles Contractor, Subcontractor, or Supplier, including delegated design professionals, to rely on such advisory or to assume that any further such reviews or written or oral advisories are forthcoming.

## 1.7 RESPONSIBILITIES OF DELEGATED DESIGN PROFESSIONALS

A. Standard of Care:
   1. Unless a higher standard of care is established by the Division 02-49 Specifications section where the associated delegated design Work is required, the delegated design services shall comply with the following standard of care:
   2. Except as provided in the paragraph immediately above this, the standard of care for all delegated design professional services and related services performed or furnished by delegated design professionals for the Project will be the care and skill ordinarily used by members of the subject profession practicing under similar circumstances at the same time and in the same locality.

B. Responsibilities of delegated design professionals employed on the Work include, but are not necessarily limited to, the following, unless specifically indicated otherwise in the associated elements of the Contract Documents where the delegated design is required:
   1. Ethical Conduct and Professionalism: Comply with Laws and Regulations and applicable standards and guidelines relevant design professional organizations for ethical conduct and professional practice.
   2. Comply with Laws and Regulations and relevant design standards applicable to the subject delegated design Work.
   3. Performance and Design Criteria Indicated in the Contract Documents and Other Information:
      a. Review performance and design criteria, indicated in the Contract Documents, that the delegated design Work must satisfy.
      b. Prepare written requests for interpretations or clarifications of performance or design criteria.
      c. Review existing information about the Site that constitutes Technical Data (if any, applicable to the subject delegated design Work), as indicated in the Supplementary Conditions.
   4. Site Information and Investigations: With Contractor, obtaining all other necessary dimensions, field information, and other information necessary for preparing delegated design Submittals.
   5. Design and Other Professional Services: Personally perform and prepare, or actively exercise direct, personal, supervisory control over others performing or preparing:
      a. Necessary design professional evaluations of conditions, materials, and equipment.
      b. Prepare the instruments of service Submittals and calculations Submittal for the subject delegated design Work, where required by the associated Division 02-49 Specifications and other, associated Contract Documents.

c. Assist Contractor with applying for and obtaining permits and approvals (not previously obtained by Owner or those for whom Owner is responsible) necessary for the delegated design Work.
d. Review and approve or take other appropriate action on Shop Drawings (unless such Shop Drawings are sealed and signed by delegated design professional), product data, Samples, and testing plans, and other Submittals associated with the delegated design Work.
e. Prep modifications of the delegated design instruments of service as necessary.

6. Sealing and Signing:
   a. Seal, sign, and indicate date of sealing and signing, on all of the following when such Submittals are required by the Division 02-49 Specifications where the delegated design Work is required:
      1) Instruments of service Submittals, including certification of compliance required.
      2) Calculations.
      3) Modifications to the delegated design.
      4) Other documents required to be sealed and signed by Laws or Regulations or the Contract Documents.
   b. Sealing and signing documents in accordance with Laws and Regulations and the Contract Documents, prior to submittal (through Contractor) to Engineer, and for submittal to authorities having jurisdiction to obtain necessary permits and approvals.
   c. Sealing and signing shall be in accordance with Laws and Regulations.
7. Certification of Compliance by Delegated Design Professional:
   a. Through Contractor, submit to Engineer, delegated design professional's written certification indicating:
   b. General Information; (1) Project name and designation, (2) Contractor name and Contract designation, (3) Subcontractor or Supplier name (when applicable), (4) full name of delegated design professional's business entity under which the delegated design services were performed, (5) full name and license number of the individual sealing and signing the subject delegated design Work, (6) specific elements of delegated design Work to which the certification applies, and (7) delegated design professional's seal, signature, and date of signature.
   c. Explicit certification that the subject delegated design complies with:
      1) All applicable performance and design criteria indicated in the Contract Documents. Expressly indicate on certification of compliance the specific performance and design criteria used in the delegated design, and reaction forces of the delegated design imparted to other Work and existing construction.
      2) All Laws and Regulations.
      3) Applicable design standards commonly applicable to such types of construction. Expressly indicate such design standards on the certification of compliance.
      4) The applicable standard of care. Expressly indicate the applicable standard of care.
8. Approvals of Other Delegated Design Submittals:
   a. Review and taking appropriate action on Submittals for delegated designs:
   b. Such reviews and approvals or other appropriate action shall be to ascertain compliance with:
      1) Delegated design professional's design intent.
      2) Delegated design professional's instruments of service and calculations.
      3) Associated requirements of the Contract Documents.
   c. Delegated design professional's review stamp or facsimile thereof, review action or disposition concerning the associated Submittal for the delegated design, date of review, and name of person performing the review shall be clearly legible on the associated Submittals (except for delegated design professional's own instruments of service Submittals, calculations, and reports of delegated design professional's visits to the Site). Prominently display delegated design professional's Submittal review stamp or facsimile thereof on: (1) each sheet of Shop Drawings, (2) each major section of

product data Submittals, (3) each Sample, (4) each testing plan, and (5) each other Submittal associated with the delegated design for which such review stamp is required.

d. Do not apply delegated design professional's Submittal review stamp and comments, if any, over other text, tables, or graphics.

e. Where review stamp or facsimile thereof is required, submit to Engineer only those Submittals for delegated design Work that bear delegated design professional's explicit approval of the Submittal.

9. Respond promptly to requests for interpretation or clarification on delegated design professional's instruments of service and other Submittals for the delegated design Work.
10. Progress and Quality of Construction of Delegated Design Work:
    a. Where appropriate for the subject delegated design Work, periodically visit the Site at appropriate intervals to observe the progress and quality of the subject delegated design Work.
    b. Where delegated design professional does not visit the Site during construction, keep informed of the progress and quality of the subject delegated design Work via discussions with Contractor, Subcontractor, and Suppliers, via photographic documentation, and other means acceptable to delegated design professional.
    c. Advise Contractor in writing when the subject delegated design Work is not in accordance with the delegated design professional's instruments of service (approved by Engineer) and related Submittals approved by delegated design professional.
    d. Furnish to entity that retained delegated design professional copy of delegated design professional's written report of each visit to the Site.
11. Modifications to Design:
    a. Design appropriate modifications to the delegated design Work, including preparing new or revised certifications, reports, design drawings, sketches, design specifications, and calculations, as appropriate.
    b. Such instruments of service and calculations shall be submitted to Engineer through Contractor to same extent original instruments of service Submittals and calculations, if any, where required by the Contract Documents for the subject delegated design Work.
12. Other services, as mutually agreed upon by delegated design professional and its client, or as required elsewhere in the Contract Documents.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

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# SECTION 01 41 24
PERMIT REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. General requirements relative to permitting of which Owner and Engineer are aware that apply to the Work.
   2. Required municipal permits of which Owner and Engineer are aware.
   3. Erosion and sediment control permits.

B. Scope:
   1. Contractor shall provide labor, materials, equipment, tools, and incidentals shown, specified, and required to obtain required permits and comply with required permits and licenses.
   2. Obtain, pay for, and comply with required permits and licenses whether or not indicated in this Specifications section or elsewhere in the Contract Documents.

C. Related Requirements:
   1. In addition to permits and licenses required under this Specifications section, obtain and comply with permits required under the following Specifications:
      a. Section 01 11 00 – Summary of Work.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compliance with permit and license requirements with Work under other Specifications sections and with other contractors, if any, working at the Site.
   2. Coordinate with the Progress Schedule the time required to apply for and obtain required permits and licenses and to comply with requirements thereof. Changes in Contract Times or Contract Price will not be authorized because of timing and costs associated with obtaining permits and licenses required for the Work.

### 1.3 MUNICIPAL PERMITS AND LICENSES

A. Permits:
   1. The City of Ashland permits indicated below are required for the Project. Contractor shall be responsible for obtaining required permits from the City and paying associated permit fees. Contractor shall complete work in accordance with requirements of permits.
      a. Hillside Lands Permit.
      b. Site Design Review.
      c. Conditional Use Permit.
      d. Physical and Environmental Constraints Permit
      e. Tree Removal Permit
      f. Limited Use Permit
      g. Building Permit
      h. Electrical Permit
      i. Mechanical Permit
      j. Plumbing Permit
   2. The Jackson County permits indicated below are required for the Project. Contractor shall be responsible for obtaining required permits from the City and paying associated permit fees. Contractor shall complete work in accordance with requirements of permits.
      a. Type II Land Use Application

### 1.4 EROSION AND SEDIMENT CONTROL PERMIT

A. Erosion and Sediment Control Permit – General:
   1. Oregon Department of Environmental Quality 1200-C Construction Stormwater General Permit.
      a. Contractor shall complete work in accordance with requirements of permit.
   2. Coordinate compliance with erosion and sediment control permit with requirements of Section 01 41 26 - Storm Water Pollution Prevention Plan and Permit.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

# SECTION 01 41 26
## STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for compliance with the Project's Storm Water Pollution Prevention Plan (SWPPP) and its revisions, Laws and Regulations, and permit(s) applicable to the Project, including:
      a. Contractor's general responsibilities for storm water discharges associated with construction activity.
      b. SWPPP Revisions.
      c. Inspection, during construction, of storm water controls and temporary erosion and sediment controls, and associated repair and maintenance.
   2. Administrative forms for documenting compliance with the SWPPP and the Project's storm water permit are attached to this Section.

B. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, services, and incidentals necessary and required to fulfill Contractor's responsibilities under this Section, including complying with the applicable NPDES general permit for storm water discharges associated with construction activity ("storm water permit") administered by Oregon Department of Environmental Quality.
      1) Other prime Contractors shall cooperate and, as applicable to their Work, provide to the contractor responsible for preparing SWPPP Revisions such information necessary to prepare SWPPP Revisions relative to their Work.
      2) Other prime Contractors (other than contractor responsible for temporary storm water controls and temporary erosion and sediment controls) engaging in earthwork, including trenching, stockpiling soil or other erodible material, and backfilling, shall be co-permittee with Owner on the Project's storm water permit, and shall comply with the SWPPP and other applicable permits and with requirements for controlling discharges of storm water and erosion and sediment, control requirements associated with their Work. Such other prime Contractors engaging in earthwork shall coordinate their earthwork with contractor responsible for the temporary storm water controls and temporary erosion and sediment controls on a daily basis, and submit to Engineer complete Notice of Termination documents.
   2. Requirements of this Section are in addition to, and do not supersede or conflict with, requirements of other Specifications, including:
      a. Section 01 57 05 - Temporary Controls, including requirements for controlling storm water during construction and temporary erosion and sediment controls.

C. Related Requirements:
   1. Include, but are not necessarily limited to:
      a. Section 01 57 05 - Temporary Controls.

### 1.2 REFERENCES

A. Relevant Documents:
   1. Storm Water Pollution Prevention Plan (SWPPP):
      a. Initially prepared for the Project by or for Owner, prior to construction, the SWPPP was submitted to authorities having jurisdiction over storm water discharges associated with construction activity.

b. The SWPPP is part of the Contract Documents and includes:
   1) This Section.
   2) Section 01 57 05 – Temporary Controls, relative to temporary storm water controls and temporary provision and sediment controls.
   3) Required temporary erosion and sediment controls shown on the Drawings.
c. The SWPPP is intended to establish requirements so that the Project's construction complies with the Project's storm water permit and other, related permits (if any).

2. Storm Water Permit for the Project:
   a. Application for the Project's storm water permit was prepared by or for Owner and, prior to construction, was submitted to the authority having jurisdiction.
   b. The Project's storm water permit is part of the Contract Documents and is an attachment to this Section.
   c. Prior to starting Work at the Site that disturbs ground cover, Contractor shall sign Co-Permittee Agreement and become a co-permittee with Owner on the Project's storm water permit.
3. Erosion and Sediment Control Permit:
   a. Application for the Project's erosion and sediment control permit was prepared by or for Owner and, prior to construction, was submitted to Oregon Department of Environmental Quality, which is the authority having jurisdiction over erosion and sediment control during construction.
   b. Erosion and sediment control permit are part of the Contract Documents and is an attachment to this Section.
4. SWPPP Revisions:
   a. SWPPP Revisions shall be prepared by Contractor or Subcontractor and submitted to Engineer by Contractor.
   b. Contractor shall submit SWPPP Revision prior to starting Work at the Site, and as required by authorities having jurisdiction.
   c. SWPPP Revision shall include Contractor's proposed temporary means for storm water control during all phases of the Work and include plans for storm water conveyance and retention, as applicable. Coordinate with Contractor's plans for excavation and filling.
   d. Should Contractor-propose deviations to the SWPPP included in the Contract Documents, or if Project-specific modifications of the SWPPP are required because of field conditions, Contractor shall prepare and submit additional SWPPP Revisions as necessary, in accordance with requirements of authorities having jurisdiction and applicable permits.
   e. Comply with this Section's Article titled, "SWPPP Revisions".
   f. SWPPP Revisions shall use the SWPPP Revision form included in this Section, with supporting documents attached as necessary and required, or forms available from authorities having jurisdiction.
   g. SWPPP Revisions that do not comply with the Contract Documents and are not required by authorities having jurisdiction will be regarded as substitutions, in accordance with the General Conditions and substitution procedures requested by the Specifications.
5. Storm Water Inspection Report:
   Prepared by Engineer's Resident Project Representative (RPR) using the appropriate form included in this Section, or appropriate form provided by authority having jurisdiction.
   a. Storm water inspection reports will be filed in a log book kept at the Site by RPR. Copy of each storm water inspection report will be furnished to Contractor upon Contractor's request.
   b. Storm water inspection report will be completed for each of the following:
      1) Preconstruction: After installation of temporary storm water management measures, including erosion and sediment controls, and temporary field offices and other temporary facilities, prior to starting Work at the Site (other than mobilization and initial establishment of temporary controls).

2) During the Work: Every seven days until Notice of Termination is completed. When the Site is stabilized relative to storm water, erosion, and discharge of sediment, inspection frequency during temporary shutdowns of construction and seasonal shutdowns of construction shall be once per month until Notice of Termination is completed.
3) Final: Final inspection report will be prepared prior to completion of Notice of Termination.

6. Notice of Termination (NOT):
   a. Prepared by Contractor on the form included in the Project's storm water permit and submitted to Engineer for review and signature by Owner.
   b. Engineer will submit the NOT to authorities having jurisdiction.
   c. Contractor shall submit the NOT following completion of all Work that may result in pollution in storm water discharges, including landscaping Work.
   d. Final payment to Contractor will not be made until the NOT is submitted to authorities having jurisdiction in accordance with this provision and the Project's storm water permit.

## 1.3 CONTRACTOR'S GENERAL RESPONSIBILITIES UNDER THIS SECTION

A. The Contract Price includes all labor, material, tools, equipment, services, and incidental costs necessary for:
   1. Preparing SWPPP Revisions and other documents that are Contractor's responsibility, in accordance with this Section.
   2. Installing and maintaining structural and non-structural items used in complying with the SWPPP and its revisions.
   3. Other administrative Work required by this Section.
   4. Clean-up, disposal, and repairs following precipitation events or spills caused by Contractor.
   5. Implementing and maintaining "best management practices", as defined in applicable permits and Laws or Regulations, to comply with requirements that govern storm water discharges at the Site.
   6. Complying with other requirements of this Section.

B. Storm Water Pollution Prevention and Approval of System Owner:
   1. Prevent erosion on the Site and discharge of sediment to surface waters, drainage routes, streets and rights-of-way, and private property, including dewatering operations.
   2. Prevent onsite trash, debris, and other pollutants from leaving the Site via storm water runoff.
   3. Provide berms, swales, and other appropriate methods of directing storm water around work areas to appropriate drainage routes.
   4. Prior to starting the Work associated with such discharge of storm water, construction-related discharges to publicly-owned conveyance or treatment systems shall be approved by owner of system to which the discharge will be directed.

C. Water Quality:
   1. Do not cause or contribute to a violation of water quality standards, Laws or Regulations, or the Project's storm water permit.
   2. Notify Engineer of revisions to the SWPPP, update the SWPPP, and implement SWPPP changes necessary to prevent any violations of the stormwater permit.

D. Liability for Costs Incurred due to Violations:
   1. Contractor shall pay civil penalties and other costs incurred by Owner, including additional engineering (including RPR) and inspection services, associated with non-compliance with applicable permits related to storm water discharges associated with construction activity and erosion and sediment controls associated with the Project.
   2. Owner may deduct such amounts, as one or more set-offs, from payments due Contractor for the Project.

E. Inspections and Recordkeeping:
   1. Contractor shall perform inspections of storm water, and erosion and sediment controls in accordance with this Section
   2. Resident Project Representative (RPR) shall prepare and maintain records of storm water inspections.
   3. Contractor shall maintain records of maintenance of storm water controls and temporary erosion and sediment controls, SWPPP Revisions, and other records required by this Section and shall keep these records and copies of all documents that make up the SWPPP at the construction site and available to the inspector and engineer that may need to review them.

F. Coordination:
   1. Coordinate requirements of this Section with requirements for earthwork, temporary and permanent erosion and sediment controls, and landscaping in the Contract, applicable permit requirements, and Laws and Regulations.
   2. Implement SWPPP controls and practices prior to starting other Work at the Site. Each prime contractor and Subcontractor identified in the SWPPP and SWPPP Revisions shall sign a copy of the storm water certification statement.

## 1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with Laws and Regulations, including federal, state, and local, relative to storm water discharges associated with construction activity, and associated restoration. Comply with applicable permits.

## 1.5 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Submit the following, in accordance with Paragraph 1.2.A and Article 1.6 of this Section. When the Project involves Work at multiple sites, submit each of the following for each Site, as applicable:
      a. SWPPP Revisions.
      b. Co-permittee Agreement.
      c. Storm Water Certification Statement.
   2. Approval to Discharge to Publicly-Owned Conveyance or Treatment Works:
      a. For storm water discharges associated with construction activity that are discharged to a publicly owned conveyance or treatment system, prior to commencing discharges, submit system owner's written approval for such discharges.
   3. Storm Water Site Plan Updates:
      a. Within three days after each storm water inspection, submit updated storm water site plan.

B. Closeout Submittals: Submit the following:
   1. Notice of Termination:
   2. Submit in accordance with Paragraph 1.2.A and Article 1.6, "SWPPP Revisions", of this Section.
   3. When the Project involves Work at multiple sites, submit separate Notice of Termination for each Site, as applicable.

## 1.6 SWPPP REVISIONS

A. Contractor shall prepare a SWPPP Revision in accordance with the Project's storm water permit when:
   1. There is a significant change in design, construction, operation, or maintenance of the Project that significantly affects the potential for discharging pollutants.
   2. SWPPP proves ineffective relative to:
      a. Eliminating or significantly minimizing discharge of pollutants from sources identified in the SWPPP required by the Project's storm water permit; or

b. Achieving general objectives of controlling pollutants in storm water discharged from permitted construction activity.

3. Prepare and submit SWPPP Revisions identifying responsibilities of Contractor, Subcontractors, and other prime contractors (if any) at the Site, relative to implementing part of the SWPPP.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 INSPECTIONS AND REPAIRS

A. Perform site inspections and assessments of the Site as required by the Project's storm water permit and this Section. Inspections and assessments shall be by Contractor's site superintendent or project manager, together with RPR.

B. Inspections:
   1. After the Effective Date of the Contract, relative to the Project's storm water permit, inspect the Site:
      a. Preconstruction: After controls required to comply with the SWPPP, including temporary erosion and sediment controls and other temporary controls necessary for mitigating or eliminating pollution in storm water discharged from the Site, are installed and prior to starting other Work at the Site.
      b. During Construction: At the interval called out within the SWPPP until Notice of Termination is completed and submitted to authority having jurisdiction. When the Site is stabilized relative to storm water and pollution sources that may impair quality of storm water discharged from the Site, temporary shutdowns of construction activity, and during seasonal shutdowns of construction activity, required frequency of inspections shall be at the interval called out within the SWPPP until Notice of Termination is completed.
      c. Prior to Contractor submitting the Notice of Termination.
   2. During each inspection:
      a. Inspect and verify erosion and sediment control physical controls and practices, and other controls of pollution of storm water discharges associated with construction activity.
      b. For temporary erosion and sediment controls, record the approximate degree of sediment accumulation as percentage of acceptable sediment storage volume. Where appropriate, obtain measurements of sediment accumulation to support reasonably accurate estimation of sediment accumulation.
      c. Inspect and record maintenance performed on physical controls for erosion and sedimentation, and for other sources of storm water pollution.
      d. Inspect (where possible) and verify pollution control management practices performed and practices for managing and maintaining such physical controls.
      e. Record maintenance performed on physical controls for storm water pollution.
      f. Observe and record deficiencies relative to implementation of the SWPPP.
   3. RPRwill complete Storm Water Inspection Report (on the form attached to this Section).
   4. Contractor shall record and submit the following:
      a. Storm Water Site Plan: On a copy of the Site plan included in the Drawings or other map of the Site acceptable to Engineer, indicate extent of all areas of disturbed ground cover and drainage pathways. Indicate areas expected to undergo initial disturbance of ground cover or significant site work within the next 14 days.
      b. Indicate on storm water Site plan areas of Site that have undergone temporary or permanent stabilization of ground cover and other erodible materials.
      c. Indicate on storm water site plan all disturbed areas that have not undergone active site work during the previous 14 days.

C. Maintain at the Site a copy of storm water Site plans from each storm water inspection and submit each storm water Site plan to RPR. RPR will maintain at the Site a log book with a copy of each Storm Water Inspection Report.

D. Cooperate with representatives of authorities having jurisdiction during their periodic visits to the Site, and promptly furnish information requested by authorities having jurisdiction.

E. Repair physical controls of storm water pollution, including (but not limited to temporary erosion and sediment controls), in accordance with applicable requirements and to satisfaction of Engineer, within two days of each inspection (unless shorter period is required elsewhere in the Contract Documents).

**END OF SECTION**

## STORM WATER INSPECTION REPORT

**Owner:** _____ **Date of Inspection:** _____

**Site:** _____ **Day of Week:** S M T W T F S

**Project:** _____ **Sheet No.** _____ of _____ sheets

**Contractor:** _____

| **If pertinent to the Operation** | |
|---|---|
| Weather: | |
| Temperature: | |

This inspection and maintenance form is to be used when the Work is subject to a Storm Water General Permit for Construction Activity. Inspections shall be performed not less than once every seven calendar days; for sites that are stabilized and temporarily shut down inspections may be reduced to once per month. Each erosion and sediment control measure installed on the Site is to be inspected and the Contractor must complete all required maintenance within two calendar days from the date of inspection.

**Reason for this inspection:**

- ☐ Pre-construction Site assessment
- ☐ Seven calendar day inspection
- ☐ Monthly inspection (when Site is stabilized and shut down)
- ☐ Post-construction inspection prior to Notice of Termination

**Key for erosion and sediment control measures to be inspected:** (1) mulch, (2) seed and mulch, (3) check dams, (4) hay bale/straw bales, (5) silt fence, (6) sediment trap, (7) turbidity curtains, (8) pipe slope drains, (9) drainage structure inlet protection, (10) rolled erosion control products, (11) soil stabilizers, (12) construction entrances, (13) pipe inlet/outlet protection, (14) water diversion structures, (15) sedimentation basins, (16) cofferdams, (17) Other_____.

| ID | Location | Disturbance | | Measure | | Remarks (Evaluate integrity of measure, describe evidence of erosion) | Approximate Sediment Accumulation (% of Depth) | Maintenance Required? (Y or N) (If Yes, Describe Below) |
|---|---|---|---|---|---|---|---|---|
| | | Existing? (Y or N) | Next 14 Days? (Y or N) | Code # | Temp or Perm? (T, P or NA) | | | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
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| 4 | | | | | | | | |
| 5 | | | | | | | | |
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| 7 | | | | | | | | |
| 8 | | | | | | | | |

| ID | Location | Disturbance | | Measure | | Remarks (Evaluate integrity of measure, describe evidence of erosion) | Approximate Sediment Accumulation (% of Depth) | Maintenance Required? (Y or N) (If Yes, Describe Below) |
|---|---|---|---|---|---|---|---|---|
| | | Existing? (Y or N) | Next 14 Days? (Y or N) | Code # | Temp or Perm? (T, P or NA) | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
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DESCRIPTION OF REQUIRED MAINTENANCE AND ANY EXISTING DEFICIENCIES IN THE SWPPP:
Specify for each location using row ID number from the table above.

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I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system to ensure that qualified personnel property gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature _____ Prepared _____ Copy to Contractor _____

Resident Project Representative (Date) (Date)

Qualified Professional Name
(w/Firm Name, if Consultant) _____

## STORM WATER PERMIT CERTIFICATION STATEMENT

**Contract Number:** _____ **Project:** _____

**Owner** _____

Each Contractor and Subcontractor identified in the Storm Water Pollution Prevention Plan (SWPPP) must certify that they understand the permit conditions and their responsibilities. Every Contractor and Subcontractor performing an activity that involves soil disturbance shall sign this certification and submit it to the Engineer prior to performing the Work. This certification shall be signed by an owner, principal, president, secretary, or treasurer of the firm.

I certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP for the construction Site identified in such SWPPP as a condition of authorization to discharge storm water. I also understand that my firm and its employees and Subcontractors shall comply with the terms and conditions of Owner's general permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards, Laws, or Regulations.

**Firm:** _____

**Address:** _____ **City:** _____ **State:** _____ **Zip:** _____

**Name (Print):** _____ **Signature:** _____ **Date:** _____

## STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REVISION

**Owner:** _____ **Date of Inspection:** _____

**Site:** _____ **Sheet No.** _____ of _____ sheets

**Project:** _____

**Contractor:** _____

This form shall be used when revisions to the current Storm Water Pollution Prevention Plan (SWPPP) are required by the Storm Water General Permit for Construction Activity or the Contract Documents.

**Reason for the Revision(s):** Revisions were requested by State: ☐ Yes ☐ No

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**Describe the Revision(s) to the SWPPP:**

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I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: _____ Prepared: _____ (Date) Submitted: _____ (Date)

Copy to: ☐ Engineer ☐ Contractor: _____

# SECTION 01 42 00
REFERENCES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Defined terms and terminology.
2. Construction Codes: Indication of applicable building code and other construction codes.
3. Referenced Standard Specifications and Construction Guidelines: Indication of Owner's or third-party specifications and construction standards applicable to one or more parts of the Work.
4. Abbreviations in general use in the Contract Documents.
5. Reference Standards: General requirements regarding reference standards, including a listing of reference standard-issuing organizations (and their acronyms) used in the Contract Documents.

### 1.2 REFERENCES

A. Contract Language Addressed to Contractor:
1. Unless expressly indicated otherwise, language of the Contract Documents addresses Contractor, and the Contract Documents show and indicate Contractor's obligations.
2. Unless indicated otherwise, expressions such as, "provide", "furnish", "install", "perform", "retain services of", "remove", "demolish", "replace", and the like refer to Contractor's obligations under the Contract.

B. Defined Terms:
1. Defined terms, indicated with initial capital letters or with all-capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional defined terms, if any, in general use in the Contract Documents are indicated below. Where used, such defined terms apply to the singular and plural thereof.
   a. None.
2. Additional defined terms, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

C. Terminology:
1. Terminology, indicated without initial capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional terminology in general use in the Contract Documents are indicated below. Where used, such terminology applies to the singular and plural thereof.
   a. "Shown" means information or requirements presented on the Drawings, in schedules, or in other types of graphic instruments.
   b. "Indicated" means, as applicable: (1) graphic representations, notes, or schedules on the Drawings, or (2) other paragraphs, provisions, tables, or schedules in the Specifications and elsewhere in the Contract Documents.
   c. "Specified", "noted", "scheduled", and similar terms, have the same meaning as "shown" and "indicated", as applicable, and are used to help the user locate the reference without limitation on the location.
   d. "Installer", "applicator", or "erector" is Contractor's employees or Subcontractor, engaged to perform a specific construction activity, including installation, erection, application, or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.
   e. "Experienced", when used in conjunction with terms such as "installer", "Subcontractor", "Supplier", "manufacturer", and similar terms means (unless

expressly indicated otherwise for the subject Work elsewhere in the Contract Documents) such person or entity, as applicable, has successfully completed not less than five previous projects similar in size, scope, and complexity to such person's or entity's work on this Project; being familiar with the special requirements indicated and required; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with written requirements of the Supplier of the material or equipment being installed.

f. "Assigned specialists" and similar terms: Certain Specifications require specific construction activities be performed by specialists with recognized, extensive experience in such operations. Engage said specialists for such activities, and their engagement is a requirement over which Contractor has no option. These requirements do not conflict with enforcement of building codes and other Laws and Regulations. Such requirements are not intended to interfere with local trade union jurisdictional settlements and similar conventions. Such assignments shall not relieve Contractor of responsibility for complying with the requirements of the Contract Documents.

g. Trades: Use of terms such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter", unless otherwise indicated in the Contract Documents or required by Laws or Regulations, or required by an applicable project labor agreement. Such terminology also does not imply that indicated requirements apply exclusively to trade personnel of the corresponding generic name.

2. Additional terminology, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

## 1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. References in the Contract Documents to local building and construction code(s) means the following:
      a. 2019 Oregon Structural Specialty Code (OSSC):
      b. As amended by 2021 Ashland Municipal Code.
      c. 2019 Oregon Fire Code (OFC).
      d. 2019 Oregon Mechanical Specialty Code (OMSC).
      e. 2017 Oregon Plumbing Specialty Code (OPSC).
      f. 2014 Oregon Energy Efficiency Specialty Code (OEESC).
      g. 2017 Oregon Electrical Specialty Code.

## 1.4 REFERENCED STANDARD SPECIFICATIONS AND CONSTRUCTION GUIDELINES

A. Except as otherwise shown or indicated in the Contract Documents, the Work shall comply with the Contract Documents and the following referenced specifications and construction guidelines:
   1. Engineering Design Standards for Public Improvements by City of Ashland, OR, which can be obtained at the City's website.
   2. Oregon Department of Transportation (DOT) Standard Specifications , which can be viewed online on the DOT website. Paper copies can be obtained directly from the DOT at Contractor's (non-compensable) cost. DOT Standard Specifications' bidding and contracting requirements do not apply to this Contract.

B. Engineer is not the author of, is not responsible for, and did not seal and sign the referenced specifications and construction guidelines indicated above. Such referenced specifications and construction guidelines are not part of the Contract Documents. Where compliance with referenced specifications or construction guidelines is required by the Contract but requirements are unclear or conflict with requirements of the Contract Documents, submit to Engineer request for interpretation or clarification.

C. Maintain at the Site complete copy (in either paper or electronic form) of referenced specifications and construction guidelines indicated above. Make such copy available for

Engineer's, Resident Project Representative's (RPR), or Owner's Site Representative's (OSR) use in Contractor's field office at the Site.

## 1.5 ABBREVIATIONS.

A. Abbreviations - General:
   1. Abbreviations commonly used in the Contract Documents are indicated in this Article or on the Drawings, except as further indicated in the following paragraphs, .
   2. Additional abbreviations, specific to the Work of a given Specifications section, may be indicated in the associated Specifications.
   3. Typical equipment abbreviations are indicated in Section 01 61 03 - Equipment - Basic Requirements.
   4. Piping system abbreviations are indicated in Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

B. Common abbreviations that may be used in the Contract Documents are indicated below, alphabetically by their written-out meaning:

| | |
|---|---|
| alternating current | AC |
| ampere | A, or amp |
| Americans with Disabilities Act | ADA |
| Americans with Disabilities Act Accessibility Guidelines | ADAAG |
| ante meridian | a.m. |
| Architectural Barriers Act | ABA |
| average | avg |
| biochemical oxygen demand | BOD |
| five-day biochemical oxygen demand | $BOD_5$ |
| brake horsepower | Bhp or BHP |
| British thermal unit | Btu |
| building information model | BIM |
| carbonaceous biochemical oxygen demand | CBOD |
| five-day carbonaceous biochemical oxygen demand | $CBOD_5$ |
| chemical oxygen demand | COD |
| Celsius (or Centigrade) | C |
| chlorinated polyvinyl chloride | CPVC |
| chlorofluorocarbons | CFC |
| Code of Federal Regulations | CFR |
| computer-aided drafting and design | CADD, or CAD |
| cubic inch | cu in, or CU IN, or $in^3$ |
| cubic foot | cu ft, or CU FT, cf, CF, or $ft^3$ |
| cubic yard | cu yd, or CU YD, or CY, or $yd^3$ |
| cubic feet per minute | CFM, or cfm |

| | |
|---|---|
| cubic feet per second | CFS, or cfs |
| decibel | dB, dBA, or dBa |
| degree Celsius | degrees C, °C, or deg C |
| degrees Fahrenheit | degrees F, °F, or deg F |
| diameter | dia |
| direct current | DC |
| dollars | $ |
| each | ea |
| efficiency | eff |
| Fahrenheit | F |
| feet | ft or FT |
| feet per hour | FPH, or ft/hr |
| feet per minute | FPM or ft/min |
| feet per second | fps, or ft/s |
| figure | fig |
| flange | flg |
| foot-pound | ft-lb or FT-LB |
| gallon | gal or GAL |
| gallons per hour | GPH, gph, or gal/hr |
| gallons per minute | GPM, or gpm |
| gallons per second | GPS, or gps |
| gram | g |
| grams per liter | g/L |
| heating, ventilating, and air conditioning | HVAC |
| Hertz | Hz |
| horsepower | hp or HP |
| hour | hr or HR |
| human-machine interface | HMI |
| inch | in. or IN |
| inches of mercury | in. Hg |
| inches water gage | in. w.g. |
| inch-pound | in.-lb |
| inside diameter | ID |
| iron pipe size | IPS |
| thousand pounds | kips |

| | |
|---|---|
| thousand pounds per square inch | ksi or KSI |
| kilovolt-ampere | kva, or kVA |
| kilowatt | Kw, or |
| kilowatt-hour | Kwhr, kWhr, or kwh, kWh |
| linear foot | lin ft or LF |
| liter | L |
| Leadership in Energy and Environmental Design (USGBC) | LEED |
| maximum | max |
| mercury | Hg |
| mile | mi |
| miles per hour | mph or MPH |
| milligram | mg |
| milligrams per liter | mg/l or mg/L |
| milliliter | ml |
| millimeter | mm |
| million gallons per day | MGD or MGD |
| million gallon | MG |
| minimum | min |
| national pipe threads | NPT |
| net positive suction head | NPSH |
| net positive suction head available | NPSHA |
| net positive suction head required | NPSHR |
| nitrogen oxide (total concentration of mono-nitrogen oxides such as nitric oxide (NO) and nitrogen dioxide ($NO_2$)) | NOx |
| nominal pipe size | NPS |
| number | no. or #. |
| operator interface terminal | OIT |
| ounce | oz |
| ounce-force | ozf |
| outside diameter | OD |
| parts per hundred | PPH, or pph |
| parts per million | PPM, or ppm |
| parts per billion | PPB, or ppb |
| polychlorinated biphenyl | PCB |
| polyvinyl chloride | PVC |

| | |
|---|---|
| post meridian | p.m. |
| pound | lb, LB, lbs, or LBS |
| pounds per square inch | PSI, or psi |
| pounds per square inch absolute | PSIA, or psia |
| pounds per square inch gauge | PSIG, or psig |
| pounds per square foot | PSF, or psf |
| process control system | PCS |
| programmable logic controller | PLC |
| revolutions per minute | RPM, or rpm |
| second | sec, or s |
| specific gravity | sp gr, or SG |
| square | sq |
| square foot | sq ft, or SQ FT, or sf, or $ft^2$ |
| square inch | sq in., or SQ IN, or $in^2$ |
| square yard | sq yd, or SY, or $yd^2$ |
| standard | std |
| standard cubic feet per minute | SCFM, or scfm |
| total dynamic head | TDH |
| totally-enclosed fan-cooled | TEFC, or tefc |
| volt | V |
| volts alternating current | VAC, or vac |
| volts direct current | VDC, or vdc |
| volatile organic compounds | VOC |

## 1.6 REFERENCE STANDARDS AND ORGANIZATIONAL ACRONYMS

A. Reference Standards - General:
   1. Each entity engaged in the Work, including Contractor, Subcontractors, and Suppliers, shall be familiar with reference standards applicable to its portion(s) of the Work. Comply with such reference standards when required by the Contract Documents or appropriate fabrication and construction practice, unless the Contract Documents requirements exceed those of the associated reference standard.
   2. Refer to the General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents.
   3. Provisions of reference standards are in effect in accordance with the Specifications and other provisions of the Contract Documents where reference standards are cited.
   4. Copies of applicable reference standards are not included in or bound with the Contract Documents. Where reference standards are needed for the Work, obtain such reference standards(s) from the publication source.

B. Organization Names and Acronyms:
   1. Where reference standards, specifications, manuals, Laws or Regulations, or other published data of international, national, regional, or local organizations are cited in the Contract Documents, the organization issuing the standard (or other type of document) may be referred to by its acronym only.
   2. The following acronyms that may appear in the Contract Documents shall have the meanings indicated below, unless expressly indicated otherwise in that part of the Contract Documents where such standard (or other document) is cited.
   3. Listing is alphabetical by acronym.

| | |
|---|---|
| AA | Aluminum Association |
| AABC | Associated Air Balance Council |
| AAMA | American Architectural Manufacturers Association |
| AAR | Association of American Railroads |
| AASHTO | American Association of State Highway and Transportation Officials |
| ABMA | American Bearing Manufacturers Association (formerly Anti-Friction Bearing Manufacturers Association (AFBMA)) |
| ACI | American Concrete Institute |
| ACS | American Chemical Society |
| ADSC-IAFD | International Association of Foundation Drilling. |
| AEIC | Association of Edison Illuminating Companies |
| AF&PA | American Forest and Paper Association |
| AGI | American Geosciences Institute |
| AGMA | American Gear Manufacturers Association |
| AI | Asphalt Institute |
| AIA | American Institute of Architects |
| AIChE | American Institute of Chemical Engineers |
| AIPG | American Institute of Professional Geologists |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| AITC | American Institute of Timber Construction |
| ALSC | American Lumber Standards Committee |
| AMA | Acoustical Materials Association |
| AMCA | Air Movement and Control Association |
| AMP | National Association of Architectural Metal Manufacturers, Architectural Metal Products Division |
| AMPP | Association for Materials Protection and Performance |
| ANSI | American National Standards Institute |
| APA | The Engineered Wood Association |
| APHA | American Public Health Association |

| | |
|---|---|
| API | American Petroleum Institute |
| AREA | American Railway Engineering Association |
| ARI | Air Conditioning and Refrigeration Institute |
| ARS | American Rail Standard |
| ASAE | American Society of Agricultural Engineers |
| ASCE | American Society of Civil Engineers |
| ASHRAE | American Society of Heating, Refrigerating and Air Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASNT | American Society for Non-Destructive Testing |
| ASQ | American Society for Quality |
| ASSE | American Society of Safety Engineers |
| ASTM | American Society for Testing and Materials |
| AWCI | Association of the Wall and Ceiling Industry |
| AWI | Architectural Woodwork Institute |
| AWPA | American Wood Protection Association |
| AWPI | American Wood Preservers Institute |
| AWS | American Welding Society |
| AWWA | American Water Works Association |
| BAAQMD | Bay Area Air Quality Management District |
| BHMA | Builders Hardware Manufacturers Association |
| BIA | Brick Industry Association |
| CASE | Coalition of American Structural Engineers (part of the American Council of Engineering Companies (ACEC)) |
| CBMA | Certified Ballast Manufacturers Association |
| CBP | United States Customs and Border Protection |
| CDA | Copper Development Association |
| CEMA | Conveyor Equipment Manufacturers Association |
| CGA | Compressed Gas Association |
| CISCA | Ceilings and Interior Systems Construction Association |
| CISPI | Cast Iron Soil Pipe Institute |
| CLFMI | Chain Link Fence Manufacturers Institute |
| CMAA | Crane Manufacturers Association of America |
| CRSI | Concrete Reinforcing Steel Institute |

| | |
|---|---|
| CSI | Construction Specifications Institute |
| DBIA | Design-Build Institute of America |
| DHS | United States Department of Homeland Security |
| DIN | Deutsches Institut für Normung, eV (German Institute for Standardization)u |
| DIPRA | Ductile Iron Pipe Research Association |
| EJCDC | Engineers Joint Contract Documents Committee |
| EJMA | Expansion Joint Manufacturers Association, Inc. |
| ETL | Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.) |
| FAA | Federal Aviation Administration (US Department of Transportation) |
| FCC | United States Federal Communications Commission |
| FEMA | Federal Emergency Management Agency (US Department of Homeland Security) |
| FHWA | Federal Highway Administration (US Department of Transportation) |
| FIDIC | International Federation of Consulting Engineers |
| FM | Factory Mutual (FM Global) |
| FRPI | Fiberglass Reinforced Plastics Institute |
| FS | Federal Specification |
| FTA | Federal Transit Administration, United States Department of Transportation |
| GA | Gypsum Association |
| GANA | Glass Association of North America |
| HEW | United States Department of Health, Education and Welfare |
| HI | Hydraulic Institute |
| HMI | Hoist Manufacturers Institute |
| HUD | United States Department of Housing and Urban Development |
| IBC | International Building Code |
| ICC | International Code Council |
| ICEA | Insulated Cable Engineers Association |
| IEEE | Institute of Electrical and Electronics Engineers |
| IESNA | Illuminating Engineering Society of North America |
| IFI | Industrial Fasteners Institute |
| IRI | Industrial Risk Insurers |
| ISA | International Society of Automation |
| ISI | Institute for Sustainable Infrastructure |
| ISO | Insurance Services Office |
| ISO | International Organization for Standardization |
| LPI | Lightning Protection Institute |
| MIA | Marble Institute of America |

| | |
|---|---|
| ML/SFA | Metal Lath/Steel Framing Association |
| MS | Military Specifications |
| MSS | Manufacturers' Standardization Society |
| MMA | Monorail Manufacturers Association |
| NAAMM | National Association of Architectural Metal Manufacturers |
| NACE | National Association of Corrosion Engineers |
| NAPF | National Association of Pipe Fabricators, Inc. |
| NARUC | National Association of Regulatory Utilities Commissioners |
| NAVFAC | Naval Facilities Engineering Command (US Navy) |
| NBHA | National Builders Hardware Association |
| NBS | National Bureau of Standards (United States Department of Commerce) |
| NCMA | National Concrete Masonry Association |
| NEC | National Electric Code |
| NELMA | Northeastern Lumber Manufacturers' Association |
| NEMA | National Electrical Manufacturers Association |
| NEPA | National Environmental Policy Act |
| NESC | National Electrical Safety Code |
| NETA | International Electrical Testing Association |
| NFPA | National Fire Protection Association |
| NFRC | National Fenestration Rating Council |
| NGA | National Glass Association |
| NHLA | National Hardwood Lumber Association |
| NHPMA | Northern Hardwood and Pine Manufacturers Association |
| NICET | National Institute for Certification in Engineering Technologies |
| NIST | National Institute of Standards and Technology (United States Department of Commerce) |
| NLGA | National Lumber Grades Authority |
| NRC | United States Nuclear Regulatory Commission |
| NRCA | National Roofing Contractors Association |
| NRMCA | National Ready Mixed Concrete Association |
| NSF | National Sanitation Foundation |
| NSPE | National Society of Professional Engineers |
| NSSGA | National Stone, Sand, and Gravel Association |
| NTMA | National Terrazzo and Mosaic Association |
| OSHA | Occupational Safety and Health Administration, United States Department of Labor |
| PCA | Portland Cement Association |

| | |
|---|---|
| PCI | Precast/Prestressed Concrete Institute |
| PEI | Porcelain Enamel Institute |
| PFI | Pipe Fabrication Institute |
| PPI | Plastics Pipe Institute |
| PGMC | Primary Glass Manufacturers Council |
| PS | Product Standards Section, United States Department of Commerce |
| RCSC | Research Council on Structural Connections (part of AISC) |
| RMA | Rubber Manufacturers Association |
| RUS | Rural Utility Service (division of Rural Development of the USDA) |
| SAE | Society of Automotive Engineers |
| SCAQMD | Southern California Air Quality Management District |
| SCPRF | Structural Clay Products Research Foundation |
| SCTE | Society of Cable Telecommunications Engineers |
| SDI | Steel Deck Institute |
| SDI | Steel Door Institute |
| SIGMA | Sealed Insulating Glass Manufacturing Association |
| SJI | Steel Joist Institute |
| SMACNA | Sheet Metal and Air Conditioning Contractor's National Association |
| SPI | Society of the Plastics Industry |
| SPIB | Southern Pine Inspection Bureau |
| SSPC | Society for Protective Coatings (formerly, Steel Structurs Painting Council) |
| SWI | Steel Window Institute |
| TCNA | Tile Council of North America |
| TEMA | Tubular Exchanger Manufacturers Association |
| TIA/EIA | Telecommunications Industry Association/Electronic Industries Alliance |
| TSA | Transportation Security Administration (United States Department of Homeland Security) |
| UCC | Uniform Commercial Code |
| UL | Underwriters Laboratories, Inc. |
| USAB | United States Access Board |
| USACE | United States Army Corps of Engineers (also abbreviated as COE or USACOE) |
| USDA | United States Department of Agriculture |
| USDOE | United States Department of Energy |
| USDOT | United States Department of Transportation |
| USEPA | United States Environmental Protection Agency |
| USGBC | United States Green Building Council |

| | |
|---|---|
| USGS | United States Geological Survey |
| USPHS | United States Public Health Service |
| WCLIB | West Coast Lumber Inspection Bureau |
| WCMA | Window Covering Manufacturers Association |
| WCMA | Wood Component Manufacturers Association |
| WDMA | Window and Door Manufacturers Association |
| WEF | Water Environment Federation (formerly the Water Pollution Control Federation) |
| WWEMA | Water and Wastewater Equipment Manufacturers Association |
| WWPA | Western Wood Products Association |

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

# SECTION 01 45 25
## TESTING CONCRETE STRUCTURES FOR WATERTIGHTNESS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for furnishing all labor, materials, tools, equipment, and services, for all testing of concrete structures for watertightness, in accord with provisions of the Contract Documents.
   2. Completely coordinate with work of all other trades.
   3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete leak test.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

C. Payment:
   1. Contractor to pay all costs required for testing, retesting, patching, repair and work required to provide access for repair as required to meet watertightness requirements specified or indicated.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Concrete Institute (ACI):
      a. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.
   2. NSF International (NSF).
   3. Underwriters Laboratories, Inc. (UL).
   4. United States Department of Agriculture (USDA).
   5. Water Quality Association (WQA).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Watertightness testing plan:
      a. Plan shall include:
         1) Scheduling for testing.
         2) Description of testing apparatus for measuring water level in structure and evaporation pan.
            a) Include Drawings (plans, sections and details) as appropriate to fully describe apparatus.
         3) Location plan showing measurement location and evaporation pan location.
         4) Procedures for isolation of tank or compartments to assure a constant volume during testing.
         5) Narrative describing testing procedure.
         6) Calculations showing:
            a) Total structure volume at water elevation for commencement of test period.
            b) Maximum water leakage allowed.
            c) Test period: See ACI 350.1.
         7) Plan shall be in accordance with ACI 350.1, Chapters 1 and 2.

3. Prior to start of watertightness testing, submit repairing and patching plan with procedures for addressing running water leaks and steps to be follow if watertightness test fails.
    a. Include with plan:
        1) Location and areas of leaks.
        2) Repair material and procedures proposed for repair.
        3) Photographs of all visible leaks and damp areas.
            a) Include distant photos and close-ups to document conditions.

B. Informational Submittals:
1. Results of watertightness testing indicating the following:
    a. Level of water in structure and in evaporation pan and water temperature at commencement of test period.
    b. Level of water in structure and in evaporation pan and water temperature at end of test period.
    c. Net leakage in percent of total volume during test period (gross leakage minus that due to evaporation).
    d. Results of retesting required due to leakage exceeding percentages allowed.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Water for Testing:
1. See ACI 350.1.
2. Water treatment: Potable water.
3. Coordinate delivery of water for testing with Owner.

B. Any patching or repair materials that may come into contact with potable water in tanks shall be approved for drinking water per NSF, UL, USDA, or WQA.

## PART 3 - EXECUTION

### 3.1 PREPARATION BEFORE TESTING

A. General:
1. Verify the specified 28-day concrete strength has been achieved prior to testing.
2. Testing to be performed prior to placement of exterior backfill soil.
    a. Contractor is responsible for phasing construction to minimize the impact of and to leak testing.
3. Contractor to furnish all necessary materials (such as gaskets and flange cover plates).
4. Testing to be performed prior to application of specified waterproofing.
5. Test the following tanks prior to backfilling:
    a. Ballasted Flocculation Tank(s)
    b. Filters
    c. Intermediate Pump Station Wet Well (under the filters).
    d. Clearwell
    e. All chemical storage tanks
    f. Backwash waste basin(s)

B. Source of water for watertightness testing:
1. Coordinate use of water for filling tanks with Owner.
2. The source of water will be potable water.
3. The cost of providing water will be paid by the Owner.
    a. The cost of additional water due to retesting will be paid by the Contractor.
4. Contractor shall provide the means of transporting the water to the structure being tested.

C. Cleaning:

1. Thoroughly clean interior of structure to be tested of all debris and dirt and hose down surfaces of all walls and slabs.
2. Cleaning may be required after satisfactory test completion.
3. See Specification Section 01 74 00.

D. Patching and Finishing:
1. Prepare concrete surfaces in accordance with ACI 350.1 and Section 03 35 00.
   a. Fill all holes, voids and honeycombed areas per Section 03 35 00. Cracks suspected to cause leakage to be filled and sealed.
   b. Review tank for areas of potential leakage before filling.
2. Prior to patching activities, Contractor to submit patching materials and procedures for review and approval by Engineer.

## 3.2 WATERTIGHTNESS TESTING

A. Provide watertightness testing for the following structures in accordance with the indicated criteria:
1. Where no elevation is given for WATER ELEVATION AT COMMENCEMENT OF TEST PERIOD in the following table, use the normal operating water elevation for the indicated structure.

| STRUCTURE NAME or TYPE | WATER ELEVATION AT COMMENCEMENT OF TEST PERIOD | MAXIMUM WATER LEAKAGE ALLOWED IN TEST PERIOD (PERCENT OF TOTAL VOLUME) |
|---|---|---|
| a. Ballasted Flocculation Tank(s) | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |
| b. Filters | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |
| c. Intermediate Pump Station Wet Well (under the filters) | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |
| d. Clearwell | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |
| e. All chemical storage tanks | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |
| f. Backwash waste basin(s) | Maximum operating water level (plug overflow) | 0.1 (no visible leakage on walls) |

B. Perform a watertightness test as required by Engineer on any additional structure when in the opinion of the Engineer the structure contains sufficient concrete defects that could impair the watertightness of the structure.
1. Testing to conform to requirements of this Specification Section with allowable leakage and other criteria as established by Engineer.

C. Test for leakage in accordance with ACI 350.1, latest edition, Chapters 1 and 2, and this Specification Section.
1. Isolate sections of structures that can be isolated during operation.
   a. Test each section separately.
2. Allow Owner's Representative to witness testing for watertightness and review accompanying results.

D. Place evaporation pan in an easily accessible location.

E. Record level of water in structure and evaporation pan and water temperature at commencement of the test period.

F. During testing period, inspect structure for areas indicating leakage.
   1. Any areas evidencing running water to be repaired and patched.
   2. Patching or repair of leaks as defined above shall be completed independent of the watertighness test.
      a. Passing watertightness test does not relieve Contractor from repairing running water leaks.

G. Record level of water surface in the structure and evaporation pan and temperature every 24 HRS until end of test period.
   1. Test periods defined per ACI 350.1.

H. If leakage is greater than that allowed, repair and patch areas suspected of causing the leakage.
   1. Re-test structure using the same procedure until leakage is equal to or less than that allowed.
   2. Provide repair plan to Engineer for approval prior to repair of tank.
   3. Cracks suspected to cause leakage to be filled and sealed to prevent leakage.
      a. Patching to be performed after defective concrete area is cleaned of all loose material to surface of sound concrete.
   4. Prior to patching activities, Contractor to submit patching materials and procedures for review and approval by Engineer.

I. Dispose of water used for testing.
   1. Dispose of water used for testing to an area which will not damage new or existing construction and will not interfere with construction operations or plant operations.
   2. Provide hoses, temporary connections, temporary fittings and other conduits as necessary to dispose of test water without damage to structure or terrain.
   3. Point of disposal to be approved by Owner.

**END OF SECTION**

# SECTION 01 45 33
## SPECIAL INSPECTIONS AND TESTING PROGRAM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Contractor responsibilities for special inspection and testing.
   2. Special Inspection program and reporting requirements.
   3. Attachment A to this Specification Section includes the Submittal of Special Inspections.
   4. Attachment B to this Specification Section includes Special Inspector qualifications, reporting requirements, and material specific inspections and tests.
      a. This information is for the Contractor reference only and is not part of the Contract Documents.
      b. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
      c. The Service Provider(s) responsible for the Owner-provided Services will be selected after Contract award.

B. Purpose:
   1. This Document was developed to address the requirements of the 2019 Oregon Structural Specialty Code section 1704.1 including:
      a. One or more special inspectors will be hired by the Owner or the Owner's Agent to provide inspections during constructions on the types of work listed under Section 1704.
   2. A Statement of Special Inspections will be submitted to the Building Code Official as a condition for permit issuance. This statement is included as Attachment A to this Specification. Attachment B includes a complete list of materials and work requiring special inspections, the inspections to be performed and a list of the minimum qualifications of the individuals, approved agencies or firms intended to be retained for conducting such inspections.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 DEFINITIONS

A. Special Inspector: Representative of the Owner approved inspection agency designated for that portion of the work.

B. Testing Agency: Approved agency, not affiliated or hired by the Contractor, which is responsible for the materials testing requirements of the project including but not limited to concrete cylinder breaks, soils testing, and masonry materials testing.

C. Statement of Special Inspections: Document provided to the Building Code Official outlining special inspections and tests to be done on the project and frequency of required test.

D. Soils Engineer or Geotechnical Engineer: For the purposes of Special Inspection "Soils Engineer," "Geotechnical Engineering," and "Special Inspector" shall be interchangeable as pertains to the Division 31 specifications.

E. NICET: National Institute for Certification in Engineering Technologies.

### 1.3 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with testing agency personnel, special inspector, and agents of the Building Code Official and provide access to the work.

1. Providing access to the work shall include all labor and facilities to perform inspections and tests as listed in the specifications for the duration of the inspections or tests involved.
2. Provide means to obtain and handle samples taken on site.
3. Provide a Statement of Responsibility as described by Chapter 17 of the Building Code.

B. Attend a pre-construction meeting to coordinate and clarify inspection and testing procedures, requirements.

C. Notify special inspector and/or testing agency of work to be inspected/tested minimum of 24 HRS prior.

D. Work for which special inspections are required shall remain accessible and exposed for the purposes of special inspections until completion of required special inspections.

E. Any portion of work that is not in conformance shall be corrected and re-inspected. Such portions of the work shall not be covered or concealed until authorized by Owner's Representative.

F. Work to be inspected should be complete at time of inspector's arrival on-site.

G. Payment for Special Inspection services will be in accordance with the following:
   1. Payment described below is for the Testing Agency and Special Inspector costs and does not include the Contractor's costs listed in Paragraph 1.3 A.
   2. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined in Item 4 below.
      a. Inspection reveals work is satisfactory.
      b. Owner pays all costs associated with this inspection.
   3. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined in Item 4 below.
      a. Inspection reveals work is deficient.
      b. Contractor corrects deficiencies within timeframe defined in Item 4) below.
      c. Work is re-inspected and work is satisfactory.
      d. Owner pays all costs associated with this inspection.
   4. After Contractor notification, inspector arrives at site and work is not ready for inspection when inspector arrives.
      a. Inspector will remain on-site for a maximum of 2 HRS awaiting the completion of the work.
      b. If work is not ready for inspection at the end of this period, inspector will be dismissed until Contractor requests re-inspection.
      c. All costs associated with this inspection trip will be charged to the Contractor.
   5. After Contractor notification, inspector arrives at site and performs inspection within the timeframe defined above.
      a. Inspection reveals work is deficient.
      b. Contractor attempts to correct deficiencies within 2 HR timeframe and calls for re-inspection.
      c. Work is re-inspected and found to still be deficient.
      d. Inspector will be dismissed.
      e. All costs associated with this inspection trip will be charged to the Contractor.
   6. Owner will pay for "passing" soils on the Project. Costs of corrective actions and cost of failed test areas requiring retesting are the sole responsibility of the Contractor. For additional specific payment requirements for soils see the respective Division 31 Section.

H. Special Inspection is intended to be an independent quality assurance. Special Inspections shall not relieve the Contractor of any quality assurance, quality control, workmanship, or warranty responsibilities. Contractor's own personnel shall review all work to be inspected for conformance with Contract Documents prior to calling for inspection.

### 1.4 REPORTING DUTIES AND AUTHORITY

A. A pre-construction meeting to coordinate and clarify inspection, testing, and procedural requirements will be held per Section 01 30 00.
   1. The meeting is to be attended by:
      a. Owner.
      b. Engineer.
      c. Building Code Official or designee.
      d. Testing Agency and Special Inspectors.
      e. General Contractor.
      f. Appropriate Sub-contractor(s).

B. Special Inspector shall report all deficient work to the Contractor as soon as possible.
   1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Engineer and the Building Code Official.

C. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

## ATTACHMENT A TO SECTION 01 45 33
## STATEMENT OF SPECIAL INSPECTIONS

Statement Date: January, 2023

Project Name: Ashland Creek Water Treatment Plant
Project Address: _____
Owner: City of Ashland
Registered Design Professional in Responsible Charge (DPRC): Mark Hijazi, PE

The Statement of Special Inspections (Statement) is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the Building Code. The Special Inspection program is outlined in Specification Section 01 45 33 and Attachments A and B. A detailed explanation of the requirements for Special Inspections and Testing can be found in specification Section 01 45 33 of the Project Manual in conjunction with the Technical Specifications for each material.

Bi-weekly Special Inspection reports will be submitted to the DPRC and the Building Official. Discovered discrepancies will be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies will be brought to the attention of the DPRC and the Building Official. Only documents that are prepared and signed or sealed by the Special Inspectors (SI) are valid.

The SI is responsible for verifying all information on each document prior to signing or sealing and directly forwarding it to the DPRC and Building Official. The SI is responsible for verifying all inspectors under his supervision maintain current certifications during the course of the project. At the conclusion of each individual Special Inspection type, the SI will complete a Final Report.

The Special Inspection program does not relieve the Contractor or any other entity of any contractual duties, including quality control, quality assurance, or safety. The Contractor is solely responsible for construction means, methods, and job site safety. Failure to adhere to the SI program as outlined herein may result in a stop work notice being issued by the Building Official.

Respectfully submitted,
Design Professional in Responsible Charge,

_Mark Hijazi, PE_____
Type or Print Name

Oregon License # 70910
Expires: 6/30/25

_____ _____
Signature Date

## END OF ATTACHMENT A

# ATTACHMENT B TO SECTION 01 45 33

## SPECIAL INSPECTIONS, INSPECTOR QUALIFICATIONS AND REPORTING REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 05 12 00 - Structural Steel.
   5. Section 05 50 00 - Metal Fabrications.
   6. Section 07 81 00 - Fireproofing.
   7. Section 31 23 00 - Earthwork.

### 1.2 QUALIFICATIONS

A. Qualifications stated here are the minimum recommended by the Engineer. If the Building Code Official has more stringent qualifications, the more stringent qualifications will take precedence.

B. All Special Inspections and Testing to be done under the direction of a Professional Engineer or Registered Architect registered in the State of Oregon herein referred to as Registered Professional for Special Inspections (RPSI).

C. Soil, concrete, masonry, mortar, grout, steel and aluminum related testing.
   1. The Testing Agency shall have a minimum of 10 years experience in the testing of these materials.
   2. The Testing Agency's technician(s) conducting this testing:
      a. Shall have a minimum of five years experience in the testing of soil, concrete, mortar, grout, steel and aluminum as appropriate.
   3. Concrete related work:
      a. International Code Council certification for Reinforced Concrete and American Concrete Institute Concrete Field Testing Technician – Grade 1.

D. Special Structural Inspections:
   1. Professional Engineers or Architects, licensed in the State of Oregon, may perform special inspections in accordance with their license qualifications.
   2. Other individuals, working under the direct supervision of a licensed engineer and meeting the following qualifications, may perform special inspections.
   3. Soils related work:
      a. NICET Level II Certification in geotechnical engineering technology/construction; or
      b. Registered Geologist; or
      c. Engineer Intern under the direct supervision of a Licensed Professional Engineer.
   4. Concrete related work:
      a. International Code Council certification for Reinforced Concrete Special Inspector or American Concrete Institute Concrete Construction Special Inspector.
      b. Alternatively, may be an Engineer Intern under the direct supervision of a Licensed Professional Engineer.
   5. Steel and aluminum related work:
      a. Frame and material verification.
      b. OSSC Table 1705.2, items 3 thru 5:
         1) Qualified per AISC 360 N4.2.
      c. Welding:
         1) American Welding Society as a Certified Welding Inspector; or

2) International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and one year of related experience; or
3) NDT Level II or II Certificate (for non-destructive testing only).

d. High strength bolting:
1) International Code Council Structural Steel and Welding Certification and one year related experience.
2) Alternatively, may be an Engineer Intern with appropriate training.

6. Fire resistive coating (intumescent paint) related work:
a. International Code Council Spray-Applied Fireproofing Certification and three years of related experience; or
b. International Code Council Fire Inspector 1 Certification and three years of related experience.
7. Other equivalent certifications will not be acceptable unless approved by the Engineer.

## 1.3 REPORTING DUTIES AND AUTHORITY

A. Reporting requirements for special inspector per OSSC 2019 for Building System Related Work.
1. Comply with requirements of OSSC Section 1704.2.4.
2. Provide written documentation of all inspections and testing.
a. Include exact location of work.
b. If testing of specimens is included, include detailed information on storage and curing of specimens prior to testing.
3. Furnish inspection and test reports to the Contractor, the Engineer's Project Manager and the Owner's on-site representative.
a. Indicate that work inspected was done in conformance with approved construction documents.
b. Immediately report any discrepancies to the Contractor for correction.
c. If the discrepancies are not corrected in a timely fashion, notify the Engineer's Project Manager and Owner's on-site representative.
4. Issue an electronic report summarizing all inspections, corrective action notifications and resolution of discrepancies and non-conforming work every two weeks (14 calendar days).
a. Copy will be available to:
1) Engineer's Project Manager.
2) Owner.
3) The Building Code Official.
4) General Contractor.
5. At the end of the Project, the RPSI shall compile all test reports for each inspected material and for each Special Inspector and summarize into a single PDF and submit to the Engineer and Building Code Official.
a. Final summary report to be signed and sealed by a Registered Professional for Special Inspections stating:
1) The required Special Inspections have been performed.
2) All discrepancies have been resolved except as specifically stated in the summary report.

B. Special Inspector shall report all deficient work to the Contractor as soon as possible.
1. Deficient work that has been covered up or concealed prior to re-inspection shall be reported to the Engineer and the Building Code Official.

C. Special Inspector does not have authority to stop work or modify the requirements of the Contract Documents.

## 1.4 MATERIAL SPECIFIC SPECIAL INSPECTIONS AND TESTS

A. Material specific requirements for special inspection and testing are listed in the technical specifications listed below. Special inspection and testing requirements will be located in each appropriate technical specification under "SOURCE QUALITY CONTROL", "FIELD QUALITY CONTROL" and/or "QUALITY ASSURANCE" as appropriate for each material.

### 1.5 SOILS

A. Special Inspection/testing will be provided per OSSC Section 1705.6 as required to determine that the site has been prepared in accordance with the approved soils report, and to verify the allowable soil bearing pressure, materials, compaction densities, trenching and backfill and conformance to the project Specifications.

B. Inspection/testing requirements are listed separately in Specification Division 31 and are indicated as the work to be done by the Geotechnical Engineer, Testing Agency, or Special Inspections and Testing Provider.

### 1.6 CONCRETE

A. Special Inspection and testing will be provided per OSSC Section 1705.3. Inspection is required for material verification, reinforcing steel, embedded bolts, mechanical splices, concrete tests, welding of reinforcing, concrete placement and curing, and waterstop placement.

B. Inspection and testing requirements are listed separately in Specification Section 03 05 05 and are indicated as the work to be done by the Special Inspector or Testing Agency.

### 1.7 PRECAST CONCRETE

A. Special Inspection and testing will be provided per OSSC Section 1705.3 Item 10. Inspection and testing is required for connection embed number and placement, connection welding, and proper panel detailing prior to placement.

B. Inspection requirements are listed separately in Specification Section 03 41 33 and are indicated as the work to be done by the Special Inspector.

### 1.8 STEEL, STAINLESS STEEL, AND ALUMINUM

A. Special Inspection will be provided for structural steel per OSSC section 1705.2. Inspection is required for material verification, high-strength bolting, welding and other work noted on the Contract Documents.

B. Inspection/testing requirements are listed separately in Section 05 12 00 and Section 05 50 00 and are indicated as the work to be done by the Special Inspector. Inspection requirements listed are applicable to aluminum, stainless steel, and structural steel.

### 1.9 MASTIC AND INTUMESCENT FIRE-RESISTANT COATINGS

A. Special Inspection will be provided per OSSC section 1705.14 or OSSC section 1705.15 as required to determine that the mastic and intumescent fire-resistant coatings have been installed in conformance with the Contract Documents.

B. Inspection requirements are listed separately in Specification Section 07 81 00 and are indicated as the work to be done by the Special Inspector.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF ATTACHMENT B

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# SECTION 01 57 05
TEMPORARY CONTROLS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for temporary controls during construction, including:
      a. Noise control.
      b. Temporary pest and rodent controls.
      c. Pollution control, including solid waste, water pollution, atmospheric pollution, and other types of pollution.
      d. Odor control.

B. Scope:
   1. Contractor shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to control environmental conditions at the Site and adjacent areas during construction.
   2. Contractor shall pay all costs, including fines and civil penalties, if any, for failure to implement and maintain temporary controls in accordance with the Contract Documents and Laws and Regulations. Contractor is not eligible for increase in Contract Price or Contract Times due to failure to comply with requirements for temporary controls.
   3. Maintain temporary controls until no longer necessary or required. Provide temporary controls at all times when Contractor is working at the Site.

C. Related Requirements:
   1. Include, but are not necessarily limited to, the following:
   2. Section 01 74 00 - Cleaning.
   3. Section 31 23 00 - Earthwork.

### 1.2 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with applicable provisions and recommendations of the following:
      a. Oregon Department of Environmental Quality

### 1.3 SUBMITTALS

A. Action Submittals:
   1. Submit the following:
      a. Shop Drawings:
         1) Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a site plan approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Contractor proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional areas.
         2) Location and details of each temporary settlement basin.
      b. Product Data:
         1) Silt fencing materials.
         2) Other materials proposed for temporary erosion and sediment controls, when requested by Engineer.

B. Informational Submittals:
   1. Submit the following:
      a. Procedural Submittals:

1) Proposed dust control measure, when Submittal is requested by Engineer.

b. Field Quality Control:
   1) When requested by Engineer, promptly obtain and submit results of field measurements and field test data substantiating compliance of Contractor's temporary controls with the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings.

## PART 3 - EXECUTION

### 3.1 NOISE CONTROL

A. Noise Control – General:
   1. Contractor's vehicles, construction equipment, and machinery shall minimize noise emissions to greatest degree practicable. When necessary, provide mufflers and silencers on construction equipment, machinery, and vehicles, and provide temporary sound barriers sound-absorbing blankets, sound-reducing enclosures, modified backup alarms, and other mitigation measures when necessary.
   2. Noise threshold levels shall comply with Laws and Regulations, including (a) OSHA requirements and recommendations, and (b) local ordinances or other Laws or Regulations.
   3. Noise emissions shall not interfere with the work of Owner, facility manager (if other than Owner), or others. The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning and emergency purposes only.
   4. Music or entertainment systems, including personal and vehicle radios, media players, and the like, when used, shall not be audible at the property line and shall not disturb others at the Site.
   5. Field Quality Control of Noise:
      a. If Owner or Engineer believes potential exists that allowable noise levels are being exceeded, Contractor will be required to, and shall promptly perform, appropriate noise monitoring in presence of Owner or Engineer and shall submit written results to Engineer.
      b. Owner and Engineer reserve the right to perform independent noise monitoring at any time during the Work.
   6. If noise level exceeds allowable maximum, Contractor shall immediately cease the activity emitting the excessive noise and promptly implement noise-mitigating measures to comply with noise limitations.

### 3.2 DUST CONTROL

A. Dust Control – General:
   1. Control objectionable dust caused by Contractor's operation of vehicles and construction equipment and machinery, site clearing, demolition, cleaning, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Engineer and approval of authorities having jurisdiction.
   2. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce onsite and off-Site damage, inconvenience, nuisances, and health hazards associated with dust emissions from Contractor's activities.

B. Dust Control Methods:
   1. Dust control may be accomplished by irrigation in which the dust-prone work activity or area of the Site is sprinkled with water until the surface is moist.

2. Apply dust controls as frequently as necessary or required without creating inconveniences, nuisances, or hazards, such as excessive mud and ponding of water at or adjacent to the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
3. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt, mud, and dust onto pavement.
4. Do not allow water used for dust control to discharge to storm water drainage system or surface waters.
5. Where appropriate, reduce travel speed of construction vehicles and construction equipment to reduce the potential for dust emissions arising from vehicle and equipment passage.
6. Where appropriate, apply gravel or other appropriate binder to access roads and parking areas.

C. Removal of Dust and Dirt from Pavement and Other Travelled Ways:
1. Remove dust, mud, and dirt from roads, parking areas, and other travelled ways not less than the frequency indicated in Section 01 74 00 - Cleaning.
2. Remove mud from roads, parking areas, and other travelled ways by appropriate means, including scraping. Avoid damaging surface of travelled way. Remedy damage to roads, parking areas, and travelled ways resulting from mud removal activities.

D. Removal of Dust and Dirt from Buildings and Structures:
1. When dust and dirt from Contractor's activities has accumulated to a noticeable or objectionable extent (compared with preconstruction conditions) on buildings or structures, remove the dust and dirt caused by Contractor's operations by appropriate methods, including power-washing using mild detergent. Remedy damage caused by dust, dirt, and power-washing.
2. Dust in sensitive equipment, such as electrical and control panels, instruments, HVAC systems and other equipment shall be cleaned by a Subcontractor specializing in cleaning such items.
3. During the Project, remove objectionable and noticeable dust, dirt, and mud in areas occupied by Owner or facility manager, and Contractor's work areas, resulting from Contractor's activities. Owner and facility manager will take reasonable measures to avoid tracking dust, dirt, and mud into their occupied areas.
4. Comply with Section 01 74 00 - Cleaning.

## 3.3 PEST AND RODENT CONTROL

A. Pest and Rodent Control – General:
1. Provide pest and rodent controls as necessary to prevent infestation of the Site, storage areas, and adjacent areas.
2. Pests and rodents include, but are not limited to: flies, mosquitoes, gnats, midges, stinging insects, other insects and the like, worms, rats, mice, moles, voles, and similar animals, objectionable numbers and species of birds, and others.
3. Implement appropriate pest and rodent controls when pests, rodents, or both are apparent at the Site or offsite storage, staging, or laydown areas.
4. Control or remove pests and rodents from adjacent properties when Contractor's activities have fostered or exacerbated pest or rodent problems. For example, ground vibration, such as that associated with horizontal directional drilling, may cause migrations of subterranean animals such as moles and voles. Coordinate with affected property owners regarding appropriate control methods, materials, equipment, and disposal techniques.

B. Methods, Materials, and Equipment for Pest and Rodent Control during Construction:
1. Employ methods and use materials and equipment for pest and rodent control that do not adversely affect conditions at the Site or on adjacent and nearby properties.
2. Do not use control methods or poisons injurious to household pets or animals other than targeted pests and rodents.
3. Avoid control methods that present hazards to humans, including children.

C. Disposal of Pests and Rodents:
   1. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled. Do not bury or dispose of deceased animals at the Site or in adjacent areas.

## 3.4 WATER CONTROL

A. Water Control – General:
   1. During the Project. provide methods to appropriately control storm water, surface water, water from excavations and structures, groundwater flows altered by Contractor's activities, and groundwater discharges from the Site, to prevent damage to the Work, the Site, adjacent properties, and downstream properties.
   2. Control trenching, filling, and grading to direct water away from excavations, pits, tunnels and other construction areas, and prevent water from entering existing buildings and structures.
   3. Properly manage and control storm water, surface water, and groundwater entering the Site from upstream, where such flows or discharges have potential to affect the Work or to be exacerbated by Contractor's activities.
   4. Avoid ponding of water onsite, except in specially-designated, temporary settlement basins. Where water ponding occurs during construction, perform rough grading to eliminate ponding.
   5. Prevent water from discharging onto roads, parking areas, paved or finished areas, and other travelled ways. Prevent storm water runoff from discharging across access roads and parking areas.

B. Materials, Equipment, and Facilities for Water Control:
   1. Provide, operate, and maintain materials, equipment, and facilities of adequate size, materials, and capacity to control storm water, surface water, groundwater, and discharges from tanks.

C. Discharge and Disposal of Water during Construction:
   1. Discharge storm water, surface water, and groundwater from the Site, and discharges of clean water from tanks, to proper discharge locations, in accordance with Laws and Regulations and the Contract Documents.
   2. Prevent damage and nuisances arising from water discharges on the Site and discharges from the Site.
   3. Dispose of water in manner that avoids flooding, erosion, sediment transport, and other damage, in accordance with Laws and Regulations.
   4. Avoid overland discharges from the Site and construction activities to adjacent properties,
   5. Water discharges from the Site and construction activities shall be via a storm water drainage route or conduit with sufficient capacity for the flow under associated weather and flow conditions and in accordance with requirements of authorities having jurisdiction
   6. Do not discharge storm water, surface water, groundwater, or clean water from tanks, into sanitary sewers. Obtain consent of sewerage system owner before discharging such flows into existing combined sewers.
   7. Obtain sewerage system owner's consent and approval before discharging polluted water to sewerage system.

## 3.5 POLLUTION CONTROL

A. Comply with section 00290.30 of the Oregon Standard Specifications for Construction 2024.

## 3.6 ODOR CONTROL DURING CONSTRUCTION

A. Odors – General:
   1. Avoid discharges of unpleasant or noxious odors from construction and related activities. Whether nature of the Work is such that odor generation is unavoidable, provide appropriate temporary controls for odors.
   2. Give priority to avoiding odor generation, followed by:

a. Counteracting (treating the cause of) odors.
b. Containing odors.
c. Odor masking as the last resort for odor control.

## 3.7 EROSION AND SEDIMENT CONTROLS

A. Installation and Maintenance of Temporary Erosion and Sediment Controls – General:
1. General Provisions:
a. Provide temporary erosion and sediment controls as shown and indicated on the Drawings and as indicated in this Section and elsewhere in the Contract Documents, and as necessary for compliance with Laws and Regulations.
b. Provide erosion and sediment controls as the Work progresses into areas where ground cover was previously undisturbed.
c. Use necessary and required methods to appropriately control erosion and sediment transport in storm water runoff, including using soil conservation-oriented construction practices (including scheduling and sequencing), vegetative measures, and temporary physical controls.
d. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in this Section's "Quality Assurance" Article (unless more-stringent requirement are shown or indicated in the Contract Documents), to control erosion and sediment transport in storm water runoff during the Project.
e. Plan and execute disturbances of soils and soil cover, and earthwork by methods to control storm water runoff from exposed soil (including stockpiles, borrow areas, and spoil disposal areas), banks of surface waters affected by the Work, and discharges of groundwater, to prevent erosion and sediment transport.
f. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provide measures for regulating storm water discharges and controlling erosion and sediment transport. Where Owner is a co-permittee with Contractor for applicable permits, or when plans for temporary erosion and sediment controls were sealed and signed by Engineer, such methods are subject to Engineer's approval or acceptance, as applicable.
g. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
2. Coordination:
a. Coordinate temporary erosion and sediment controls with this Section's requirements on water control and Section 01 41 26 - Storm Water Pollution Prevention Plan and Permit.
b. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities, permanent erosion controls and soil stabilization (if any), and other Work, to the extent necessary for effective and continuous erosion and sediment controls.
3. Before commencing activities that will disturb soil or soil cover at the Site or other areas to be occupied by Contractor during the Project, provide all appropriate temporary erosion and sediment controls required by the Contract Documents for the areas where soil or soil cover will be disturbed.
4. Vegetation Removal and Disturbance:
a. Remove only those shrubs, grasses, trees, and other vegetation that must be removed for construction.
b. Protect undisturbed vegetation. Do not wantonly or unnecessarily drive construction vehicles and equipment over undisturbed vegetation and soil cover.
c. Promptly stabilize exposed soil where vegetation or soil cover was unnecessarily disturbed. Fill and restore ruts and damage to vegetation and soil cover caused by wanton or unnecessary passage of construction vehicles and equipment.
5. Access Roads and Parking Areas:
a. When possible, locate and construct temporary access roads and parking areas to avoid adverse effects on the environment.

b. Provide measures to regulate drainage, avoid erosion and sediment transport in storm water runoff, and minimize damage to vegetation and soil cover.

6. Earthwork and Temporary Controls:
   a. Perform excavation, fill, and related activities in accordance with Section 31 23 00 - Earthwork 31 23 33 - Trenching, Backfilling, and Compacting for Utilities and Section 31 23 19 - Dewatering.
   b. Temporary erosion and sediment control measures may include, but are not limited to, using berms, swales and ditches, silt fencing, straw bale sediment barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible soils and other erodible materials exposed by construction activities.
   c. Minimize areas of bare soil exposed at one time. Provide fills and spoil areas by selectively placing fill and spoil materials to reduce or eliminate exposed erodible soils.
   d. Exercise special care on and above steep slopes, where disturbance of vegetation and soil cover shall be minimized to greatest extent reasonably practicable.
   e. Protect stockpile storage not in active use by providing suitable, durable covering prevent sediment transport in storm water runoff and windblown transport. Covering shall be suitable for outdoor exposure.
7. Inspection and Maintenance:
   a. Periodically inspect areas of non-stabilized, erodible soils, including all areas of soil cover disturbance and stockpiles, for evidence of start of erosion and sediment transport. Promptly implement corrective action as necessary and appropriate to control erosion and sediment transport. Continue inspections and corrective action until soils are permanently stabilized and permanent vegetation has been appropriately established.
   b. Inspect not less often than once per week and after each precipitation event of 0.5 inches of water or greater.
   c. Repair or replace damaged erosion and sediment controls within 24 hours of Contractor becoming aware of such damage.
   d. Periodically remove sediment that has accumulated in or behind sediment and erosion controls. Remove sediment not less often than when sediment is at approximately one-half of storage capacity of associated control element, unless more-frequent interval is indicated elsewhere in the Contract Documents Properly dispose of sediment.
8. Duration of Temporary Erosion and Sediment Controls:
   a. Maintain temporary erosion and sediment controls in effective, working condition until soil cover of the associated storm water drainage area has been permanently stabilized.
9. Work Stoppage:
   a. If the Work is temporarily stopped or suspended for any reason, Contractor shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
   b. When temporary erosion and sediment controls remain in place during periods of stopped or suspended Work, continue to perform Contractor's obligations relative to periodic inspection and maintenance of temporary erosion and sediment controls, including removal of accumulated sediment.
10. Failure to Provide Adequate Temporary Erosion and Sediment Controls:
    a. If Contractor repeatedly fails to satisfactorily control erosion and sediment transport in storm water runoff, Owner reserves the right to use Owner's own forces or employ a third-party contractors for temporary erosion and sediment control. Owner's costs for such work, including engineering and inspection costs, will be deducted from amounts due Contractor, as set-offs in accordance with the Contract Documents.

B. Erosion and Sediment Control Permit:
   1. Comply with permit requirements indicated in Section 01 41 24 - Permit Requirements.

C. Silt Fencing:

1. Provide and maintain silt fencing in a vertical plane, at the locations shown or indicated in the Contract Documents and where necessary or required.
2. Locations of Temporary Silt Fencing:
   a. Where possible, provide silt fencing along contour lines, so each run of silt fencing is at the same elevation.
   b. On slopes, provide temporary silt fencing at intervals that do not exceed the maximum indicated in the following table:

| Silt Fence Spacing on Slopes | |
|---|---|
| Slope (percent) | Maxim Allowable Length of Slope Above Each Silt Fence (feet) |
| 2 and less | 150 |
| 2.1 to 5 | 100 |
| 5.1 to 10 | 50 |
| 10.1 to 20 | 25 |
| 20.1 to 25 | 20 |
| 25.1 to 40 | 15 |
| 40.1 to 50 | 10 |

   c. Provide temporary silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated spoil material. Install silt fencing before expected soil is subject to precipitation. Maintain until stockpile is removed.
   d. Do not install temporary silt fencing at the following types of locations:
      1) Area of concentrated storm water flows such as ditches, swales, or channels.
      2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
      3) Across upstream or discharge ends of storm water conduits.
3. Installation:
   a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.
   b. When two sections of filter cloth are adjacent to each other, fold over edges and overlap by not less than 6 inches and securely fasten to wire mesh.
   c. Embed posts in the ground to the depth necessary for proper controls; embed posts to not less than 16 inches below ground.
   d. Filter cloth and wire mesh shall extend not less than 8 inches below ground and not less than 16 inches above ground.
   e. Remove accumulated sediment from behind silt fencing as necessary or required. Repair and reinstall silt fencing as necessary or required.
4. Maintenance:
   a. Do not allow formation of concentrated storm water flows on slopes above temporary silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via other appropriate stabilization methods as necessary and required to prevent flow of concentrated storm water flows toward temporary silt fencing.

D. Straw Bale Dike.
1. Provide temporary straw bale dikes where shown or indicated and where necessary or required, including in swales, along contours, and along toe of slopes.
2. Provide temporary straw bales in shallow excavation as wide as the bale and approximately 4 to 6 inches below surrounding grade.
3. Ends of straw bales shall tightly abut ends of adjacent straw bales.

4. Securely install each straw bale using two support posts, driven into the ground not less than 1.5 to 2 feet below bottom of straw bale. Top of post shall be flush with top of straw bale. Angle first post for each straw bale toward the previously-installed straw bale.
5. Frequently inspect straw bales and repair or replace as required. Remove accumulated sediment and debris from behind straw bales.

E. Mulching and Soil Stabilization:
1. Use mulching to temporarily stabilize exposed soil, including spoil and fill materials.
   a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
   b. Application of mulching for soil stabilization shall be as follows.
      1) Non-Rotted Straw or Salt Hay: Provide 1.5 to two tons per acre.
      2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.
      3) Wood-Fiber or Paper-Fiber Application: Provide 1,500 pounds per acre, installed by hydroseeding.
   c. Where mats or netting are used:
      1) Cover entire area to be stabilized with mats or netting.
      2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, 4 inches or more wide, at top and bottom of slope. Ensure that mesh or netting is secure and will not wash out over time. Tamp trench full of soil. 4 inches from trench, secure mat or netting with appropriate staples at intervals of 10 inches.
      3) Overlap adjacent strips of mat or netting by not less than 4 inches.

F. Protection of Storm Water Drainage Inlets and Catch Basins:
1. Protect each drainage inlet and catch basin that has potential to receive storm water runoff from exposed soils and does not discharge into a storm water settlement basin.
2. Provide temporary inlet protection as shown on the plans.
3. When removing sediment from inlet protection device, do not dump contents into the drainage inlet or catch basin. Promptly remove from drainage inlets and catch basins sediment accidentally dumped into the structure.
4. Remove sediment from protection device, or replace device, as recommended by manufacturer .

G. Temporary Settlement Basin:
1. For constructing embankments comply with requirements in Division 31 Specifications on embankments, excavation, and fill.
2. Overflow Weir and Discharge Pipe:
   a. Provide piping in accordance with manufacturer's instructions. Where permanent piping will be used for temporary settlement basin, provide piping in accordance with the Contract Documents and fully clean piping prior to Substantial Completion.
   b. Provide overflow weirs at elevation(s) shown or indicated on the Drawings. When not shown or indicated in the Contract Documents, discharge weir elevation(s) shall be in accordance with design by licensed, professional civil engineer retained by Contractor or Subcontractor. Such design and temporary construction shall avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulic performance.
   c. Wrap and secure geotextile material specified for temporary silt fencing around discharge structures of temporary settlement basins
3. Crushed Stone and Riprap: Provide in accordance with Division 31 Specifications on excavation, fill, and riprap. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of each settlement basin's discharge piping.
4. Remove sediment when necessary or required, based on accumulation of material.
5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir, discharge piping, and spillway, fill the temporary settlement basin to

required grade in accordance with requirements of Division 31 Specifications on excavation and fill, and provide landscaping in accordance with the Contract Documents.

H. Filter Bag on Dewatering Pump Discharge:
   1. Provide dewatering of excavations in compliance with Section 31 23 00 - Earthwork 31 23 33 - Trenching, Backfilling, and Compacting for Utilities and Section 31 23 19 - Dewatering.
   2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private and public property, and Owner's and facility manager's operations. Relocate filter bags and appurtenances when necessary or required.
   3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roads, driveways, access roads, parking areas, other travelled ways, or overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
   4. Provide filter bag on discharge of each dewatering pump drawing from an excavation or other area with exposed soil.
   5. Securely attach filter bag to pump discharge pipe or hose.
   6. Maintain, clean out, and replace filter bags as necessary or required.

I. Temporary Stone Construction Entrance:
   1. Where shown on the Drawings, and where construction vehicles will regularly transition to paved surfaces from unstabilized surfaces, provide temporary stone construction entrance. Contractor vehicles and mobile construction equipment and machinery shall use temporary stone construction entrances.
   2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by 8 inches deep.
   3. Installation:
      a. Ensure that subgrade under each temporary stone construction entrance is suitably dense for the intended purpose and dry. Suitably prepare subgrade as necessary for temporary stone construction entrance.
      b. Provide on subgrade a layer of geotextile separation fabric, installed in accordance with geotextile separation fabric manufacturer's recommendations for separation.
      c. Provide stone on installed geotextile separation fabric. Grade the stone for passage of vehicles.
   4. Maintenance:
      a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
      b. When upper layer of temporary stone construction entrance becomes contaminated with soil, mud, or other material, remove the contaminated material and replace with clean stone.
      c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is unacceptable.

## 3.8 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:
   1. Unless otherwise indicated elsewhere in this Section in requirements for respective temporary controls, upon completion of the associated Work and when temporary controls are no longer necessary, remove temporary controls and restore the Site to condition in accordance with the Contract Documents; if condition is not shown or indicated, restore the Site to pre-construction condition.
   2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

**END OF SECTION**

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# SECTION 01 61 03
## EQUIPMENT - BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 81 10 - Wind and Seismic Design Criteria.
   4. Section 03 15 19 - Anchorage to Concrete.
   5. Section 03 31 30 - Concrete, Materials and Proportioning.
   6. Section 05 50 00 - Metal Fabrications.
   7. Section 07 92 00 - Joint Sealants.
   8. Section 09 96 00 - High Performance Industrial Coatings.
   9. Section 10 14 00 - Identification Devices.
   10. Section 26 05 09 - Motors.
   11. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
   12. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   13. Section 40 67 00 - Control System Equipment Panels and Racks.
   14. Section 40 71 00 - Flow Instrumentation.
   15. Section 40 72 00 - Level Instrumentation.
   16. Section 40 73 00 - Pressure Instrumentation.
   17. Section 40 74 00 - Temperature Instrumentation.
   18. Section 40 75 00 - Process Liquid Analytical Measurement.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. ASTM International (ASTM):
      a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
      b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   4. Hydraulic Institute (HI):
      a. 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Valves.
   5. International Electrotechnical Commission (IEC).
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   7. International Organization for Standardization (ISO):
      a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
      b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.
   8. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG 1, Motors and Generators.

9. InterNational Electrical Testing Association (NETA):
    a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
10. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC):
11. National Institute for Certification in Engineering Technologies (NICET).
12. National Institute of Standards and Technology (NIST).
13. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
14. Underwriters Laboratories, Inc. (UL).
    a. 508, Standard for Safety Industrial Control Equipment.
    b. 508A, Standard for Safety Industrial Control Panels.
    c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
15. Vibration Institute.

B. Natural frequency analysis firm:
    1. An independent firm, whose sole or principal part of its business is the calculation of and analysis of natural frequencies of rotating equipment.
    2. Minimum of 10 years' experience.
    3. Employs a registered professional engineer who has experience in finite element analysis, rotordynamic analysis and experimental modal analysis.
        a. Minimum five years combined field testing and data analysis experience.
        b. Qualified Vibration Category III certification from the Vibration Institute.

C. Vibration Testing Program:
    1. Testing firm:
        a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
        b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
    2. Field personnel:
        a. Minimum of three years field experience covering all phases of field vibration testing and data gathering.
        b. Qualified Vibration Category II certification from the Vibration Institute.
    3. Analysis personnel:
        a. Minimum five years combined field testing and data analysis experience.
        b. Qualified Vibration Category III certification from the Vibration Institute.

D. Electrical Equipment and Connections Testing Program:
    1. Testing firm:
        a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
        b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
    2. Field personnel:
        a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
        b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
        c. Supervisor certified by NETA or NICET.
    3. Analysis personnel:
        a. Minimum three years combined field testing and data analysis experience.
        b. Supervisor certified by NETA or NICET.

E. Miscellaneous:
   1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
      a. More than one manufacturer is listed for a given "product" in Specifications.
      b. No manufacturer is listed.
   2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations shown on Electrical Power Drawings and defined in the Electrical specifications.

## 1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:
   1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;
   2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
   3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:
   1. One or more assemblies capable of performing a complete function.
   2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
   3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. General for all equipment:
      a. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
      b. Data sheets that include manufacturer's name and complete product model number.
         1) Clearly identify all optional accessories that are included.
      c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
      d. Manufacturer's delivery, storage, handling, and installation instructions.
      e. Equipment identification utilizing numbering system and name utilized in Drawings.
      f. Equipment installation details:
         1) Location of anchorage.
         2) Type, size, and materials of construction of anchorage.
         3) Anchorage setting templates.
         4) Manufacturer's installation instructions.
      g. Equipment area classification rating.
      h. Shipping and operating weight.
      i. Equipment physical characteristics:
         1) Dimensions (both horizontal and vertical).
         2) Materials of construction and construction details.
      j. Equipment factory primer and paint data.
      k. Manufacturer's recommended spare parts list.
      l. Equipment lining and coatings.

m. Equipment utility requirements include air, natural gas, electricity, and water.
n. Ladders and platforms provided with equipment:
    1) Certification that all components comply fully with OSHA requirements.
    2) Full details of construction/fabrication.
    3) Scaled plan and sections showing relationship to equipment.

2. Staff qualifications and certificates for firms completing testing of equipment
3. Mechanical and process equipment:
    a. Operating characteristics:
        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
        2) Brake horsepower requirements.
        3) Copies of equipment data plates.
    b. Piping and duct connection size, type and location.
    c. Equipment bearing life certification.
    d. Equipment foundation data:
        1) Equipment center of gravity.
        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
4. Electric motor:
    a. Motor manufacturer and model number.
    b. Complete motor nameplate data.
    c. Weight.
    d. NEMA design type.
    e. Enclosure type.
    f. Frame size.
    g. Winding insulation class and temperature rise.
    h. Starts per hour.
    i. Performance data:
        1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage a minimum permissible or specified terminal voltage for all motors over 100 HP.
        2) Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 100 HP.
        3) Guaranteed minimum efficiencies at 100 PCT, 75 PCT, and 50 PCT of full load.
        4) Guaranteed minimum power factor at 100 PCT, 75 PCT, and 50 PCT of full load.
        5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
        6) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
    j. Bearing data and lubrication system.
    k. Natural frequency calculations for:
        1) Completed assembly including but not limited to the equipment base, rotating piece of equipment, and the rotating piece of equipment driver.
        2) Individual piece of rotating equipment.
        3) Equipment driver and connected gear reducer, if applicable.
    l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.
    m. Recommended size of power factor correction capacitors to improve power factor to 0.95 lagging when operated at full load.
    n. Fabrication and/or layout drawings:
        1) Dimensioned outlined drawing.
        2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
    o. Certifications:

1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
2) When utilized with a variable frequency controller, certify motor is inverter duty.
a) Include minimum speed at which the motor may be operated for the driven machinery.

p. Electrical gear:
1) Unless specified in a narrow-scope Specification Section, provide the following:
a) Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
2) Control panels:
a) Panel construction.
b) Point-to-point ladder diagrams.
c) Scaled panel face and subpanel layout.
d) Technical product data on panel components.
e) Panel and subpanel dimensions and weights.
f) Panel access openings.
g) Nameplate schedule.
h) Panel anchorage.
i) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.

5. Systems schematics and data:
a. Provide system schematics where required in system specifications.
1) Acknowledge all system components being supplied as part of the system.
2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
3) Provide technical data for each system component showing compliance with the Contract Document requirements.
4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.
6. For factory painted equipment, provide paint submittals in accordance with Section 09 96 00.
7. Qualifications and staff certificates for:
a. Natural frequency analysis firm and personnel.
b. Vibration testing firm and personnel.
c. Infrared thermography testing firm and personnel.
d. Electrical equipment and connections testing firm and personnel.
8. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:
a. Natural frequency analysis and calculations.
b. Vibration testing.
c. Thermography testing.
d. Electrical equipment and connection testing.

B. Factory Test Reports:
1. Natural frequency bump test reports where required for rotating equipment.
a. Minimum characteristics of impact hammer.
1) Frequency Range 1 kHz.
2) Range (5v output) 5,000 LBF (22,200 N).
3) Hammer Sensitivity (7pprox.) 1 mV/lbf (0.23 mV/N).
4) Resonant Frequency 12 kHz
2. Motor, equipment and final assembled equipment including motor.
a. Determine natural frequency of assembled motor prior to shipping to OEM or job site.
1) Individual motor fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.
b. Determine natural frequency of the pump.

1) Pump fastened to an "infinitely rigid" mass at the same bolt circle as the final assembled equipment.

c. Determine natural frequency of the pump/motor assembly.
1) Pump/motor assembly fastened to an "infinitely rigid" mass at the same bolt circle as the final field assembled equipment.

d. For this use, the "infinitely rigid" mass shall be at least 10 times the weight of the equipment being tested.

3. Submit natural frequency report(s) for approval prior to shipment.
4. Equipment performance tests.
a. As listed in individual equipment specifications.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
1. Notification, at least one week in advance, that testing will be conducted at factory.
2. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
3. Submit sample Manufacturer's Field Service Report (MFSR). Report shall use manufacturer's standard report or use the form in the Exhibits and have at least the following information:
a. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
b. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
c. Motor test reports.
d. Field noise testing reports if such testing is specified.
e. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
f. Provide three bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
1) Include the acceptance criteria of all equipment tested.
2) Provide individual tabbed sections for information associated with each piece of tested equipment.
g. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
h. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
4. Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Motors:
a. Baldor.
b. General Electric.

c. Hyundai Heavy Industries.
d. Marathon Electric.
e. Rockwell - Reliance.
f. Siemens.
g. TECO-Westinghouse.
h. Toshiba U.S.
i. U.S. Motors, Nidec Motor Corporation.
j. WEG.

2. Mechanical variable speed drives:
   a. Reeves.
   b. U.S. Motors (VariDrive).

B. Submit request for substitution in accordance with Section 01 25 13.

## 2.2 MANUFACTURED UNITS

A. Electric Motors:
1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
2. Design for frequent starting duty equivalent to duty service required by driven equipment.
3. Design for full voltage starting.
4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
5. Size for altitude of Project.
6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
8. AC electric motors less than 1/3 HP:
   a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
   b. Permanently lubricated sealed bearings conforming to ABMA standards.
   c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
9. AC electric motors 1/3 to 1 HP:
   a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
   b. Permanently lubricated sealed bearings conforming to ABMA standards.
      1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
10. AC electric motors 1-1/2 to 10 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
11. AC electric motors greater than 10 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
       1) Design bearing life for 90 PCT survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
       2) For motors greater than 100 HP, design bearing life for 90 PCT survival rating at 100,000 HRS of operation.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
    d. Thermal protection:
       1) For motors 50 HP and above controlled from a variable frequency drive and for all other motors 100 HP and above, provide integral thermal detectors with normally closed contacts that will open on overtemperature or resistance type temperature

detector (RTD) complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.

a) Two thermal sensing devices per phase in each phase hot-spot location.
b) Monitor and alarm panel:
   (1) For constant speed motors, install panel in and energize from the motor starter equipment.
   (2) For variable speed motors, install panel in and energize from the variable speed drive equipment.

12. Severe duty motor to have the following minimum features:
    a. All cast iron construction.
    b. Gasketed conduit box.
    c. Epoxy finish for corrosion protection.
    d. Hydroscopic varnish on windings for corrosion protection.
    e. Drain plug and breather.

B. NEMA Design Squirrel Cage Induction Motors:
1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
4. For use on variable frequency type adjustable speed drives, provide:
   a. Induction motors that are in compliance with NEMA MG 1, Part 31.
   b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
   c. Insulated drive end bearing on all motors.
   d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
   e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.
   f. Shaft grounding ring on all motors:
      1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
      2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
   g. Have the following minimum turndown ratio without the use of additional cooling, such as a blower, to provide continuous supply of cooling air over the motor.
      1) Variable torque: 10:1.
      2) Constant torque: 6:1.
5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DEGC ambient.
6. Design motors for continuous duty.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 PCT greater than the maximum HP requirements of the driven equipment over its entire operating range.
   a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.
8. Motor enclosure and winding insulation application:
   a. The following shall apply unless modified by specific Specification Sections:

| MOTOR LOCATION | MOTOR ENCLOSURE / WINDING INSULATION |
|---|---|
| Unclassified Indoor Areas | WP-I (for vertical motors) standard insulation, TEFC, Standard Insulation |

| MOTOR LOCATION | MOTOR ENCLOSURE / WINDING INSULATION |
|---|---|
| Wet indoor Areas | TEFC, Standard Insulation, TEFC, Encapsulated Windings, WP-II (for vertical motors) |
| Wet outdoor Areas | TEFC, Extra Dip and Bake for Moisture, TEFC Encapsulated Windings |
| Corrosive Areas | TEFC, Severe/ Chemical Duty |
| Class I, Division 1 Areas | Explosion Proof, Approved for Class I Division 1 Locations |
| Class II, Division 1 Areas | Explosion Proof, Approved for Class II Division 1 Locations |
| Class I or Class II, Division 2 Areas | Explosion Proof, Approved for Division 1 Locations or TEFC with maximum external frame temperature compatible with the gas or dust in the area, Encapsulated Windings |

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
10. Balance motors to ISO G2.5 level.
    a. Submit prior to shipping to OEM or job site.

C. Submersible Motors: Refer to individual narrow-scope Specification Sections for submersible motor requirements.

D. V-Belt Drive:
1. Provide each V-belt drive with sliding base or other suitable tension adjustment.
2. Provide V-belt drives with a service factor of at least 1.6 at maximum speed.
3. Provide static proof belts.

E. Mechanical Variable Speed Drives:
1. Oil-lubricated shaft-mounted reduction gear drive capable of 300 PCT shock load and providing a 1.5 service factor in accordance with AGMA.
2. Assure infinite speed adjustment over a 4:1 range.
3. Secure drive to equipment base.
4. Flexible coupling between drive shaft and equipment shaft.

F. Vibration Isolators:
1. Provide all equipment subject to vibration with restrained spring type vibration isolators or pads according to the manufacturer's written recommendation.

G. Space Heaters:
1. Silicone rubber strip type, 120 V rated.
2. Provided on:
    a. All motors 10 HP and larger mounted outdoors.
    b. Indoor motors in humid environments as indicated.

## 2.3 COMPONENTS

A. Gear Drives and Drive Components:
1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
3. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.
4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
5. Gear reducers:
    a. Provide gear reducer totally enclosed and oil lubricated.

b. Utilize antifriction bearings throughout.
c. Provide worm gear reducers having a service factor of at least 1.20.
d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

## 2.4 ACCESSORIES

A. Guards:
1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
2. Interior applications:
a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. Exterior applications:
a. Construct from 16 GA stainless steel or aluminum.
b. Construct to preclude entrance of rain, snow, or moisture.
c. Roll to conform to shaft or coupling surface.
d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
1. Cast-in-place anchorage:
a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
c. Provide two nuts for each bolt.
2. Drilled anchorage:
a. Adhesive anchors per Section 03 15 19.
b. Epoxy grout per Section 03 31 30.
c. Threaded rods same as cast-in-place.

C. Data Plate:
1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:
1. Provide at the following locations:
a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
b. At locations identified on Drawings.
2. Utilize tapping sleeves for mounting per Section 40 05 00.

E. Lifting Eye Bolts or Lugs:
1. Provide on all equipment 50 LBS or greater.
2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

## 2.5 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
   1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
   1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.
   1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
   2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07 92 00.

I. Natural frequency/critical Speed:
   1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
   2. Excessive vibration is sufficient cause for equipment rejection.
   3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.

J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
   1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.
   2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
   3. Affix entire assembly with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to delivery.
      a. Control panels without an affixed UL 508A or UL 698A label shall be rejected.
   4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
      a. Determine the SCCR rating by one of the following methods:
         1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
         2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
         3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
      b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
      c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

## 2.6 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:
   1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Section 09 96 00 to receive field painting.
      a. Field painted equipment: See Section 09 96 00 for factory applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Section 09 96 00.
   1. See Section 09 96 00 for factory applied primer/field paint compatibility requirements.

## 2.7 SOURCE QUALITY CONTROL

A. Motor Tests:
   1. Test motors in accordance with NEMA and IEEE standards.
   2. Provide routine test for all motors.
   3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
      a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
      b. Pay all costs, including shipping and handling, for all motors failing the tests.
      c. If two successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

B. Balance:
   1. Unless specified otherwise, for all equipment 10 HP or greater, all rotating elements in motors, pumps, blowers, and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. Balance all rotating elements to the following criteria, per ISO 21940-11:

$$Uper = \frac{G \; x \; 6.015 \; x \; W/2}{N}$$

Where:
Uper = Permissible residual unbalance for each correction plane in ounce-inches (OZ-IN). See ISO 21940-11 for acceptable values.
G = ISO Balance Quality Grade Number, per ISO 21940-11
W = Rotor weight in pounds
N = Maximum continuous operating RPM

   a. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
   1. Route clear of major traffic areas and as approved by Engineer.

D. DO NOT construct foundations until major equipment supports are approved.

E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

F. Equipment Base:
   1. Construct level in both directions.
   2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Base:
   1. Mount machine base of rotating equipment on equipment base.
      a. Level in both directions, using a machinist level, according to machined surfaces on base.

2. Level machine base on equipment base and align couplings between driver and driven unit using stainless steel blocks and shims.
    a. Blocks and shims milled flat and coplanar of both faces.
    b. Maximum of 3 shims under each foot.
    c. Size blocks and shims to provide solid support at each mounting bolt location.
        1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.
    d. Provide blocks and shims at each mounting bolt.
        1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
    e. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

H. Rotating equipment Couplings:
1. Align in the annular and parallel positions.
    a. For equipment rotating at 1200 RPM or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
    b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
    c. For equipment rotating at speeds greater than 1200 RPM allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:
1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
    a. Extend dam or formwork to cover leveling shims and blocks.
    b. Do not use nuts below the machine base to level the unit.
2. Saturate top of roughened concrete subbase with water before grouting.
    a. Add grout until entire space under machine base is filled to the top of the base underside.
    b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
    a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
    b. When the grout has fully hardened (after a minimum of seven days) tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
    c. Recheck driver-driven unit for proper alignment.

## 3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
1. Has been properly installed and lubricated.
2. Is in accurate alignment.

3. Is free from any undue stress imposed by connecting piping or anchor bolts.
4. Has been operated under full load conditions and that it operated satisfactorily.
    a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.
1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

## 3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Section 10 14 00.

## 3.4 FIELD PAINTING AND PROTECTIVE COATINGS

A. For required field painting and protective coatings, comply with Section 09 96 00, High Performance Industrial Coatings.

## 3.5 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.
1. Wrapping thickness shall be 150 PCT of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

## 3.6 FIELD QUALITY CONTROL

A. General:
1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
2. Execute pre-demonstration requirements in accordance with Section 01 75 00.
3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
4. Provide testing of electrical equipment and connections in accordance with the Electrical specifications.
5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
    a. Contract Drawings and Specifications.
    b. Related construction change documentation.
    c. Approved Shop Drawings.
    d. Approved Operation and Maintenance Manuals.
    e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:
1. Approved in accordance with Shop Drawing submittal schedule.
2. Included as a minimum:
    a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
    b. List and description of testing and analysis equipment to be utilized.
    c. List of all equipment to be testing, including:
        1) Name and tag numbers identified in the Contract Documents.
        2) Manufacturer's serial numbers.
        3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
1. Minimum calibration frequency:

a. Field analog instruments: Not more than 6 months.
b. Field digital instruments: Not more than 12 months.
c. Laboratory instruments: Not more than 12 months.
d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.

2. Carry current calibration status and labels on all testing instruments.
3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
1. Provide reports with tabbed sections for each piece of equipment tested.
2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
a. Include legible copies of all forms used to record field test information.
3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:
a. Equipment identification, including:
1) Name and tag numbers identified in the Contract Documents.
2) Manufacturer's serial numbers.
3) Other pertinent manufacturer identification,
b. Date and time of each test.
c. Ambient conditions including temperature, humidity, and precipitation.
d. Visual inspection report.
e. Description of test and referenced standards, if any, followed while conducting tests.
f. Results of initial and all retesting.
g. Acceptance criteria.
h. "As found" and "as left" conditions.
i. Corrective action, if required, taken to meet acceptance.
j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
k. Instrument calibration dates of all instruments used in testing.
5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:
1. Perform testing on Electrical equipment and connections in accordance with the Electrical specification requirements.
2. Testing of motors:
a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 50 HP or above.
b. Ensure motor has been lubricated.
c. Bump motor to check for correct rotation.
3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Other Testing:
1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

G. Equipment Vibration Monitoring and Testing Program:

1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
2. Provide vibration testing on all rotating and reciprocating equipment having driver 50 HP and greater.
3. Additional requirements for vibration monitoring and testing equipment at 25 DEGC:
   a. Requirements for analyzer.
      1) Frequency range: 10 Hz to 20 kHz.
      2) Frequency Accuracy: 0.02 PCT.
      3) Non-integrated spectral amplitude accuracy: 5 PCT, 3 Hz to 65 kHz.
      4) Single integrated spectral amplitude accuracy: 5 PCT 10 Hz to 20 kHz.
      5) Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
      6) Capable of two-place computer balancing.
   b. Requirements for vibration sensor at 25 DEGC:
      1) Sensitivity: ±5 PCT = 100 mV/g.
      2) Acceleration range: ±50 g.
      3) Amplitude nonlinearity: ±1 PCT.
      4) Frequency response: ±10 Hz to 7 kHz (±3 dB).
      5) Permanently attach vibration test and monitoring mounting pads to mechanical equipment at location recommended by the equipment manufacturer or as recommended by the testing firm.
4. Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria.
5. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
   a. ANSI/HI 11.6-2012 for Submersible Pumps in a Wet-pit or Dry-pit configuration.
   b. ANSI/HI 9.6.4-2009 for all other centrifugal pumps.
6. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.
7. Utilize an Engineer approved testing agency to perform vibration monitoring and testing on equipment.
8. Permanently attach vibration test and monitoring mounting pads to the equipment at locations recommended by the equipment manufacturer or as recommended by the vibration testing agency.
9. Utilize mounting pads suitable for permanent installation and for incorporation into a predictable maintenance program.
10. For variable speed equipment provide vibration testing at 1 Hz increments of VFD speed throughout entire operating range.
11. Diagnosis to include, but is not limited to the following:
    a. Unbalance.
    b. Misalignment.
    c. Bent shaft.
    d. Journal bearing related problems.
    e. Rolling contract bearing problems.
    f. Mechanical looseness.
    g. Resonance.
    h. Foundation flexibility.
    i. Electrically induced problems.
    j. Pump problems.
    k. Fan problems.
    l. Coupling problems.
    m. Drive belt problems.
    n. Gear problems.
    o. Centrifugal compressor problems.
    p. Electric motor induced vibration from VFD or VFD carrier frequency.
    q. Natural frequency of the installed equipment.

12. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.
13. Tolerances for pumping equipment shall be per HI published standards.
14. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
15. Document testing with written report.
    a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
    b. Natural frequency of installed equipment utilizing an impact hammer.
    c. Report to include graphical plots of vibration signature for each test point at a scale which illustrates all vibration levels greater than 0.025 ips RMS.

## 3.7 DEMONSTRATION

A. Demonstrate equipment in accordance with Section 01 75 00.

## 3.8 ABBREVIATION TABLE

A. As indicated on the Drawings.

**END OF SECTION**

## EXHIBIT A

## MANUFACTURER FIELD SERVICE REPORT

This field service report is generic in nature. An electronic copy of this form will be furnished upon request from the Engineer. This report is to reflect that all requirements of the Operations and Maintenance Manual and the individual equipment specification requirements have been performed for the installation and operation and also to provide a baseline for amperage draw for each phase, vibration readings, rotation, alignment and all other applicable tests required to insure that the equipment has been installed properly. A MFSR will be required for each individual piece of equipment requiring a MFSR.

**Definitions of Reports:**

Initial service report: Required for construction preparations. Equipment delivered to site is in good condition and conforms to specification requirements. Anchor bolts, hardware and ancillary items (piping, flanges, conduits, fuel/power supply) are compatible with equipment.

Interim service report: Required for equipment installation onto base or foundation. Piping connections, electrical and control connections or structural attachment are complete. For equipment stored on site over four weeks, interim service report will document that manufacturer's long-term storage procedures have been incorporated and equipment has not been damaged, nor coatings deteriorated.

Final service report is to be completed when equipment can be started, electrical amperage and voltage draw measured, cold and hot alignments performed, vibration testing and monitoring performed and the equipment is found to be in compliance with Manufacturer's operating parameters and the requirements of the individual equipment specifications.

**PROJECT:** _____

**Report Status:**

Initial Service Report completed and submitted on _____

Interim Service Report completed and submitted on _____

Final Service Report completed and submitted on _____

Commencement of Warranty _____

**I Description**

A. Equipment Name and Identification: _____

_____

B. Serial Number: _____

C. Specification Section Number: _____

D. Manufacturer: _____

E. Representative: _____

F. Type of Service: Initial _____ Interim _____ Final _____

**II General Review**

A. The above referenced equipment/material/supplies have been inspected, checked, and adjusted. Yes _____ No _____

Summary: _____

_____

B. The above referenced equipment/material/supplies were placed upon properly prepared or suitable substrate. N/A _____ Yes _____ No _____

Summary: _____

_____

C. The above referenced equipment/material/supplies are free from any undue stress imposed by any connected piping, anchor bolts or any other load. N/A _____ Yes _____ No _____

Summary: _____

_____

D. The above referenced equipment/material/supplies have operated under design conditions. N/A _____ Yes _____ No _____

Summary: _____

_____

E. The above referenced equipment/material/supplies have been installed in accordance with the manufacturer's recommendations and the Procurement Documents, require no corrective work, and are hereby approved. Yes _____ No _____

Summary: _____

_____

F. The above referenced equipment/material/supplies are acceptable to the manufacturer as installed providing the following corrective action(s) are performed:

1. _____
2. _____
3. _____
4. _____
5. _____

**III Inspection Checklist**

| Item | Acceptable (Yes/No) | Readings/Comments |
|---|---|---|
| Bearings (1) | | |
| Belts (tension reading) | | |
| Lubrication Levels | | |
| Vibration (1) (2) (MILS/SEC) | | |
| Infrared Thermography (1) (2) | | |
| Starting AMPS | | |
| Full Load AMPS | | |
| Volts | | |
| Rotation | | |
| Jacket Temperature (DEGF) | | |
| Seal Water Flow Rate (GPH or GPM) | | |
| Seal Water Pressure (PSI) | | |
| O-rings/Packing | | |
| Alignment (1) | | |
| Anchor Bolts | | |

| Item | Acceptable (Yes/No) | Readings/Comments |
|---|---|---|
| Grout | | |
| Substrate Approval | | |
| Sound level (4 FT from unit) (1) (dB) | | |
| Other | | |
| | | |
| | | |
| | | |
| | | |
| | | |

(1) Inspection or testing reports must be attached.
(2) Provide vibration testing and monitoring procedures for Engineer's review and approval prior to testing.

## IV O&M Manuals

A. The O&M manual as presented contains all information required for proper operation, maintenance, and instruction of this system. N/A _____ Yes _____ No _____

Summary: _____

_____

## V Preventive Maintenance

A. The preventive maintenance summary outlined in the O&M manual is acceptable for operation of the system throughout the warranty period. N/A _____ Yes _____ No _____

Summary: _____

_____

## VI Operator Training/Classroom Instruction

A. Training and instruction have been performed in accordance with the requirements of the Procurement Documents. N/A _____ Yes _____ No _____

B. Final Training/Classroom Instruction Completed on: _____

Summary: _____

_____

## VII Remarks

_____

_____

_____

## VIII Certification

I hereby certify, that I, _____, am a duly authorized representative of the manufacturer, that I am empowered by the manufacturer to inspect, approve, and operate his equipment, and that I am authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as modified herein. I also certify that all information contained herein is true and accurate.

By: _____
(Authorized Representative)

For: _____

Date: _____

## IX Acknowledgments

By: _____

For: _____
(Contractor)

Date: _____

By: _____

For: _____
(Engineer)

Date: _____

# SECTION 01 65 50
## PRODUCT DELIVERY, STORAGE, AND HANDLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Scheduling of product delivery.
   2. Packaging of products for delivery.
   3. Protection of products against damage from:
      a. Handling.
      b. Exposure to elements or harsh environments.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

C. Payment:
   1. No payment will be made to Contractor for equipment or materials not properly stored and insured or without approved Shop Drawings.
      a. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

### 1.2 DELIVERY

A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.

C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.

D. Protection and Handling: Provide manufacturer's instructions for storage and handling.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PROTECTION, STORAGE AND HANDLING

A. Manufacturer's Instruction:
   1. Protect all products or equipment in accordance with manufacturer's written directions.
      a. Store products or equipment in location to avoid physical damage to items while in storage.
      b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
   2. Protect equipment from exposure to elements and keep thoroughly dry.
   3. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.

B. Contractor Responsibilities:

1. The Contractor is responsible for proper protection, storage, handling, and maintenance of all stored and/or installed equipment until it is handed over to the Owner at project completion.
2. Where manufacturer's written directions are not available, Contractor is responsible for protection, storage and handling in accordance with common industry best practices.

## 3.2 STORAGE FACILITIES

A. Temporary Storage Building:
   1. Provide a weatherproof temporary storage building specifically for the purpose of providing for protection of products and equipment.
      a. Size building to accommodate anticipated storage items.
   2. Equip building with lockable doors and lighting, and provide electrical service for equipment space heaters and heating or ventilation as necessary to provide storage environments acceptable to specified manufacturers.
   3. Provide methods of storage of products and equipment off the ground.
   4. Provide this structure within 60 days after Notice to Proceed.
      a. Locate building on-site where shown on the Drawings or in location approved by Engineer.
      b. Remove building from site prior to startup and demonstration period.

## 3.3 FIELD QUALITY CONTROL

A. Inspect Deliveries:
   1. Inspect all products or equipment delivered to the site prior to unloading.
      a. Reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.

B. Monitor Storage Area: Monitor storage area to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

**END OF SECTION**

# SECTION 01 71 23
FIELD ENGINEERING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for Contractor's onsite recordkeeping.
   2. Contractor's field engineering.
   3. Contractor's surveying and layouts, and associated requirements.
   4. This section supplements the General Conditions' provisions on reference points and other matters.

B. Scope:
   1. Contractor shall provide onsite recordkeeping, field engineering (not related to design of the completed Work), surveying and layout services, and professional services of the types indicated for the Project, including:
      a. Furnishing civil, structural, geotechnical, electrical, and other professional engineering and geology services, whether required by the Contract Documents or necessary in Contractor's judgment, to perform Contractor's means, methods, techniques, sequences, and procedures of construction. Such services do not include professional services associated with delegation of professional design responsibility, which (when required as part of the Work) is addressed elsewhere in the Contract Documents.
      b. Developing and making all detail surveys and measurements required for construction; including slope stakes, batter boards, and all other working lines, elevations, and cut sheets.
      c. Providing materials required for Contractor's benchmarks, control points, batter boards, grade stakes, structure and pipeline elevation stakes, and other items.
      d. Keeping a transit, theodolite, or total station (i.e., theodolite with electronic distance measurement device); leveling instrument; and related implements such as survey rods and other measurement devices, at the Site at all times, and having a skilled instrument person available when necessary for laying out the Work and verifying lines, grades, and elevations.
      e. Being solely responsible for all locations, dimensions, and levels of the Work. No data other than Change Order, Work Change Directive, or Field Order shall justify departure from dimensions and levels required by the Contract Documents.
      f. Rectifying all Work improperly installed because of not maintaining, not protecting, or removing without authorization established reference points, stakes, marks, and monuments.
      g. Providing such facilities and assistance necessary for Engineer and Resident Project Representative (if any) or Owner's Site Representative (if any) to check lines and grade points placed by Contractor.

C. Related Requirements:
   1. Section 01 78 39 - Project Record Documents.
   2. Section 01 31 26 - Electronic Communication Protocols.

### 1.2 PRICE AND PAYMENT PROCEDURES

A. Unit Price Work:
   1. Do not perform excavation or embankment work until all cross-sectioning necessary for determining payment quantities for Unit Price Work have been completed and accepted by Engineer.

## 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Review requirements of this and other Specifications sections and coordinate other elements of the Work with field engineering, surveying, and layout Work and recordkeeping obligations set forth in this Specifications section..

## 1.4 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Certificates:
      a. When requested by Engineer following completion of the Work or a part thereof, submit certificate signed by professional engineer or professional surveyor, as applicable, indicating that elevations and locations of the Work comply with the Contract Documents. Explain each discrepancy, if any, from the requirements of the Contract Documents.
   2. Contractor's Daily Reports and Field Engineering Records:
      a. Submit daily reports as indicated in this Specification Section.
      b. When requested by Engineer, submit documentation verifying accuracy of field engineering.
   3. Contractor's Surveying Plan and Records:
      a. Complete plan for performing surveying Work, submitted not less than 10 days prior to beginning surveying Work.
      b. Example of proposed surveying field books to be maintained by Contractor's surveyor. Example surveying field book shall have sufficient information and detail, including example calculations and notes, to demonstrate that surveying field books will be organized and maintained in a professional manner in accordance with the Contract Documents.
      c. Submit original surveying field books within two days after completing surveying Work.
      d. Submit certified survey in accordance with this Specifications' section.
   4. Qualifications Statements:
      a. Field Engineer: Name, employer, and professional address. When requested by Engineer, submit qualifications, including detailed resume'.
      b. Surveyor: Name, employer, professional address of firm, and detailed resumes of each professional land surveyor and crew chief that will be engaged in surveying Work. Submit not less than 10 days prior to beginning surveying Work. During the Project, submit detailed resume' for each new registered, licensed land surveyor and crew chief employed by or retained by Contractor not less than 10 days prior to starting on the surveying Work.

## 1.5 CONTRACTOR'S ENGINEERS

A. Qualifications of Contractor's Field Engineer:
   1. Employ and retain at the Site a field engineer with experience and capability of performing all field engineering tasks required of Contractor, as indicated in this Article and elsewhere in the Contract Documents.
   2. Contractor's field engineer shall possess not less than five years of experience performing duties similar in scope and complexity to those required of Contractor's field engineer on this Project.
   3. Contractor's field engineer may serve as Contractor's Site superintendent, or as the recorder of as-constructed conditions in accordance with Section 01 78 39 - Project Record Documents, or as any combination of these roles as deemed appropriate by Contractor.

B. Responsibilities of Contractor's Field Engineer:
   1. Daily Reports:
      a. Prepare and maintaining daily reports of activity on the Contract. Submit reports to Engineer. Contractor's daily reports shall indicate the following information:

1) Contractor's Employees: Number of Contractor's employees at the Site, apportioned by trade(s).
2) Subcontractors: Separately indicate and identify each Subcontractor and the number of workers onsite for each. Apportion number of workers by trade(s).
3) Equipment and materials installed as part of the Work.
4) Equipment and materials, to be installed in the Work, delivered to the Site or offsite storage location that day. When delivered to offsite storage, indicate the storage location.
5) Major construction equipment utilized by major activity. Indicate for each manufacturer, model number, and year of manufacture.
6) Location of areas in which construction was performed.
7) Work performed, including field quality control activities such as inspections and testing. Indicate field quality control activities witnessed by Engineer, Resident Project Representative (if any), or Owner's Site Representative (if any).
8) Weather conditions, including minimum and maximum ambient air temperatures, relative humidity, conditions of high winds or other extreme weather, and precipitation.
9) Safety concerns, events, and precautions taken.
10) Defective Work observed or believed to exist.
11) Delays encountered, extent of delay incurred, reasons for the delay, and measures that will be taken to rectify delays encountered.
12) Acknowledgement of specific instructions received from Engineer, Resident Project Representative (if any), Owner, or Owner's Site Representative (if any).
13) Visitors to the Site.
14) Other notable events occurring on the Project.

b. Daily reports shall be signed and dated by responsible member of Contractor's staff, such as Contractor's field engineer, superintendent, project manager, or foreman designated by Contractor as having authority to sign daily reports.
c. Submit Contractor's daily reports in accordance with Section 01 31 26 - Electronic Communication Protocols, by 9:00 a.m. (local time at the Site) the next working day after the day covered in the associated report.

2. Check all formwork, reinforcing materials, inserts, structural steel, masonry, insulation, waterproofing and element protection, doors and windows, finishes, bolts, sleeves, piping, other materials and equipment for compliance with the Contract Documents.
3. Continually inspect the Work to ensure that the quality and quantities required by the Contract Documents are provided.
4. Promptly report defective Work to Contractor, Engineer, Resident Project Representative (if any), and Owner's Site Representative (if any).
5. Cooperate as required with Engineer, Resident Project Representative (if any), and Owner's Site Representative (if any) in observing the Work and performing field inspections and other field quality control activities.
6. Check and coordinate the Work for conflicts and interferences, and immediately advise Engineer and Resident Project Representative (if any) of all discrepancies of which Contractor is aware.
7. Maintain field office files and drawings, record documents, and coordinate field engineering services with Subcontractors and Suppliers as appropriate, and other prime contractors (if any).
8. Supervise or personally prepare and maintain Project record documents in accordance with Section 01 78 39 - Project Record Documents.
9. Prepare layout and coordination drawings for construction operations.
10. Review and coordinate the Work with Shop Drawings approved by Engineer, other Submittals accepted by Engineer, and Contractor's means, methods, techniques, sequences, and procedures of construction and safety programs incident thereto.
11. Coordinate onsite work of Subcontractors and Suppliers, or assist Contractor's Site superintendent in doing so.

C. Design Professionals Services Retained by Contractor (whether or not stationed at the Site):
   1. Delegated Professional Design Services:
      a. Where the Contract Documents require Contractor to furnish professional engineering, geology, or architecture services as delegated professional design, the provisions of the General Conditions, Specifications, and other Contract Documents regarding delegated design responsibility apply.
   2. Design Professional Services that are Not Delegated Professional Design of the Completed Work:
      a. Where the Contract Documents require that Contractor retain a design professional such as a professional engineer, geologist, or architect, or when in Contractor's judgment retaining such entity is necessary for implementing Contractor's means, methods, techniques, sequences, or procedures of construction or safety and protection programs incident thereto, retain a design professional with necessary skills, experience, and qualifications to perform the required services. Where required by the Contract Documents or by Laws or Regulations, such entity shall be duly licensed and registered to perform the associated design professional services in the same jurisdiction as the Site, unless otherwise allowed by Laws or Regulations or by the Contract Documents.
      b. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed by such design professional(s).

## 1.6 CONTRACTOR'S SURVEYOR

A. Qualifications:
   1. Employ or retain the services, as needed, at the Site a surveyor with experience and capability of performing surveying and layout tasks required in the Contract Documents and as required for the Work. Comply with Laws and Regulations governing land surveying.
   2. Contractor's surveyor shall possess not less than five years of experience performing duties similar in scope and complexity to those required of Contractor's surveyor on this Project.

B. Responsibilities of Contractor's Surveyor:
   1. Providing required surveying equipment, including transit, theodolite, or total station; level; stakes; and surveying accessories.
   2. Establishing required lines and grades for constructing all facilities, structures, pipelines, and site improvements, including outdoor electrical equipment and feeders.
   3. Preparing and maintaining professional-quality, accurate, well-organized, legible notes of all measurements and calculations made while surveying and laying out the Work.
   4. Prior to backfilling operations, survey, locate, and record on a copy of the Drawings accurate representation of buried Work and Underground Facilities provided and encountered.
   5. Locating on a site plan of the Site the actual location of above-ground Work to be indicated on record documents.
   6. Complying with requirements of the Contract Documents relative to surveying and related Work, including requirements of this Specification section's Articles 1.6 and 3.1.

## 1.7 RECORDS

A. Records – General:
   1. Maintain at the Site:
      a. Contractor's field engineer's daily reports, with information and submitted in accordance with Article 1.5 of this Specification Section.
      b. Information and documents required by Section 01 78 39 - Project Record Documents.
      c. Complete and accurate log of control and survey Work as such Work progresses.
      d. Other records deemed by Contractor to be necessary or appropriate.

B. Field Books and Records:

1. Survey data and records shall be in accordance with recognized professional surveying standards, Laws and Regulations, and prevailing standard of care in the locality where the Site is located.
2. Original field notes, calculations, and other surveying data shall be recorded by Contractor's surveyor in Contractor-furnished hard-bound field books.
3. Completeness and accuracy of surveying Work, and completeness and accuracy of surveying records, including field books, shall be responsibility of Contractor.
4. Unacceptable Records of Contractor's Surveyor:
   a. Failure to organize and maintain survey records in an appropriate manner that allows reasonable and independent verification of calculations, and to allow identification of elevations, lines, locations, dimensions, and grades of the Work, shall be cause for rejecting the surveying records, including field books.
   b. Illegible notes or data, and erasures on any page of field books, are unacceptable. Do not submit copied notes or data. Corrections by ruling or lining out errors will be unacceptable unless initialed by the surveyor. Violation of these requirements may require re-surveying the data questioned by Engineer.
   c. Other provisions of the Contract notwithstanding, Contractor shall have sole responsibility for uncovering, re-surveying, and restoring uncovered Work should survey data be unacceptable to Engineer.

C. Survey of Surface Structures:
1. Upon completion of foundation walls and major site improvements, prepare a survey showing or indicating dimensions, locations, angles and elevations of construction and locations and elevations of Underground Facilities installed and encountered during the Work.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 SURVEYING

A. Reference Points:
1. Refer the General Conditions, as may be modified by the Supplementary Conditions, for requirements regarding reference points.
2. Owner's established reference points that are damaged or destroyed by Contractor will be re-established by Owner at Contractor's expense. Owner may deduct from payments due Contractor such amounts as set-offs in accordance with the Contract Documents.
3. From Owner-established reference points, establish lines, grades, and elevations necessary to control the Work. Obtain measurements required for performing the Work to tolerances indicated in the Contract Documents.
4. Establish, place, and replace as required, such additional stakes, markers, and other reference points necessary for controlling the Work and verifying accuracy and compliance with the Contract Documents.

B. Surveys to Determine Quantities for Payment:
1. For each application for progress payment, perform such surveying and calculations necessary to determine quantities of Work performed or placed, including Unit Price Work. Perform surveying necessary for Engineer to determine final quantities of Work in place.
2. Advise Engineer, Resident Project Representative (if any), and Owner's Site Representative (if any) not less than 24 hours before performing surveying services for determining quantities to be included in Application for Payment. Unless waived in writing by Engineer, perform quantity surveys in presence of Engineer or Resident Project Representative (if any).

C. Construction Surveying: Comply with the following:

1. Alignment Staking: Provide alignment stakes at 50 feet intervals on tangent, and at 25 feet intervals on curves.
2. Slope Staking: Provide slope staking at 50 feet intervals on tangent, and at 25 feet intervals on curves. Re-stake at every ten-foot difference in elevation.
3. Structure: Stake-out structures, including elevations, and check prior to and during construction.
4. Pipelines: Stake-out pipelines including elevations, and check prior to and during construction.
5. Roads, Drives, and Paved Areas: Stake-out roadway, driveway, and paved area elevations at 50-foot intervals on tangent, and at 25 feet intervals on curves.
6. Cross-Sections: Provide original, intermediate, and final staking as required, for site work and other locations as necessary for quantity surveying.
7. Easement Staking: Provide easement staking at 50 feet intervals on tangent, and at 25 feet intervals on curves. Also provide wooden laths with flagging at maximum intervals of 100 FT.
8. Record Staking: Provide permanent stake at each blind flange and each utility cap provided for future connections. Stakes for record staking shall be material acceptable to Engineer, durably installed for long-term reference by Owner, utility owners, and others as necessary.

D. Accuracy:
1. Establish Contractor's temporary survey references points for Contractor's use to not greater than second-order accuracy (i.e., 1:10000). Construction staking used as a guide for the Work shall be set at not greater than third-order accuracy (i.e., 1:5000). Basis on which such orders are established shall provide the absolute margin for error specified below.
2. Horizontal accuracy of easement staking shall be plus or minus 0.1 feet. Accuracy of other staking shall be plus or minus 0.04 feet horizontally and plus or minus 0.02 feet vertically.
3. Survey calculations shall include an error analysis sufficient to demonstrate required accuracy.

**END OF SECTION**

# SECTION 01 73 20
## OPENINGS AND PENETRATIONS IN CONSTRUCTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Methods of installing and sealing openings and penetrations in construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Miscellaneous Metals.
   4. Section 06 82 00 - Fiberglass Reinforced Plastic Fabrications.
   5. Section 07 62 00 - Flashing and Sheet Metal.
   6. Section 07 84 00 - Firestopping.
   7. Section 07 92 00 - Joint Sealants.
   8. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      d. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
      f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
      g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      i. A995, Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 501, Class 1 Locations.
      b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
      c. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

### 1.3 DEFINITIONS

A. Corrosive Areas: For the purpose of this specification section, the following areas are defined as corrosive:
   1. Chemical rooms (any rooms with chemicals normally or intended to have stored in them).
   2. Ozone rooms.

B. Hazardous Areas: Areas shown in the Contract Documents as having Class I or Class II area classifications.

C. Washdown Areas: Areas having floor drains or hose bibbs.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. For each structure provide dimensioned or scaled (minimum 1/8 IN = 1 FT) plan view drawings containing the following information:
      a. Vertical and horizontal location of all required openings and penetrations.
      b. Size of all openings and penetrations.
      c. Opening type.
      d. Seal type.
   3. Manufacturer's installation instructions for standard manufactured products.

### 1.5 PROJECT CONDITIONS

A. For purposes of this Project, water table level elevation is described by area.
   1. Proposed water treatment plant, water table level is approximately 100 FT below grade.
   2. Existing water treatment plant and Ashland Creek crossing area, water table shall be assumed to be at grade.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Pipe Sleeves:
   1. Areas listed as Corrosive Areas in PART 1:
      a. Stainless steel, Type 316L.
      b. Penetrations 24 IN DIA or less: ASTM A269, ASTM A312 or ASTM A554, Schedule 40.
      c. Penetrations larger than 24 IN DIA: Stainless steel, ASTM A666, Minimum 1/4 IN thickness.
   2. All other Areas:
      a. Steel, Hot-dipped galvanized after fabrication.
      b. Penetrations 24 IN DIA or less: ASTM A53, Schedule 40.
      c. Penetrations larger than 24 IN DIA: ASTM A36, Minimum 1/4 IN thickness.

B. Backing Rod and Sealant: See Specification Section 07 92 00.

C. Modular Mechanical Seals:
   1. Acceptable manufacturers:
      a. Link-Seal.
   2. 316 stainless steel bolts, nuts and washers.

D. Firestopping Material: See Specification Section 07 84 00.

E. Sheet Metal Sleeves:
   1. Areas listed as Corrosive Areas in PART 1: Stainless steel: ASTM A240, Type 316L.
   2. All other areas: Galvanized steel: ASTM A653, G90.
   3. Minimum 12 GA.

F. Commercial Wall Castings:
   1. Ductile iron, ASTM A536.
   2. Grade equal to connecting piping system.

## PART 3 - EXECUTION

### 3.1 FABRICATION

A. Fabricate pipe sleeves in accordance with Specification Section 05 50 00.

B. Fabricate sheet metal sleeves in accordance with Specification Section 07 62 00.

C. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in-place in concrete.
   1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
   2. For commercial castings, cast water stop/anchor with wall pipe.
   3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.
   4. For fabricated units, diameter of plate or flange to be 4 IN larger than outside diameter of sleeve, pipe or ductwork.
   5. For commercial castings, waterstop/anchor size to be manufacturer standard.
   6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

D. Factory or shop-coat painted components in accordance with Specification Section 09 96 00.

## 3.2 INSTALLATION AND APPLICATION

A. Firestopping materials used in fire-resistance rated construction shall be in full compliance with Specification Section 07 84 00.

B. Seal openings and penetrations in non-fire-resistance-rated construction in accordance with Specification Section 07 92 00.

C. Obtain prior approval from Engineer when any opening larger than 100 SQIN must be made in existing or newly completed construction.

D. Perform HVAC penetrations in accordance with NFPA 90A.

E. Perform electrical penetrations in accordance with NFPA 70, Article 501.

F. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.
   1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.

G. Where pipes, conduits or ducts pass through floors in washdown areas, install sleeves with top 3 IN above finish floors.
   1. In non-washdown areas, install sleeves with ends flush with finished surfaces.

H. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.

I. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.

J. Where pipes, conduits or ducts pass through grating, provide banding at the entire perimeter of the opening.
   1. Metal grating: See Specification Section 05 50 00.
   2. FRP grating: See Specification Section 06 82 00.

K. Where pipes, conduits or ducts are removed where passing through grating:
   1. Metal grating:
      a. Provide banding at perimeter and cover opening with 1/4 IN plate of the same material of the grating.
      b. See Specification Section 05 50 00.
   2. FRP grating:
      a. Provide full depth cover meeting same loading requirement as existing material or replace grating section.
      b. See Specification Section 06 82 00.

L. Do not cut into or core drill any beams, joists, or columns.

M. Do not install sleeves in beams, joists, or columns.

N. Do not install recesses in beams, joists, columns, or slabs.

O. Field Cutting and Coring:
   1. Saw or core drill with non-impact type equipment.
   2. Mark opening and drill small 3/4 IN or less holes through structure following opening outline.
   3. Sawcut opening outline on both surfaces.
      a. Knock out within sawcuts using impact type equipment.
      b. Do not chip or spall face of surface to remain intact.
      c. Do not allow any overcut with saw kerf.

P. Precast-Prestressed Concrete Construction:
   1. Do not cut openings or core drill vertically or horizontally through stems of members.
   2. Do not locate or install sleeves or recess sleeves vertically or horizontally through or in stems of members.
   3. Cast openings and sleeves into flanges of units.
   4. Cast openings larger than 6 IN in diameter or 6 IN maximum dimension in units at time of manufacture.
   5. Cast openings smaller than 6 IN in diameter or 6 IN maximum dimensions in flanges of units at time of manufacture or field cut.

Q. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.

R. Where area is blocked out to receive sheet metal sleeve at later date:
   1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
      a. Size blockout based on sleeve size required plus 4 to 6 IN each side of sleeve for concrete encasement.
      b. Provide #4 dowels at 12 IN spacing along each side of blockout with minimum of two dowels required per side.
   2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
      a. Size blockout based on sleeve size required plus 2 to 4 IN each side of sleeve for concrete encasement.

S. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.

T. Refer to Drawings for location of fire-rated walls, floors, and ceilings.
   1. Utilize firestopping materials and procedures specified in Specification Section 07 84 00 IN conjunction with scheduled opening type to produce the required fire rating.

U. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.

V. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.

W. Modular Mechanical Seals:
   1. Utilize one seal for concrete thickness less than 8 IN and two seals for concrete, 8 IN thick or greater.
   2. Utilize two seals for piping 16 IN diameter and larger if concrete thickness permits.
   3. Install seals such that bolt heads are located on the most accessible side of the penetration.

X. Backer Rod and Sealant:
   1. Install in accordance with Specification Section 07 92 00.
   2. Provide backer rod and sealant for modular mechanical seal applications.
      a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

## 3.3 SCHEDULES

A. General Schedule of Penetrations through Floors, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:
   1. Provide the following opening and penetration types:
      a. Type A - Block out 2 IN larger than outside dimensions of duct, pipe, or conduits.
      b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
      c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring for wet and/or washdown areas.
      d. Type D - Commercial type casting or fabrication.
      e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.
      f. Type F - Integrally cast pipe, duct or conduit.
      g. Type G - Saw cut or line-drill and remove area 1 IN larger than outside dimensions of duct, pipe or conduit.
      h. Type H - Core drill.
      i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
      j. Type J - Grating Banding for any field cut openings.
   2. Provide seals of material and method described as follows.
      a. Category 1 - Modular Mechanical Seal.
      b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings. Refer to Specification Section 07 62 00 and roofing Specification Sections for additional requirements.
      c. Category 3 - 12 GA sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
      d. Category 4 - Backer rod and sealant.
      e. Category 5 - Full depth compressible sealant with escutcheons on both sides of opening.
      f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 IN larger than opening.
      g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.
      h. Category 8 - Banding for all grating openings and banding and cover plate of similar materials for abandoned openings.
      i. Category 9 - Modular mechanical seal on both sides of opening separated by compressible sealant. Finish with grout pack on both sides. High performance industrial coating installed on top of grout throughout containment.
   3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.
   4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

## SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE FOR NEW CONSTRUCTION

| APPLICATIONS | DUCTS | | PIPING | | CONDUIT | |
|---|---|---|---|---|---|---|
| | OPENING TYPE | SEAL CATEGORY | OPENING TYPE | SEAL CATEGORY | OPENING TYPE | SEAL CATEGORY |
| Through floors with bottom side a hazardous location | C<br>F<br>I | 7<br>Not Req<br>7 | D<br>F<br>I (1) | Not Req<br>Not Req<br>7 | C<br>F | 7<br>Not Req |
| Through floors on grade above water table | C<br>F<br>I | 4<br>Not Req<br>4 | C<br>F<br>I (1) | 7<br>Not Req<br>7 | C<br>F<br>I (1) | 4<br>Not Req<br>7 |
| Through slab on grade below water table | F | Not Req | F | Not Req | F | Not Req |
| Through floors in washdown areas | C<br>I | 4<br>4 | C<br>H (2)<br>I (1) | 4<br>3<br>4 | F<br>H (2)<br>I (1) | Not Req<br>3<br>7 |
| Through walls where one side is a hazardous area | C<br>F<br>I | 7<br>Not Req<br>7 | D<br>F<br>I (1) | Not Req<br>Not Req<br>7 | C<br>F | 7<br>Not Req |
| Through exterior wall below grade above water table | C<br>F<br>I | 7<br>Not Req<br>7 | C<br>D<br>F<br>I (1) | 1<br>Not Req<br>Not Req<br>1 | F<br>I (1) | Not Req<br>7 |
| Through wall from tankage or wet well (above high water level) to dry well or dry area | C<br>F<br>I | 7<br>Not Req<br>7 | C<br>D<br>F<br>H (2) | 1<br>Not Req<br>Not Req<br>1 | C<br>F<br>H (2)<br>I (1) | 7<br>Not Req<br>7<br>7 |
| Through wall from tankage or wet well (below high water level) to dry well or dry area | F | Not Req | F | Not Req | F | Not Req |
| Through exterior wall above grade | A<br>B<br>C | 6<br>6<br>6 | A<br>B<br>D<br>H (2) | 5<br>5<br>Not Req<br>5 | C<br>H (2) | 5<br>4 |
| Roof penetrations | A | 2 | A | 2 | A | 2 |
| Through interior walls and slabs not covered by the above applications | A<br>C | 4<br>4 | A<br>C | 4<br>4 | A<br>C<br>F | 4<br>4<br>Not Req |
| Grating openings and penetrations | J | 8 | J | 8 | J | 8 |
| Through chemical containment wall | N/A | N/A | C | 9 | N/A | N/A |

## SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE FOR EXISTING CONSTRUCTION

| APPLICATIONS | DUCTS | | PIPING | | CONDUIT | |
|---|---|---|---|---|---|---|
| | OPENING TYPE | SEAL CATEGORY | OPENING TYPE | SEAL CATEGORY | OPENING TYPE | SEAL CATEGORY |
| Through floors with bottom side a hazardous location | B<br>E | 7<br>Not Req | B (1)<br>E (3)<br>H (2) | 7<br>Not Req<br>7 | B (1)<br>E (3)<br>H (2) | 7<br>Not Req<br>7 |
| Through floors on grade above water table | B | 7 | B | 7 | B | 7 |
| Through slab on grade below water table | E | Not Req | E | Not Req | E | Not Req |
| Through floors in washdown areas | G | 3 | G<br>H (2) | 3<br>3 | G<br>H (2) | 3<br>3 |
| Through walls where one side is a hazardous area | B<br>E | 7<br>Not Req | B (1)<br>B (3)<br>E<br>H (2) | 7<br>1<br>Not Req<br>7 | B (1) (3)<br>E<br>H (2) | 7<br>Not Req<br>7 |
| Through exterior wall below grade above water table | B | 7 | B (1)<br>B (3)<br>H (2) | 7<br>1<br>7 | B (1) (3)<br>H (2) | 7<br>7 |
| Through wall from tankage or wet well (above high water level) to dry well or dry area | B<br>E | 7<br>Not Req | B<br>E<br>H (2) | 1<br>Not Req<br>1 | B (1) (3)<br>E<br>H (2) | 7<br>Not Req<br>7 |
| Through wall from tankage or wet well (below high water level) to dry well or dry area | E | Not Req | E | Not Req | E | Not Req |
| Through exterior wall above grade | G | 6 | G (1) (3)<br>H (2) | 5<br>5 | G (1) (3)<br>H (2) | 5<br>7 |
| Roof penetrations | G | 2 | G (1) (3)<br>H (2) | 2 | G | 2 |
| Through interior walls and slabs not covered by the above applications | G | 4 | G (1) (3)<br>H (2) | 4<br>4 | G (1) (3)<br>H (2) | 4<br>4 |
| Grating openings and penetrations | J | 8 | J | 8 | J | 8 |

(1) Multiple piping 3 IN and smaller or multiple conduits.
(2) Single pipe 3 IN and smaller or single conduit.
(3) Single pipe or conduit larger than 3 IN.

**END OF SECTION**

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# SECTION 01 73 29
## CUTTING AND PATCHING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. General requirements for cutting and patching Work.

B. Scope:
   1. Contractor shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.
   2. Provide cutting, coring, fitting, and patching, including attendant excavation and fill, required to complete the Work, and to:
      a. remove and replace defective Work;
      b. remove samples of installed Work as specified or required for testing;
      c. remove construction required to perform required alterations or additions to existing construction;
      d. uncover the Work for Engineer's observation of covered Work, testing, or inspection by testing entities, or observation by authorities having jurisdiction;
      e. connect to completed Work not performed in proper sequence;
      f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;
      g. make connections or alterations to existing or new facilities.

C. Related Requirements:
   1. Section 03 31 30 - Concrete, Materials and Proportioning.
   2. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   3. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Cutting and Patching Request:
      a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:
         1) Design function or intent of Project.
         2) Work of Owner or other contractors retained by Owner.
         3) Structural capacity or integrity of an element of the Project, building, or structure.
         4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
         5) Efficiency, operational life, maintenance, or safety of operational elements.
         6) Visual qualities of elements that will be exposed to view after completion of the Work.
      b. Request shall include:
         1) Identification of Project and Contract designation.
         2) Description of affected Work of Contractor and work of others (if any) retained by Owner.
         3) Necessity for cutting.
         4) Effect on work or operations of Owner and other contractors (if any) retained by Owner, and on structural and weatherproof integrity of Project, building, or structure.
         5) Description of proposed Work, indicating: scope of cutting and patching; trades that will execute the cutting and patching Work; materials and equipment to be

used; extent of refinishing; schedule of operations; alternatives (if any) to cutting and patching, and net effect on aesthetics following completion of finishing Work.
6) Indication of entity responsible for cost of cutting and patching, when applicable.
7) Written permission of other prime contractors (if any) whose work will or may be affected.

2. Recommendation Regarding Cutting and Patching:
   a. Should conditions of work or schedule indicate a change of materials or specified methods, furnish Submit written recommendation to Engineer including:
      1) Conditions indicating change.
      2) Recommendations for alternative materials or alternatives to specified methods.
      3) Material manufacturer's printed recommendations for the proposed product and recommendations of manufacturer's technical representative for the specific application(s). The latter shall be on technical representative's letterhead and shall explicitly indicate the Project and specific cutting and patching application(s) to which the recommendation(s) apply.
      4) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.
3. Product Data:
   a. Submit manufacturer's published data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
   b. When not required under other Specifications sections, submit manufacturer's published data on materials to be used for finishing around the cut or patched area(s), together with indication of the location(s) where each is proposed for use.
   c. Furnish Submittals for patching materials under the associated Specifications section. Submittal to include letter of recommendation from product manufacturer's technical representative indicating on technical representative's letterhead, explicitly indicating:
      1) Project name and facility name;
      2) specific cutting and patching application(s) to which the recommendations apply;
      3) that product manufacturer's technical representative has personally observed and is familiar with conditions in the work area(s) of the subject cutting and patching;
      4) materials that are the subject of the Submittal are appropriate for the condition(s) of the proposed patch and will remain durable in the patch's final exposure upon Substantial Completion; and.
      5) patching material manufacturer's technical representative's recommendations for surface preparation, installation of patching material(s), and curing.

B. Informational Submittals: Submit the following:
1. Written Notification of Cutting and Patching:
   a. Furnish as a Submittal written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.
2. X-ray Investigations:
   a. Proposed method of investigation. Submit and obtain Engineer's acceptance prior to performing x-ray inspections.
   b. Report of x-ray evaluation of slabs, floors, and walls to be cut or core-drilled.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Materials – General:
1. Provide materials that comply with the Contract Documents.
2. If not shown or indicated in the Contract Documents, use materials identical to existing materials affected by cutting and patching Work.

3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, provide materials whose installed performance will equal or surpass that of existing materials.
4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.

B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
1. After core-drilling or sawcutting (as applicable) and before installing the utility or equipment through the penetration, coat exposed concrete and exposed steel with solvent-free, two-component, protective, epoxy resin coating.
2. Color shall approximate the finish color of the existing surface to be coated.
3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Sikagard 62, by Sika Corporation.
   b. Or equal.

C. Grout Materials:
1. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.

D. Epoxy Bonding Adhesive:
1. Provide two-component, moister-insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.
2. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.
3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Euco No.452 MV by Euclid Chemical Co.
   b. Sikadur 32, Hi-Mod by Sika Corporation.
   c. Or equal.

E. Epoxy Patch Material:
1. Product and Manufacturer:
   a. 1/8 IN to 1 ½ IN deep spalls: SikaTop- 123+.
   b. 1 ½ IN and deeper spalls:
      1) SikaTop 111
         a) 3/8 IN aggregate is required for 1 to 6 IN lifts.
         b) Vertical surfaces, must be formed.
         c) Horizontal surfaces, pour and screed.
2. All products to be installed per Manufacturer's printed installation instructions.
3. Engage the manufacturer's representative to observe and recommend a suitable patching material of the actual construction conditions.
4. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Depth of patch greater than 3/4 IN:
      1) Five Star MP Epoxy Patch.
      2) Or equal.
   b. Depth of patch between 1/8 IN and 3/4 IN:
      1) Five Star Fluid Epoxy.
      2) Or equal

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examination and Assessment – General:
1. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.
2. Report unsatisfactory or questionable conditions to Engineer in writing.

3. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.

B. Non-Destructive Investigation:
   1. In advance of cutting or coring through existing slabs or walls, use x-ray or other non-destructive methods accepted by Engineer to determine location of reinforcing steel, electrical conduits, and other items embedded in slabs and walls.
   2. Submit to Engineer written report of findings of evaluation.
   3. Perform x-ray investigation and submit results to Engineer sufficiently in advance of cutting Work to allow time to identify and implement alternatives, if changes to the Work are necessary because of conduit or other features in floor or wall.

## 3.2 PREPARATION

A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.

B. Protection of Existing Construction during Cutting and Patching:
   1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.
   2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
   3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

## 3.3 CUTTING AND PATCHING – GENERAL

A. Perform cutting and coring in such manner that limits extent of patching required.

B. Structural Elements:
   1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.

C. Operating Elements:
   1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.
   2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.

D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.

E. Provide adequate temporary covering over openings (whether cut or core-drilled) where not in use. Avoid creating tripping hazards for openings provided in floors and slabs.

## 3.4 CORING

A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by Engineer in writing.

B. Coring:
   1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.
   2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of Engineer. To extent possible, avoid cutting reinforcing steel in slabs and walls.

C. Protection:
   1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.

2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specification Section. Apply protective coating in accordance with manufacturer's instructions.

D. Cleaning:
   1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

## 3.5 CUTTING

A. Cutting – General:
   1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.
   2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping. Carefully chip out concrete where necessary and as indicated in the Contract Documents.
   3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.
   4. Prior to starting cutting, provide adequate bracing of area to be cut.
   5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
   6. Use equipment of adequate size to remove the cut panel or "coupon".

B. Cutting – Concrete and Masonry:
   1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
   2. On both sides of the element being cut, provide for control of slurry generated during sawing.
   3. Concrete Cutting:
      a. Make openings by sawing through existing concrete. Core drill with 6 IN DIA core at the corners of openings to avoid overcutting at corners.
      b. When the cut-out concrete or "coupon" cannot be removed in one piece, or where concrete is too thick for saw to penetrate fully, break out concrete after initial saw cuts.
      c. Where saw cutting is not possible:
         1) Make openings by drilling holes around perimeter of required opening and subsequently carefully chip out concrete.
         2) Holes shall be sufficient in quantity to prevent damage to remaining concrete.
   4. Sizing and Repair of Cut Concrete Surfaces:
      a. Where reinforcing steel is cut, remove existing reinforcing back to 1.5 IN below finished surface of concrete. Provide bonding adhesive on surfaces of resulting hole and fill resulting hole with non-shrink grout.
      b. Oversize required openings in existing concrete by one inch on all sides and build back to required opening size by providing epoxy grout bonded to existing concrete.
      c. Where oversizing the cut opening by one inch is not possible, cut the opening to the required dimensions. After cutting concrete and before installing subsequent construction on or through the opening, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specifications Section. Apply protective coating in accordance with manufacturer's instructions.
      d. Where indicated, finish remaining surfaces as indicated in Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

## 3.6 PATCHING

A. Patching – General:
   1. Patch large openings to be filled with concrete in accordance with the Contract Documents. Before installing new concrete, apply bonding adhesive indicated in Paragraph 2.1.C of this Specifications section in accordance with manufacture's recommendations.

2. Where large openings to be filled with concrete are indicated on the Drawings as requiring reinforcing steel, provide reinforcing steel as shown and indicated in the Contract Documents.
3. Where concrete infill or grout repair materials are not used, patch using epoxy patch material indicated in Paragraph 2.1.D of this section unless otherwise indicated on Drawings.
4. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.
5. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents and the published installation instructions of the material's manufacturer.
6. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
7. Where feasible, test patched areas to demonstrate integrity of installation.

B. Restoration:
1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.
2. For continuous surfaces, refinish to nearest intersection.
3. For an assembly, refinish the entire unit that was patched.
4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

## 3.7 CLEANING

A. Cleaning and Restoration:
1. Perform cleaning promptly after associated cutting, coring, and patching.
2. Clean areas and spaces where cutting, coring, or patching were performed.
3. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.
4. Restore damaged coverings of pipe and other utilities to original condition.

**END OF SECTION**

# SECTION 01 74 00
CLEANING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for keeping the Site free of accumulations of waste materials during construction ("progress cleaning").
   2. Cleaning for Substantial Completion and prior to final inspection (collectively, "closeout cleaning").

B. Scope:
   1. Contractor shall perform cleaning during the Project, including progress cleaning, as condition precedent to Substantial Completion, upon completion of the Work, and as required by the General Conditions, as may be modified by the Supplementary Conditions, this Specifications section, and elsewhere in the Contract Documents.
   2. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PROGRESS CLEANING

A. Progress Cleaning – General:
   1. Clean the Site, work areas, and other areas occupied by Contractor not less than weekly. Dispose of waste materials in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and the following:
      a. Comply with NFPA 241 for removing combustible waste materials and debris.
      b. Do not hold non-combustible materials at the Site more than three days if the ambient air temperature is expected to rise above 80 DEGF. When ambient air temperature is less than 80 DEGF, dispose of non-combustible materials within seven days of their generation.
      c. Provide suitable containers for storage of waste materials and debris. Avoid generation of odors and creation of nuisances.
      d. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Progress Cleaning – Site:
   1. Keep outdoor, dust-generating areas wetted down or otherwise control dust emissions.
   2. Not less than weekly, brush-sweep roadways and paved areas at the Site and adjacent areas used by construction vehicles or otherwise affected by construction activities.
   3. Comply with dust control requirements of Section 01 57 05 - Environmental Protection and Special Controls.

C. Progress Cleaning – Work Areas:
   1. Clean areas where the Work is in progress to maintain an extent of cleanliness necessary for proper execution of the Work and safety of personnel.
   2. Remove liquid spills promptly. Where spills may have harmful effects on health, safety, protection of facilities, or the environment, immediately report spills to Owner, Engineer, and authorities having jurisdiction, in accordance with the Contract Documents and Laws and Regulations.
   3. Where dust would impair proper execution of or quality of the Work, broom-clean or vacuum entire work area, as necessary.
   4. Concealed Spaces: Remove waste material and debris from concealed spaces before enclosing the space.

D. Progress Cleaning – Installed Work:
   1. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of installed materials and equipment, using only cleaning agents and methods specifically recommended by material or equipment Supplier.
   2. If Supplier does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage or mar exposed surfaces.

E. Progress Cleaning – Exposed Surfaces:
   1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.

F. Progress Cleaning – Cutting and Patching:
   1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, trailings and cuttings, and similar materials.
   2. Comply with Section 01 73 29 - Cutting and Patching, regarding cleaning during and after cutting and patching Work.
   3. Thoroughly clean piping, ductwork, conduits, and similar features before applying patching material, paint, or other finishing materials.
   4. Restore damaged insulation and coverings on piping, cutwork, and similar items to its pre-construction condition.

G. Cleaning of Hydraulic Structures:
   1. Clean hydraulic structures that will contain fluid, such as tanks and channels, in accordance with this Specifications section and Section 01 45 25 - Testing Concrete Structures.
   2. Do not perform field quality control activities such as testing tanks, channels, and other hydraulic structures for leakage or disinfecting (where applicable), and do not apply for inspection for Substantial Completion for hydraulic structures, until the associated hydraulic structures are clean and free of all waste materials, and ready for intended use.

H. Waste Disposal:
   1. Properly dispose of waste materials (including surplus materials, debris, rubbish, and other waste) off the Site.
   2. Do not burn or bury waste materials at the Site.
   3. Remove waste material and rubbish from excavations before backfilling.
   4. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers, gutters, sanitary sewers, or other location in the environment. Dispose of such materials in accordance with Laws and Regulations.
   5. Do not discharge wastes to surface waters, drainage routes, or groundwater.
   6. Contractor is solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste generated by Contractor's operations or brought to the Site by Contractor.

I. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering

where necessary or required for protection from damage or deterioration, until Substantial Completion.

J. Clean completed construction as frequently as necessary throughout the construction period.

## 3.2 CLOSEOUT CLEANING

A. Complete the following prior to requesting inspection for Substantial Completion:
   1. Clean and remove from the Site waste material (including rubbish and debris) and other foreign and undesirable items and substances.
   2. Sweep broom-clean paved areas suitable for access by vehicles.
   3. Remove temporary fabric from drainage inlets.
   4. Remove spills and stains or petroleum, oils, solvents, other chemicals, and other foreign and undesirable deposits.
   5. Hose-clean sidewalks and loading areas.
   6. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   7. Surface waterways and drainage routes (including storm sewers, gutters, and ditches) shall be open and clean.
   8. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to preconstruction condition.
   9. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign and undesirable substances.
   10. Clean, wax, and polish wood, vinyl, and painted floors.
   11. Remove waste material and surface dust from limited-access spaces, including roofs, plenums, shafts, trenchway, equipment vaults, manholes, and similar spaces.
   12. In unoccupied spaces, sweep concrete floors broom-clean.
   13. Clean transparent materials, including mirrors and glazing in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
   14. Remove non-permanent tags and labels.
   15. Surface Finishes:
       a. Touch-up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
       b. Do not paint over "UL" or similar labels, including mechanical and electrical nameplates.
   16. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint, and mortar droppings, and other foreign or undesirable substances.
   17. Clean interior of electrical panels; vacuum out dust and remove all installation debris.
   18. Clean exterior of electrical panels to remove dust and fingerprints.
   19. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.
   20. Clean out floor drains and remove all temporary coverings/plastic from floor drain strainers.
   21. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
   22. Clean lighting fixtures, lamps, globes, and reflectors to function with full efficiency. Replace temporary lamps provided in permanent fixtures. Replace existing lighting fixture components that are burned out or noticeably dimmed from use during construction. Replace defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
   23. Leave the Site clean, and in neat, orderly condition, satisfactory to Owner and Engineer.

B. Complete the following prior to requesting final inspection:
   1. After Substantial Completion of all the Work, following completion of items of incomplete or damaged Work ("punch list Work"), clean "punch list Work areas in accordance with Paragraph 3.2.A of this Specifications Section.

2. Remove field offices, Contractor's storage sheds, and remaining stockpiles and clean all such areas in accordance with Paragraph 3.2.B of this Specifications Section, and in accordance with Contract Documents for landscaping and restoration.

**END OF SECTION**

# SECTION 01 74 15
## DISINFECTION OF FACILITIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for cleaning and disinfection of:
      a. Water Mains and Pipelines.
      b. Finished Water (Clearwell) Storage Facilities.
      c. Pumping Facilities
      d. Chemical Storage Facilities.
   2. This Section covers the protection, cleaning, flushing, and disinfection of all pipelines, water storage (clearwell) facilities, treatment facilities, and chemical feed systems that are any part of the water treatment process, including raw water through finished water, or contain finished water or service water for distribution and use within the facility.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 – Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment: Basic Requirements.
   4. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI)/American Water Works Association (AWWA):
      a. ANSI/AWWA B300 – Hypochlorites.
      b. ANSI/AWWA B301 – Liquid Chlorine.
      c. ANSI/AWWA C651 – Disinfection Water Mains.
      d. ANSI/AWWA C652 – Disinfection of Water Storage Facilities.
      e. ANSI/AWWA C653 – Disinfection of Water Treatment Plants.
   2. American National Standards Institute (ANSI)/National Sanitation Foundation (NSF):
      a. ANSI/NSF 60 - Drinking water treatment chemicals-Health effects.
      b. ANSI/NSF 61 - Drinking water system components-Health effects.
   3. American Public Health Association (APHA)/American Water Works Association (AWWA)/Water Environment Federation (WEF):
      a. APHA/AWWA/WEF - Standard Methods for the Examination of Water and Wastewater.

B. Qualifications:
   1. Provide qualified person to supervise use of liquid chlorine as defined in Part 2.

### 1.3 SUBMITTALS

A. See Section 01 33 00.

B. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Product data for disinfectants to be used.

C. Miscellaneous Submittals
   1. Qualifications of supervising personnel for use of liquid chlorine.
   2. Flushing and Disinfection Plan:
      a. Accompany Contractor's Facility Start-up Plan as required in Section 01 75 00.

b. Include the following:
    1) Schedule for activities.
    2) Procedure and plan for cleaning and flushing system.
    3) Procedure and plan for disinfection and verification testing.
    4) Proposed locations where samples are to be taken.
    5) Proposed sampling intervals.
    6) Schedule of samples to be collected by Owner.
    7) Type of disinfecting solution and method of preparation.
    8) Method of disposal of highly chlorinated water.
c. Certified bacteriological verification test results.

### 1.4 SEQUENCING AND SCHEDULING

A. See Section 01 75 00 for requirements regarding sequencing of disinfection work with Facility Start-up.

B. Commence disinfection after completion of the following:
    1. Completion and acceptance of internal coatings systems.
    2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Water for Disinfection:
    1. Potable water furnished by Owner.

B. Equipment:
    1. Contractor shall furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
    2. Provide protection as required by AWWA for cross-connection to previously disinfected sources.

C. Disinfectants:
    1. Liquid Chlorine.
        a. Conforming to requirements of ANSI/AWWA B301.
        b. Certified for potable water application per ANSI/NSF 60.
        c. May be used only if following conditions are met:
            1) Used under direct supervision of a person familiar and experienced physiological, chemical, physical properties of liquid chlorine and who is trained and equipped to handle any emergency that may arise:
                a) Owner's Appointed Engineer must approve qualifications of supervising person designated by Contractor.
            2) When appropriate safety practices are observed to protect working personnel and the public.
    2. Chlorine gas shall not be used.
    3. Sodium Hypochlorite
        a. Conforming to requirements of ANSI/AWWA B300.
        b. Certified for potable water application per ANSI/NSF 60.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. All facilities covered by this section shall be protected, cleaned, and flushed in accordance with the requirements herein. The specific facilities to be disinfected are also listed herein. The

Owner shall have the ability to witness all steps of the Flushing and Disinfection work evolutions.

B. Protection during Construction Period:
   1. Observe Preventive and Corrective Measures during Construction as defined in ANSI/AWWA C651.
   2. Keep pipe clean and dry during storage and installation.
   3. Protect pipe during wet-trench installation and provide protection from flooding or storm events.
   4. In the event of contamination, clean and swab pipe in accordance with ANSI/AWWA C651.

C. Disinfection procedures shall conform to ANSI/AWWA, EPA Guidance Manual, and this Specification:
   1. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods specified in this section.
   2. Take care to avoid recontamination following disinfection.
   3. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so that chlorinated water is mixed and at a consistent concentration meeting or exceeding the required solution strength.
   4. Do not place concentrated commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

D. Facilities to be Cleaned, Flushed, and Disinfected:
   1. All elements of the treatment plant that include and are located downstream of the filters, shall be disinfected.
   2. Items to be disinfected include, but are not limited to:
      a. All potable water piping including plumbing and sanitary water.
      b. Fire water up to and including the shutoff valve of the backflow preventer.
         1) Flushing requirements related to the fire suppression system are under the authority of the HFMO and shall be in accordance with NFPA 24.
      c. All non-potable water piping supplying wash down connections, water to chemical feed systems, etc.
      d. All treated water process water piping including but not limited to the following:
         1) Filters, Filtered Water Storage (including intermediate pumping and intermediate pumping wetwell), Clearwell, Crowson Pump Station, Water Pumping, Backwash supply, Filtered and Finished Water Pipeline.
         2) All process water piping connecting said facilities.
         3) Chemical Systems including storage tanks and piping.
      e. Any other associated piping, samples piping/instruments, appurtenances, or treatment process units located downstream of the Filters.
   3. All equipment and storage facilities for chemical feed systems that contain or contact liquid products shall be cleaned and rinsed with disinfectant prior to being placed into service.

## 3.2 PREPARATION

A. Cleaning and Flushing for all Facilities:
   1. Thoroughly clean and flush piping systems including supply, source and any appurtenant devices before performing disinfection.
   2. Cleaning agents used shall not contain hazardous substances or deleterious compounds that would cause a violation of water quality standards or cause health effects is subsequently introduced into the water supply during any disinfection or filling operations.
   3. Clean piping in accordance with requirements of Section 40 05 00.

B. Cleaning and Flushing of Piping and In-line Equipment.
   1. Flush all foreign matter from pipe in accordance with ANSI/AWWA C651 or NFPA 24 as applicable.
   2. Provide hoses, temporary connections, ditches, and other conduits as necessary to dispose of flushing water without damage to adjacent structures or terrain.

3. Use water suitable for disinfection.
4. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.
5. Operate valves during flushing process at least twice during each flush.

C. Cleaning of Tanks:
1. Remove all materials not part of the operating facilities including temporary works, tools, and debris.
2. Remove all water, dirt, paint chips, sediment, or foreign material by rinsing, vacuuming, or other removal techniques.
3. Thoroughly clean walls, floors, and attached structures with high-pressure water jet and by sweeping, scrubbing, or other similar means.
4. Cleaning shall:
   a. Remove all deposits of foreign nature.
   b. Remove biological growths.
   c. Clean the slopes, walls, tops, and bottom.
   d. Avoid damage to the structure.
   e. Remove and avoid pollution or oil deposits by workers and equipment.

## 3.3 DISINFECTION

A. Piping and In-Line Equipment:
1. Applies to piping and inline equipment such as pumps and valves that are not covered under other disinfection provisions.
2. Disinfect in accordance with ANSI/AWWA C651.
3. Utilize any of the three disinfection procedures outlined in ANSI/AWWA C651.
   a. Tablet Method.
   b. Continuous Feed Method.
   c. Slug Method.
4. Provide signage and tagging at all outlets from the piping being disinfected to prevent discharge of highly chlorinated water.
5. After applicable retention period, flush piping at a velocity of not less than 2.5 feet per second:
   a. Flush water shall be potable water.

B. Water Storage Facilities- Tanks and Reservoirs
1. Disinfect in accordance with ANSI/AWWA C652.
2. Utilize one of the following disinfection procedures outlined in ANSI/AWWA C652.
   a. Method 1.
   b. Method 2.
   c. Method 3.
3. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.
4. Provide signage and tagging at all outlets from the tank being disinfected to prevent discharge of highly chlorinated water.
5. After applicable retention period, flush tank or reservoir with potable water with a minimum free chlorine residual of 0.5 milligram per liter to remove heavily chlorinated water.

C. Water Treatment Plant Facilities:
1. Disinfect in accordance with ANSI/AWWA C653.
2. Utilize one of the two disinfection procedures outlined in ANSI/AWWA C653:
   a. Disinfection Procedure.
   b. Alternate Disinfection Procedure.
3. Provide signage and tagging at all outlets from areas being disinfected to prevent discharge of highly chlorinated water.

4. After applicable retention period and testing of residual, flush tank or reservoir with potable water with a minimum free chlorine residual of 0.5 milligram per liter to remove heavily chlorinated water.

## 3.4 DISPOSAL OF FLUSHING AND DISINFECTION WATER

A. All water used for cleaning, flushing and disinfecting of tanks, piping and similar shall be disposed of in accordance with all federal, state and local codes and regulations. Cleaning and flushing water shall not be discharged into any portions of the water treatment system without prior approval and coordination with Owner and Engineer. It shall not be discharged to the sanitary sewer system without Owner approval.

B. Heavily chlorinated water must be dechlorinated in accordance with ANSI/AWWA C651, C652, and C653 prior to release:
   1. See appendix of ANSI/AWWA standards for additional information.

## 3.5 VERIFICATION TESTING

A. Upon completion of flushing, provide verification in the form of bacteriological sampling meeting the requirements of applicable ANSI/AWWA standard.

B. Collection of Samples:
   1. Owner shall collect samples and send to independent, state certified laboratory for analysis.
   2. Coordinate activities to allow samples to be taken in accordance with this Section.
   3. Provide valves at sampling points.
   4. Provide access to sampling points.

C. Testing Equipment:
   1. Clean containers, equipment, and connections used in sampling to make sure they are free of contamination.
   2. Owner to obtain sampling bottles with instructions for handling from laboratory.

D. Chlorine Sampling and Analysis:
   1. Collect samples in accordance with applicable ANSI/AWWA standard.
   2. Samples of Disinfecting Solution:
      a. One sample per batch of disinfecting solution mixed and injected into pipe or vessel.
      b. If mixed solution not used, sample structure or pipe being disinfected during or immediately after filling.
   3. Free Chlorine Residual Samples:
      a. As required to establish concentrations at the beginning and end of retention period.
   4. Sampling Locations and Intervals:
      a. Sampling points shall be representative and accepted by Owner.
   5. Laboratory analysis to be performed by independent laboratory. Samples will be analyzed for disinfectant residual concentration.
   6. If chlorine concentration testing results in disinfection concentrations not meeting the required standard, disinfecting procedures and verification testing shall be repeated until specified limits are met.

E. Bacteriological Sampling and Analysis:
   1. Collect samples in accordance with applicable ANSI/AWWA standard.
   2. Sampling Locations and Intervals:
      a. In accordance with applicable ANSI/AWWA Standard.
      b. Sampling points shall be representative and accepted by Owner.
      c. If ANSI/AWWA Standard is not applicable or does not fully describe sampling procedure, utilize the following minimum requirements:
         1) A minimum of two (2) samples on two (2) consecutive days from each separable structure and every 1,000 feet of pipeline.
   3. Laboratory analysis to be performed by independent laboratory certified by the State of Oregon Environmental Laboratory Accreditation Program (ORELAP). Samples will be

analyzed for disinfectant residual and coliform concentrations using methods as described in the latest edition of Standard Methods for Examination of Water and Wastewater.

4. If verification testing results in bacterially positive samples or disinfection concentrations not meeting the required standard, disinfecting procedures and verification testing shall be repeated until specified limits are met.

F. Documentation:
   1. Owner to submit certified bacteriological reports on samples taken from system to appropriate regulatory authority.

G. Cost of Testing:
   1. Contractor shall pay all testing expense associated with verification testing.

**END OF SECTION**

# SECTION 01 75 00
## CHECKOUT AND START-UP PROCEDURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for checkout and startup of equipment, systems, and facilities which are necessary to complete commissioning and demonstrate system Acceptance (Substantial Completion).

B. Scope:
   1. Contractor shall initially check out, start up, and place equipment and systems installed under the Contract into successful operation, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
   2. Provide the following:
      a. All labor, tools, materials, and equipment required to complete equipment and system checkout and startup.
      b. Chemicals, lubricants, and other required operating fluids necessary for checkout, startup, and initial operation of the Work.
      c. Filters and other temporary or consumable items necessary for checkout, startup, and initial operation of the Work.
      d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and startup of equipment and systems, unless otherwise specified.
      e. Provide settings from electrical studies and coordination for breaker settings, overload settings, relay setting and other equipment required to be properly set for testing.

C. Related Sections include but are not necessarily limited to:
   1. Section 01 33 04 - Operation and Maintenance Manuals
   2. Section 01 61 03 - Equipment - Basic Requirements.
   3. Section 26 08 13 – Acceptance Testing.
   4. Section 40 61 13 - Process Control Systems - General Requirements.
   5. Section 46 31 59 – Cleaning Requirements for Oxygen Service.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate checkout and startup with other contractors, as necessary.
   2. Do not start up equipment or system(s) for continuous operation until all components of that equipment item or system, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
   3. Subject to the constraints of this Specifications section, Owner will furnish sufficient personnel to assist Contractor in starting up equipment and system(s), but responsibility for proper operation of the Work is Contractor's.
   4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to Engineer or otherwise required by the Contract Documents.
   5. For startup of heating equipment, air conditioning equipment, and other equipment and systems that provide temperature control, that are dependent upon the time of year, return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate equipment and system(s).
   6. Do not start up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals by Contractor in accordance with the Contract Documents.

B. Checkout and Startup Planning Meeting:
   1. Contractor, with appropriate Subcontractors and Suppliers, shall attend and participate in a meeting with Owner, facility manager, and Engineer to discuss planning, scheduling, and coordination of checkout and startup activities.
   2. Meeting shall be held by the earlier of: (1) not less than 30 days prior to first scheduled training session for the equipment and system(s) to be checked out and started-up, and (2) not less than 30 days prior to the checkout and startup of the associated equipment and system(s).
   3. Attend meeting prepared to knowledgably and effectively discuss:
      a. Status of the Work and schedule-to-complete for requirements prerequisite to checkout and startup.
      b. Schedule for and status of training required for each equipment item and system.
      c. Schedule for checkout, startup, and field quality control activities for the subject Work.
      d. Status and quantities of required consumables, lubricants, and utility services necessary for checkout and startup.
   4. Meeting will be chaired by Contractor. Contractor will prepare and distribute a record of topics discussed and decisions made during the meeting.
   5. Comply with decisions made at the meeting and the Contract Documents.

C. Scheduling:
   1. Progress Schedule:
      a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, startup, and field quality control activities, including all demonstration testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, startup, and field quality control activities for each equipment item and system.
      b. Perform startup and field quality control activities on the associated, scheduled dates, unless otherwise acceptable to Owner, facility manager, and Engineer.
   2. Restrictions for Scheduling:
      a. Checkout of materials, equipment, and systems by Contractor that do not involve or require Owner's or facility manager's personnel may be performed at any time during normal working hours. Where required by the Contract Documents or requested by Engineer, perform checkout in the presence of Engineer or Resident Project Representative (RPR).
      b. Startup, including initial operation of materials, equipment, and systems, shall not be initiated on: Friday, Saturday, Sunday, holidays, or the day immediately prior to a holiday unless otherwise acceptable to Owner, facility manager, and Engineer.
      c. Unless otherwise indicated in the Contract Documents or acceptable to Owner, facility manager, and Engineer, perform all startup during normal working hours of the day shift.
      d. To the extent practicable, where extended-duration startup or field quality control activities are required by the Contract, avoid having such activities extend into evening, night, weekend, or holiday hours.
      e. Owner reserves the right to require a minimum seven days' notice of rescheduled startup when Contractor cannot perform the associated activities as scheduled.
   3. Operation and Maintenance Data:
      a. Comply with Section 01 33 04 - Operation and Maintenance Manuals.
      b. A preliminary copy of all operation and maintenance manuals shall be received by Engineer prior to the start of the demonstration period Functional Demonstration Period.

## 1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Do not start up equipment or systems or place into initial operation until required operating permits are obtained from authorities having jurisdiction.

2. Where Owner (with or without assistance of Engineer) has applied for and obtained initial approvals or permits necessary for operation, Contractor shall furnish information and assistance to Owner or Engineer for Owner to secure final approvals from authorities having jurisdiction for required operating permits.

## 1.4 DEFINITIONS

A. The following defined terms are used in this Specifications Section:
   1. Project Classified System (PCS): An established, distinct part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, cabling, materials, and incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system. PCSs may be specifically indicated in this Specifications section or elsewhere in the Contract Documents.
   2. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:
      a. Finishing type construction work to ensure the Project or each PCS is ready to function without water.
      b. Equipment start-up.
      c. Personnel training.
   3. Functional Demonstration Period: A period of time, of unspecified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the facility and starts up and operates the facility to demonstrate functional integrity of the entire facility as evidence of Completed Commissioning.
   4. Acceptance Testing Period: A period of time, of specified duration, following the Functional Demonstration Period, during which the Contractor operates the entire facility, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the facility as evidence of Substantial Completion.
   5. Substantial Completion: See Specification Section 00 73 01.

## 1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Data collection and reporting log for each required Demonstration/Testing Period.

B. Informational Submittals: Submit the following:
   1. Progress Schedules indicating dates for checkout, startup, and field quality control activates.
   2. Completed checkout and startup log required in Paragraph 3.3.B of this Specifications section.
   3. Manufacturer's installation check letters (also known as Manufacturer's Field Services Report) required in Paragraph 3.3.B of this Specifications section.
   4. Instrumentation Supplier's Instrumentation Installation Certificate, required in Paragraph 3.3.B of this Specifications section.
   5. Notice of Completed Installation Letter verifying completion of all pre-demonstration startup activities, required in Paragraph 3.2.B of this Specifications section.
   6. Report of data collected during each required Functional Demonstration Period.
   7. Qualifications Statements:
      a. Qualifications, including resume' and copy of license, of Contractor-retained licensed operator.
   8. Notice of Completed Functional Demonstration Period.
   9. Startup Sequencing Procedures for Functional Demonstration Period.
   10. Checkout and Startup Log (from Functional Demonstration Period).
   11. Data Collection and Reporting Log (from Acceptance Testing Period).
   12. Training plan and schedule.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 CHECKOUT AND STARTUP – GENERAL

A. Facility Startup Divided into Three Periods:
   1. Pre-Demonstration, including:
      a. Complete the Work to a point ready for checkout and startup, including operation available in all manual, automatic, and other modes.
      b. Checkout and initial field quality control activities that can be performed prior to startup of the equipment or system.
      c. Confirm all electrical equipment to be started up and demonstrated has the proper settings for protection. i.e. motor temperature overloads or breaker settings. All electrical equipment shall be set according to the acceptance tests, power studies and coordination report and per manufacturers' recommendations.
      d. Obtain Notice of Completed Installation executed by all parties.
   2. Functional Demonstration Period including:
      a. Obtain Engineer's approval or acceptance (as applicable) of Submittals required prior to checkout and startup, including all Shop Drawings, Samples, source quality control (shop testing) Submittals, preliminary operation and maintenance manuals, and other Submittals required by the Contract Documents, other than Submittals that cannot be furnished until after startup.
      b. Checkout and initial field quality control activities that can be performed prior to startup of the equipment or system.
      c. Startup of the Work or PCS.
      d. Field quality control activities for the subject Work as indicated elsewhere in the Specifications and other Contract Documents, other than this section.
      e. Training of operations and maintenance personnel.
      f. Obtain Notice of Completed Commissioning.
   3. Acceptance Testing Period, including:
      a. Demonstration of functional integrity of the entire facility.
      b. Obtain notice of Substantial Completion.

### 3.2 PRE-DEMONSTRATION PERIOD

A. Complete the Work to the point where it is ready for checkout and startup.

B. After the work is complete, The Contractor, manufacturer's representatives, and engineer shall jointly inspect the system and list any equipment that has not been properly installed, detailing the problems and noting the party who shall be responsible for each correction.
   1. Initiate cleaning of systems as defined in Section 46 31 59.
   2. A Notice of Completed Installation executed by all parties will end the Pre-Demonstration Period.

### 3.3 FUNCTIONAL DEMONSTRATION PERIOD

A. Checkout.
   1. Comply with Section 01 61 03 - Equipment - Basic Requirements, including provisions concerning installation checks

B. Startup:
   1. After all discrepancies noted during the pre-demonstration period have been corrected, Contractor will schedule with Owner and Engineer the filling of the piping, and tanks with clean potable water.
   2. Functional demonstration of the Facility will require recirculation of flows within the system(s).

a. The exact sequence and temporary facilities required shall be detailed in Contractor's start-up sequence procedures.
b. Recirculation of flows and temporary piping, temporary pumping systems, or equipment shall be the responsibility of the Contractor.

3. Comply with requirements for startup of materials, equipment, and systems indicated in the associated Specification sections and elsewhere in the Contract Documents.
4. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the Acceptance Testing Period.
5. Perform startup to extent possible without introducing process flow.
6. Introduce process flow to complete startup.
   a. See section 46 43 62 for additional testing required.
7. Procedures include but are not necessarily limited to the following:
   a. Test or check and correct deficiencies of:
      1) Power, control, and monitoring circuits for continuity prior to connection to power source.
      2) Voltage of all circuits.
      3) Phase sequence.
      4) Cleanliness of connecting piping systems.
      5) Alignment of connected machinery.
      6) Vacuum and pressure of all closed systems.
      7) Lubrication.
      8) Valve orientation and position status for manual operating mode.
      9) Tankage for integrity using clean water.
      10) Pumping equipment using clean water.
      11) Instrumentation and control signal generation, transmission, reception, and response.
         a) Comply with Section 40 61 13 - Process Control System General Requirements.
      12) Tagging and identification systems.
      13) Proper connections, alignment, calibration and adjustment.
   b. Calibrate safety equipment.
   c. Manually rotate or move moving parts to assure freedom of movement.
   d. "Bump-start" electric motors to verify proper rotation.
   e. Perform other tests, checks, and activities required to make the Work ready for Acceptance Testing Period.
   f. Checkout and Startup Log:
      1) Prepare a log showing each equipment item and system requiring checkout and startup. Indicate in the log activities to be accomplished during checkout and startup.
      2) Provide a place for Contractor to record date and person performing required checkout and startup. Indicate associated date(s), personnel, and employer of each.
      3) Submit completed checkout and startup log to Engineer and obtain Engineer's acceptance.
8. Personnel Training:
   a. Contractor shall organize and complete any other training defined in these Contract Documents.
9. Obtain Suppliers' certifications of the installed and operational Work, without restrictions or conditions, and submit to Engineer:
   a. Manufacturer's installation check letters (sometimes referred to as Manufacturer's Field Services Report).
   b. Instrumentation Supplier's Instrumentation Installation Certificate.

C. Completion of Functional Demonstration Period

1. Upon notification of completion of the Functional Demonstration testing by the Contractor, the Engineer shall review the operation of the equipment to verify that the testing is complete.
2. The Engineer shall perform random tests to determine if the equipment is operating properly and witness various operational sequences.
3. The Engineer may initiate alarm conditions to determine if the control system is functioning properly.
4. The Engineer's review shall include a review of the HMI interface and PLC SCADA system commissioning requirements to determine conformance with Specification Section 40 96 52.
    a. The Engineer's review shall identify any equipment that has not been properly installed, or operating, detailing the outstanding installation issues on a punch list and noting the party who shall be responsible for each correction and identify the items that require that correction.
    b. Work determined not meeting state of readiness:
        1) Contractor: Correct deficiencies noted or submit plan of action for correction.
        2) Engineer: Re-inspect work after Contractor's notice of correction of deficiencies.
        3) If more than one (1) reinspection, costs incurred by Engineer will be billed to Owner who will deduct them from final payment due Contractor.
5. Upon satisfactory completion of the review, the Engineer shall submit to the Contractor a written Notice of Completed Commissioning.
    a. Once the Notice of Completed Commissioning is issued, Acceptance Testing may commence.

## 3.4 ACCEPTANCE TESTING PERIOD

A. Acceptance Testing Period – General:
1. Prior to discharge of any treated water to the Owner's distribution system, Contractor is required to demonstrate compliance with these Contract Documents.
2. Demonstrate the operation and performance of mechanical, electrical, instrumentation, and control interfaces of the Work undergoing the Acceptance Testing Period, in accordance with the Contract Documents.
3. Duration of Acceptance Testing Period: 168 consecutive hours.
4. If, during the Acceptance Testing Period, the aggregate time used for repair, alteration, or unscheduled adjustments to any part of the Work that renders the affected Work inoperative or operation outside of recommended ranges exceeds 5 PCT of the Acceptance Testing Period, the demonstration of operation and performance will be deemed unacceptable and Contractor shall provide appropriate adjustments and remedies and re-perform the Acceptance Testing, at no additional cost to Owner or facility manager, until acceptable results are obtained. Re-performance of the Acceptance Testing Period shall comply with the same requirements as the original Acceptance Testing Period.
5. Perform the demonstration of operation and performance of the Work under full operational conditions.
6. Owner's or Facility Manager's Personnel:
    a. Owner or facility manager (as applicable) will make available operations personnel to make process decisions affecting facility performance and compliance with applicable operating permits.
    b. Owner's or facility manager's assistance will be available only for process decisions.
    c. Contractor will perform all other functions associated with the Acceptance Testing Period including but not limited to equipment operation and maintenance until successful completion of the Acceptance Testing Period in accordance with the Contract Documents.
7. Owner or facility manager reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, and similar actions and events during the Acceptance Testing Period to verify the operation and performance of the Work in

automatic, manual, and other types of operating modes, backup systems, and alternate operating modes.

8. Prior to Starting Acceptance Testing Period:
    a. Prepare data collection and reporting log for sampling, analytical data, and data to be obtained by manually recording data from field or panel indicators. Not less than 30 days prior to the start of the Acceptance Testing Period, submit the data collection and reporting log to Engineer for acceptance.
9. Timing of Start and End of Acceptance Testing Period:
    a. Schedule the end of the Acceptance Testing Period at a convenient time such as midnight, so the Owner or facility manager can assume operational responsibility on a new day beginning immediately after completion of the Acceptance Testing Period.
    b. Time of beginning and ending Acceptance Testing Period shall be agreed upon by Contractor, Owner (and facility manager, if other than Owner), and Engineer in advance of initiating Acceptance Testing Period.

B. Acceptance Testing Period, Evaluation, and Acceptance:
1. Throughout the Acceptance Testing Period, provide knowledgeable personnel to answer Owner's or facility manager's questions, provide final field instruction on select systems (where appropriate) and to respond to problems or failures of the Work.
    a. The facility shall operate in automatic mode from the Control Room for the entire duration of the testing period.
    b. Any time that any part or piece of equipment, instrumentation, or SCADA system is adjusted or manually operated shall be recorded and the duration of the event will be considered unscheduled alteration.
2. Responsibilities for Sampling and Data Collection:
    a. Use the data collection and reporting log format accepted by Engineer. Indicate data clearly and legibly.
3. Responsibilities for Data Reporting:
    a. Submit data collected to Engineer for evaluation of acceptability of results.
4. Data Evaluation:
    a. Engineer, in consultation with Owner and facility manager (as applicable) as necessary, will evaluate the data collected during the Acceptance Testing Period and other information obtained during the Acceptance Testing Period for compliance with the Contract Documents.
    b. Engineer will advise Contractor in writing of whether the data and information obtained indicate that the Acceptance Testing Period was successfully completed.
5. Criteria for Acceptance:
    a. Start/Stop operations:
        1) The facility automatically stops production at least twice during the Acceptance Testing Period to simulate that the water system does not require more water.
        2) The facility automatically starts production at least twice during the Acceptance Testing Period to simulate that the water system requires more water.
        3) The time that the facility is not producing water is not considered part of the Acceptance Testing Period.
    b. The facility operates at the plant nominal firm capacity for at least four (4) consecutive hours without any issues.
    c. The facility operates at the daily minimum plant capacity for at least four (4) consecutive hours without any issues.
    d. Each filter is backwashed at least once.
    e. No water exits through any overflow piping in the facility.
    f. All primary and secondary drinking water standards are always met.
6. Upon successful completion of the Acceptance Testing Period, Engineer will endorse certificate attesting to successful test, and citing the hour and date of supplying water to Buyer's distribution system as the effective date of substantial completion for the facility and defined as the date on which Owner has placed the facility into continuous service.

a. Certificate tentatively issued subject to Final Completion of Work.
b. Issued subject to completion or correction of items cited in the certificate (punch list).
c. Issued with responsibilities of Contractor and Owner cited.
d. Executed by Engineer.
e. Accepted by Owner.
f. Accepted by Contractor.

**END OF SECTION**

# SECTION 01 77 19
## CLOSEOUT REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for:
   1. Substantial Completion.
   2. Final inspection.
   3. Request for final payment and acceptance of the Work.

### 1.2 SUBSTANTIAL COMPLETION

A. Substantial Completion – General:
   1. Prior to requesting inspection for Substantial Completion, perform the following for the substantially completed Work:
      a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
      b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
      c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Engineer's acceptance of, field quality control tests and inspections required by the Contract Documents.
      d. Complete checkout and startup in accordance with Section 01 75 00 - Checkout and Startup Procedures, requirements of the Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
      e. Cleaning for Substantial Completion shall be completed in accordance with Section 01 74 00 - Cleaning.
      f. Spare parts, tools, and extra materials shall be delivered and accepted in accordance with the Contract Documents and documentation of Owner's acceptance thereof has been submitted to Engineer in acceptable form in accordance with Section 01 78 43 - Spare Parts and Extra Materials.
      g. Training of the facility's operations and maintenance personnel shall be completed in accordance with the Contract Documents, including Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
      h. Submit and obtain Engineer's acceptance of final operations and maintenance manuals in accordance with Section 01 78 23 - Operation and Maintenance Data.
      i. Obtain and submit to Engineer all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
      j. Complete other tasks that the Contract requires be completed prior to Substantial Completion.
   2. _____Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Supplementary Conditions.
   3. Sample letter for Contractor's request for inspection for Substantial Completion is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project and the needs of Contractor's request.
   4. Unless decided otherwise by Owner and Engineer, form of certificate of Substantial Completion will be EJCDC C-625, "Certificate of Substantial Completion" (2018 edition or later), prepared by Engineer.

5. Refer to the Agreement and Section 01 29 76 - Progress Payment Procedures, for requirements regarding consent of surety to partial release of or reduction in retainage.

## 1.3 FINAL INSPECTION

A. Final Inspection – General:
   1. Prior to requesting final inspection, verify that all the Work is fully complete and ready for final payment. Partial checklist for this purpose is attached to this Specifications section.
   2. Sample letter for Contractor to request final inspection is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project.
   3. Procedures for requesting and documenting the final inspection are in the General Conditions, as may be modified by the Supplementary Conditions, and as augmented in this Specifications section.

## 1.4 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:
   1. After successful completion of the final inspection, submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions, and using procedure specified in Section 01 29 76 - Progress Payment Procedures, and this Specifications section.
   2. Acceptance of the Work:
      a. Upon Engineer's concurrence that the Work is complete and ready for final payment (as a result of the final inspection and other communications between the parties and Engineer) and receipt of the final Application for Payment, accompanied by other required Contract closeout documentation, all in accordance with the Contract Documents, Engineer will issue to Owner and Contractor a notice of acceptability of the Work, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
      b. Unless decided otherwise by Owner and Engineer, form of acceptance will be EJCDC C-626, "Notice of Acceptability of Work", (2018 edition or later).
      c. Nothing other than receipt of such notice of acceptability from Engineer constitutes acceptance of the Work.
      d. Receipt of Engineer's notice of acceptability of the Work does not relieve Contractor of Contractor's continuing obligations under the Contract, including correction period obligations, warranty obligations, indemnification obligations, insurance requirements, and Contractor's other obligations following acceptance of the Work by Engineer and final payment. Such obligations shall commence and remain in effect as indicated elsewhere in the Contract Documents.

B. Request for final payment shall include:
   1. Documents required for progress payments in Section 01 29 76 - Progress Payment Procedures.
   2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
   3. List, on Contractor's letterhead, of all Change Proposals, Claims, and disputes that Contractor believes are unsettled. If there are no such Change Proposals, Claims, or disputes, so indicate in writing.
   4. Consent of Surety to Final Payment:
      a. Acceptable form includes AIA G707, "Consent of Surety to Final Payment" (1994 or later edition), or other form acceptable to Owner.
   5. Releases of Liens:
      a. Submit complete and legally effective releases (satisfactory to Owner) of all Liens filed in connection with the Work, regardless of whether such Lien was filed by Contractor, Subcontractor, or Supplier.

b. Each release of Lien shall be signed by an authorized representative of the entity submitting the release of Lien, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.

6. Waivers of Lien Rights:
   a. Submit legally-binding waivers of rights to file Liens, acceptable to Owner, as required in the General Conditions (as may be modified by the Supplementary Conditions) from Contractor and each Subcontractor and Supplier that furnished or provided labor, material, or equipment totaling $1,000 or more for the Work.
   b. Furnish final list of Subcontractors and Suppliers indicating final amount of the associated subcontract or purchase order for each. Include on the list all lower-tier Subcontractors and Suppliers retained by higher-tier Subcontractors and Suppliers. Prepare the list using the form included in Section 01 29 76 - Progress Payment Procedures.
   c. Each waiver of Lien rights shall be signed by an authorized representative of the entity submitting waiver of Lien rights, and shall include Contractor's, Subcontractor's, or Supplier's (as applicable) corporate seal, when applicable.
   d. Waiver of Lien rights may be conditional upon receipt of final payment.
   e. Required Affidavits: Submit the following:
      1) Affidavit of payment of debts and claims, submitted by Contractor. Acceptable form includes AIA G706, "Contractor's Affidavit of Payment of Debts and Claims" (1994 or later edition), or other form acceptable to Owner, and;
      2) Affidavit of release of Liens, submitted by Contractor. Acceptable form includes AIA G706A, "Affidavit of Release of Liens" (1994 or later edition).
      3) Each affidavit shall be signed by an authorized representative of Contractor and shall bear Contractor's corporate seal, as applicable.
   f. In the event Contractor is unable to obtain one or more required waivers of Lien rights, recourse is set forth in the General Conditions, as may be modified by the Supplementary Conditions.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 ATTACHMENTS

A. The documents listed below, following this Specification section's "End of Section" designation, are part of this Specifications section:
   1. Sample letter for Contractor's use in requesting inspection for Substantial Completion (two pages).
   2. Sample partial checklist to identify readiness for final inspection (four pages).
   3. Sample letter for Contractor's use in requesting final inspection (one page).

B. _____In the model language of the attached sample letters for Contractor to request inspection for Substantial Completion and the final inspection, italicized language in brackets, e.g., "insert date" indicates instructions to the drafter of the letter and often indicates specific information to be inserted by Contractor; do not include bracketed, italicized text in the final version of the letter(s) prepared for the Project. Non-italicized language in brackets is optional language; use the appropriate language to complete the actual letter for the Project and edit where required to suit the specific circumstances.

## END OF SECTION

**SAMPLE LETTER FOR CONTRACTOR'S USE IN REQUESTING INSPECTION FOR SUBSTANTIAL COMPLETION**

**SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED**

[Date]

[Name of Engineer's contact person]
HDR
[Street address]
[City, state, postal code]

Subject:
[Project name, Contract designation]
Request for Inspection for Substantial Completion

Dear [addressee]:

In our opinion, [all of] [or] [a portion of] the Work under the above-referenced Contract is substantially complete as of [insert month, day, year on which Substantial Completion was achieved]. [The specific portion of the Work that we believe is substantially complete is [insert identification of that portion of the Work that is substantially complete].]

Enclosed is our listing of uncompleted Work items ("punch list"). In accordance with Paragraph 15.03.A of the General Conditions, we hereby request: (1) That the Engineer schedule and perform the inspection for Substantial Completion as soon as possible, and (2) Issuance of the certificate of Substantial Completion.

In accordance with Paragraph 15.03.D of the General Conditions, upon Substantial Completion, we propose the following relative to apportionment of responsibilities between the Owner and the Contractor:

1. Security, Protection, Insurance:
    a. Site Security: [insert proposal; address whether Owner or Contractor will be responsible for security of the Site].
    b. Protection of the Substantially Completed Work: [insert proposal; address whether Owner or Contractor will be responsible for protection].
    c. Property Insurance: [insert proposal; typically Owner assumes responsibility for property insurance upon Substantial Completion]
2. Operation and Maintenance:
    a. Operation: [insert proposal; address whether Owner or Contractor will be responsible for operating the substantially completed Work].
    b. Maintenance: [insert proposal; address whether Owner or Contractor will be responsible for maintaining the substantially completed Work].
3. Utilities: [for each of the following, indicate whether Owner or Contractor will be responsible for utilities and services, or whether responsibility will be shared; if shared, indicate proposed cost-sharing]
    a. Electricity: [insert proposal].
    b. Natural Gas/Fuel/Heating: [insert proposal].
    c. Water Supply: [insert proposal].

d. Wastewater: [insert proposal].

e. Communications (Telephone, Internet, Video): [insert proposal].

In accordance with Paragraph 15.08.A of the General Conditions, we understand that the Contract's correction period for the Work covered by the certificate of Substantial Completion commences on the Substantial Completion date documented in said certificate. [Drafter: Also see Paragraph 15.04 ("Partial Utilization") of the General Conditions and, where necessary, edit this paragraph of the letter accordingly.]

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
Preliminary list of uncompleted Work items ("punch list"; [##] pages)

Copies:
[Owner's project manager]

## SAMPLE PARTIAL CHECKLIST TO IDENTIFY READINESS FOR FINAL INSPECTION

**Project**: [_____]
**Contract**: [_____]
**Contractor**: [_____]

| Item No./Description | Completed/Date | | In Progress | Not Started | Not Applicable | Target Date | Responsible Entity/Person |
|---|---|---|---|---|---|---|---|
| 1. All Submittals, including all Shop Drawings and Samples, approved or accepted by Engineer | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 1. Final services completed by Suppliers, including submittal of "Manufacturer Field Service Report" in Section 01 61 03 Equipment - Basic Requirements | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 2. Final Work completed by Subcontractors | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 3. Permits closed out and regulatory compliance transitioned from construction to operations | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 4. All outstanding change issues are addressed and all Change Proposals submitted | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 5. All Change Proposals and Claims are resolved | ☐ | | ☐ | ☐ | ☐ | | |

| Item No./Description | Completed/Date | | In Progress | Not Started | Not Applicable | Target Date | Responsible Entity/Person |
|---|---|---|---|---|---|---|---|
| *Remarks*: | | | | | | | |
| 6. All defective Work of which Contractor is aware has been corrected in accordance with the Contract Documents | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 7. Issues related to Constituents of Concern and potential Hazardous Environmental Condition have been fully addressed | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 8. All spare parts, tools, and extra materials have been furnished in accordance with the Contract Documents, and documentation thereof submitted to Engineer | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 9. All final operations & maintenance manuals have been submitted and accepted by Engineer | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 10. Manufacturer warranties and software license(s) furnished | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 11. Instruction and training of operations and maintenance personnel is complete and records of training submitted | ☐ | | ☐ | ☐ | ☐ | | |

| Item No./Description | Completed/Date | | In Progress | Not Started | Not Applicable | Target Date | Responsible Entity/Person |
|---|---|---|---|---|---|---|---|
| *Remarks*: | | | | | | | |
| 12. MBE/WBE/DBE/VBE compliance report(s) submitted (when applicable) | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 13. All field engineering Submittals, including survey data, furnished | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 14. All Work on "punch list" is complete in accordance with the Contract Documents | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 15. All record documents submitted to and accepted by Engineer | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 16. Contractor is fully demobilized from the Site | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 17. All Site restoration is complete | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 18. Final cleaning of all work areas is complete | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 19. Releases of Liens and waivers of Lien rights (or acceptable | ☐ | | ☐ | ☐ | ☐ | | |

| Item No./Description | Completed/Date | | In Progress | Not Started | Not Applicable | Target Date | Responsible Entity/Person |
|---|---|---|---|---|---|---|---|
| alternative) obtained from Subcontractors and Suppliers | | | | | | | |
| *Remarks*: | | | | | | | |
| 20. Evidence of Contractor liability insurance furnished for correction period | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| 21. All other required Contract closeout documents obtained | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| | | | | | | | |
| *Remarks*: | | | | | | | |
| 22. All other Work and documentation required prior to final payment is complete and provided in accordance with the Contract Documents | ☐ | | ☐ | ☐ | ☐ | | |
| *Remarks*: | | | | | | | |
| | | | | | | | |

# SAMPLE LETTER FOR CONTRACTOR'S USE IN REQUESTING FINAL INSPECTION

**SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED**

[Date]

[Name of Engineer's contact person]
HDR
[Street address]
[City, state, postal code]

Subject:
[Project name, Contract designation]
Request for Final Inspection

Dear [addressee]:

The Work under the above-referenced Contract is complete and ready for final payment as of [insert month, day, year on which final completion was achieved]. In accordance with Paragraph 15.05 of the General Conditions, we hereby request that the Engineer schedule and perform the final inspection as soon as possible. Upon successful completion of the final inspection, we will submit our final Application for Payment accompanied by the required Contract closeout documentation in accordance with the Contract Documents.

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
None

Copies:
[Owner's project manager]

# SECTION 01 78 39
## PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for Project record documents, to supplement record documents requirements of the General Conditions, as may be modified by the Supplementary Conditions.

B. Scope:
   1. Contractor shall provide all labor, materials, equipment, and services to establish, maintain, continuously update, and submit to Engineer Project record documents in accordance with the Contract Documents.

C. Related Sections include but are not necessarily limited to:
   1. Section 01 29 73 - Schedule of Values.
   2. Section 01 29 76 - Progress Payment Procedures.
   3. Section 01 31 26 - Electronic Communication Protocols.
   4. Section 01 33 00 – Submittals.
   5. Section 01 71 23 - Field Engineering.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Obtain necessary field measurements and record all data required for Project record documents before covering up the Work or building on subsequent phases of the Work.
   2. Promptly after obtaining measurements and information, record the data and information on Project record documents.
   3. Where a licensed, registered professional land surveyor is retained on the Project, whether by Contractor or others, to perform field measurements and record other data for as-constructed Project or Site conditions, coordinate with such entity and schedule and perform the Work accordingly. Allow surveyor sufficient timte and proper conditions for performing surveyor's work. Assist the surveyor as necessary in performance of surveyor's responsibilities.

B. Monthly Status Evaluation:
   1. Not less than once per month, as a condition precedent to submitting Application for Payment, Contractor's site superintendent will meet with either Engineer or Resident Project Representative (RPR) at the Site to review status of Contractor's Project record documents.
   2. When Engineer or RPR directs corrections to Project record documents, promptly make such corrections on the Project record documents. Engineer's or RPR's directions or lack thereof do not in any way relieve or mitigate Contractor's sole responsibility for the accuracy, completeness, and clarity of Project record documents.
   3. Requirements for review of record documents status as a condition precedent to progress payments is in Section 01 29 73 - Schedule of Values, and Section 01 29 76 - Progress Payment Procedures.
   4. Record documents shall be provided as PDF files in electronic format. Contractor shall upload latest electronic file of record documents to document management system each month as a condition of payment.

### 1.3 QUALITY ASSURANCE

A. Qualifications:

1. Comply with Section 01 71 23 - Field Engineering, regarding personnel and equipment necessary to measure and record field conditions.
2. Recorder of Changes and Field Conditions on Project Record Documents:
    a. Contractor's staff at the Site shall include not less than one person with suitable training and drafting (drawing) experience to record on the Project record documents changes made and field conditions encountered.
    b. Recorder of changes and field conditions on the Project record documents shall possess not less than two semesters of drafting (drawing) training in a classroom, either in high school, college, or bona-fide vocational school.
    c. Upon Engineer's request, submit name of proposed recorder at the Site, resume', or list of relevant experience, and copy of credentials of completion of such drafting (drawing) course(s).
    d. If original recorder of changes and field conditions is replaced, promptly advise Engineer and RPR in writing and submit to Engineer qualifications of proposed replacement.

B. Samples of Similar Prior Work:
1. Submit Samples of the personal work of Contractor's designated recorder of changes and field conditions on the Project record documents from not less than two prior projects of similar type(s) of work at the Work. Submit copies of not less than two marked-up drawings from each prior project and copies of two pages of marked-up specifications from each prior project.
2. Samples shall be in the same form as proposed for the Project record documents. For example, where Contractor intends to submit hand-drawn mark-ups of the Drawings and Specifications, Samples shall be copies of hand-drawn markups. Where Contractor intends to submit Project record documents in native (executable) file format (such as CAD files), Samples shall be developed using the same software to be used in preparing the Project record documents.
3. If original recorder of changes and field conditions is replaced by Contractor, replacement recorder shall provide the same standard of work on Project record documents as indicated in the approved Samples.

## 1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Samples:
    a. Sample of field-recorded project record documents from prior projects, in accordance with this Specifications section's "Quality Assurance" Article, to establish quality and style for markups of Project record documents. Submit within 15 days of the date the Contract Times commence running.

B. Informational Submittals: Submit the following:
1. Qualifications Statements:
    a. When requested by Engineer, submit qualifications of proposed recorder of changes and field conditions for Project record documents at Contractor's field office at the Site. Qualifications shall comply with the "Quality Assurance" Article of this Specifications section.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
    a. Prior to readiness for final payment, submit to Engineer one copy of Project's final record documents and obtain Engineer's acceptance of same. Submit complete record documents; do not make partial Submittals without Engineer's concurrence.
    b. Submit the following Project record documents:
        1) Record Drawings, including those issued via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

2) Record project manual, including Specifications, indicating changes made via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

c. Submit record documents with transmittal letter on Contractor's letterhead in accordance with requirements in Section 01 33 00 - Submittals.

2. Certifications:

a. Record documents Submittal shall include certification, with original signature of official authorized to sign legally-binding contracts on behalf of Contractor, reading as follows:

1) (Contractor's legal/contractual entity name) has maintained, continuously updated, and submitted Project record documentation in accordance with the General Conditions and Supplementary Conditions, Section 01 78 39 - Project Record Documents, and other elements of Contract Documents, for the Owner's organization's name, Municipality and state of the Site, Site name and Project name. We certify that each record document submitted is complete, accurate, and legible relative to the Work performed under our Contract, and that the record documents comply with the requirements of the Contract Documents.

By: [_____ (signature)
Print Name: [_____
Title: [_____

## 1.5 MAINTENANCE OF RECORD DOCUMENTS

A. Contractor shall maintain a hard copy of record documents on site in addition to the electronic copy which must be maintained and submitted monthly as a condition of monthly payment.

B. Maintain in Contractor's field office, in clean, dry, legible condition, complete sets of the following record documents:
1. Drawings, Specifications, and Addenda;
2. Shop Drawings, Samples, and other Submittals, including records of test results, approved or accepted as applicable, by Engineer;
3. Change Orders, Work Change Directives, Field Orders, allowance authorizations;
4. copies of all interpretations and clarifications issued;
5. photographic documentation;
6. survey data; and
7. all other documents pertinent to the Work.

C. Provide files and racks for proper storage and easy access to Project record documents. File record documents in accordance with the edition of the Construction Specification Institute's *MasterFormat* used for organizing the project manual, unless otherwise accepted by Engineer or RPR.

D. Promptly make Project record documents available for observation and review upon request of Engineer, RPR, or Owner.

E. Do not use Project record documents for any purpose other than serving as Project record. Do not remove Project record documents from Contractor's field office without Engineer's approval.

## 1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

A. Recording Changes, Field Conditions, and Other Information – General:
1. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
2. Keep record documents current consistent with the progress of the Work. Make entries on record documents within two working days of receipt of information required to record the change, field condition, or other pertinent information.

3. Do not permanently conceal the Work until required information has been recorded for Project record documents.
4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Engineer-accepted Project record documents.
5. Marking of Entries:
    a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to Project record documents.
    b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files in "portable document format" (.PDF) files.
    c. Date each entry on record documents.
    d. Indicate changes by drawing a "cloud" around the change(s) indicated.
    e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:
1. Record changes on copy of the Drawings. Submittal of Contractor-originated or -produced drawings as a substitute for recording changes on a copy of the Drawings is unacceptable.
2. Record changes on plans, sections, elevations, schematics, schedules, and details as required for clarity, accuracy, and completeness, making reference dimensions and elevations (to Project datum) for complete record documentation.
3. Record actual construction including:
    a. Depths of various elements of foundation relative to Project datum.
    b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements and Project elevation datum. For each Underground Facility, including pipe fittings, show and indicate dimensions to not less than two permanent, visible surface improvements.
    c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure and, where applicable, to Project elevation datum.
    d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
    e. Field changes of dimensions, arrangements, and details.
    f. Changes made in accordance with Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.
    g. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document such changes.
4. Recording Changes for Schematic Layouts:
    a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Contractor subject to acceptance by Engineer.
    b. Record on the Project record documents all revisions to schematics on the Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Drawings. Show and indicate actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
    c. When dimensioned plans and dimensioned sections or elevations on the Drawings show the Work schematically, indicate on the Project record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items

1) Clearly identify each item of the Work by accurate notations such as "cast iron drain", "rigid electrical conduit", "copper waterline", and similar descriptions.
2) Show by symbol or by note the vertical location of each item of the Work; for example, "embedded in slab", "under slab", "in ceiling plenum", "exposed", and similar designations. For piping not embedded, also indicate elevation dimension relative to Project elevation datum.
3) Descriptions shall be sufficiently detailed to be related to the Specifications.

d. Engineer may furnish written waiver of requirements relative to schematic layouts shown on plans, sections, and elevations when, in Engineer's judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on such waiver(s) being issued.

5. Supplemental Drawings:
   a. In some cases, drawings produced during construction by Engineer or Contractor supplement the Drawings and shall be included with Project record documents submitted by Contractor. Supplemental record drawings shall include drawings or sketches that are part of Change Orders, Work Change Directives, Field Orders, and allowance authorizations and that cannot be incorporated into the Drawings because of space limitations.
   b. Supplemental drawings submitted with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.
   c. When supplemental drawings developed by Contractor using computer-aided drafting/design (CAD), building information models (BIM), or civil information models (CIM) software are to be included in record drawings, submit electronic files for such drawings in accordance with Section 01 31 26 – Electronic Communication Protocols, as part of record drawing Submittal. Label such files, "Supplemental Record Drawings", including with Contractor's name, Project name, and Contract designation.

C. Specifications and Addenda:
   1. Mark each Specifications section to record:
      a. Manufacturer, trade name, catalog number, and Supplier of each material and equipment item actually furnished.
      b. Changes made by Addendum, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

## 1.7 ELECTRONIC DOCUMENTS FURNISHED BY ENGINEER

A. CAD, BIM, or CIM files of the Drawings will be furnished by Engineer upon the following conditions:
   1. Contractor shall submit to Engineer a letter on Contractor letterhead requesting CAD, BIM, or CIM files of the Drawings and indicating specific definition(s) or description(s) of how such Electronic Documents will be used by Contractor, and specific description of benefits to Owner (including credit proposal, if applicable) if the request is granted.
   2. Engineer does not guarantee that Electronic Documents are available in the format(s) requested by Contractor. Some projects may have Drawings developed using only CAD software instead of BIM or CIM software. Engineer will not create BIM or CIM files for Contractor if such files do not already exist.
   3. Contractor shall sign Engineer's standard agreement with Contractor for for release of Electronic Documents and shall abide by the provisions of such agreement for release of Electronic Documents.
   4. Layering system incorporated in CAD, BIM, and CIM files shall be maintained as transmitted by Engineer. CADD, BIM, and CIM files transmitted by Engineer containing cross-referenced files shall not be bound by Contractor. Drawing cross-references and paths shall be maintained. If Contractor alters layers or cross-reference files, Contractor shall restore all layers and cross-references prior to submitting Project record documents to Engineer.

5. Contractor shall submit Project record drawings to Engineer in same CAD, BIM, or CIM format that files were furnished to Contractor..

B. Microsoft Word files of Specifications:
   1. Requirements for Engineer's potential release of word processing files of the Specifications or other written documents in native format are the same as those for Drawings.
   2. When Specifications are released in native format, Contractor shall submit record specifications in the same format, with all changes tracked using Microsoft Word's "track changes" feature.
   3. Do not modify the formatting of the native files furnished by Engineer. If formatting changes are made without Engineer's authorization, remedy the formatting to the same condition and status as when the files were first delivered to Contractor. Such remedy shall be at Contractor's expense.
   4. Comply with all requirements of this Specifications section regarding record specifications.
   5. After delivery of record specifications Submittal to Engineer, delete from Contractor's files the native word processing files. Contractor may retain a PDF version of such files for Contractor's records.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

**END OF SECTION**

# SECTION 01 78 43
## SPARE PARTS AND EXTRA MATERIALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for furnishing spare parts, extra materials, maintenance supplies, and special tools required for maintenance (collectively, "spare parts and extra materials") required by the Contract Documents.

B. Scope:
   1. Contractor shall furnish spare parts, extra materials, and associated information, for materials and equipment furnished in accordance with the Contract Documents. Furnish such items in accordance with the requirements of this Specifications section and the Specifications sections in which such items are indicated.
   2. Contractor is fully responsible for loss and damage to spare parts and extra materials until such items are received by Owner's facility manager.
   3. Promptly replace spare parts and extra materials furnished by Owner to Contractor for use in remedying defective Work.

C. List of Spare Parts and Extra Materials:
   1. With the Shop Drawings and product data Submittals for each Specifications section, submit a complete listing of spare parts and extra materials necessary for maintenance for two years of operation, together with unit prices in current United States funds, and source(s) of supply for each.
   2. Also include listing of spare parts and extra materials, with pricing and sources, in the operations and maintenance data submitted in accordance with Section 01 78 23 - Operation and Maintenance Data.

### 1.2 SUBMITTALS

A. Maintenance Material Submittals: Furnish and submit the following:
   1. Spare Parts and Extra Materials:
      a. Furnish to Owner or facility manager in accordance with requirements of this Specifications section, and the Specifications section in which the spare parts and extra materials are specified.
   2. Transfer Documentation: For each delivery of spare parts and extra materials, submit to Engineer the following:
      a. Submit, on Contractor's letterhead, a letter of transmittal for spare parts and extra materials furnished under each Specifications section. Letter of transmittal shall accompany spare parts and extra materials. Do not furnish letter of transmittal separate from associated spare parts and extra materials.
      b. Furnish three original, identical, signed letters of transmittal for each delivery of spare parts and extra materials furnished under each Specifications section. Upon delivery of specified quantities and types of spare parts and extra materials to Owner or facility manager, designated person from Owner or facility manager will countersign each original letter of transmittal indicating Owner's or facility manager's receipt of spare parts and extra materials in the quantity, type, and quality required by the Contract Documents. Owner or facility manager will retain one fully-signed original, Contractor shall submit one fully-signed original to Engineer. Contractor shall retain one fully-signed original for Contractor's records.
      c. Letter of transmittal shall include the following:
         1) Information required for letters of transmittal in Section 01 33 00 - Submittal Procedures.

2) Transmittal shall list spare parts and extra materials furnished under the associated Specifications section. Indicate each individual part, material, equipment item, tool, and product and the associated quantity furnished.
3) Include space for countersignature by Owner or facility manager as follows: space for signature, space for printed name, space for signatory's title, and date.

### 1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging and Labeling of Spare Parts and Extra Materials:
   1. Furnish spare parts and extra materials in manufacturer's unopened cartons, boxes, crates, or other original, protective covering suitable for preventing corrosion and deterioration.
   2. Protect and package spare parts and extra materials for maximum shelf life normally anticipated by manufacturer.
   3. Packaging of spare parts and extra materials shall be clearly marked and identified with name of manufacturer, applicable material or equipment, part number, part description, and part location in the equipment or system.

B. Storage Prior to Delivery to Owner:
   1. Prior to furnishing spare parts and extra materials to Owner or facility manager, store spare parts and extra materials in accordance with the Contract Documents and manufacturers' written recommendations.

C. Procedure for Delivery to Owner or Facility Manager:
   1. Deliver spare parts and extra materials to Owner's or facility manager's permanent storage rooms at the Site or area(s) at the Site designated by Owner or facility manager.
   2. When spare parts and extra materials are delivered, Contractor and Owner (or facility manager) will mutually inventory the spare parts and extra materials delivered to verify compliance with the Contract Documents regarding quantity, part numbers, and quality.
   3. Additional procedures for delivering spare parts and extra materials to Owner or facility manager, if required, will be developed by Engineer and complied with by Contractor.
   4. Contractor shall reimburse Owner for all costs and expenses incurred by Owner and facility manager, including professional services, for delivery of inadequate, incorrect, or defective spare parts and extra materials. Owner may withhold such amounts from payments due Contractor via set-offs in accordance with the Contract Documents.

D. Delivery Time and Eligibility for Payment:
   1. Deliver to Owner or facility manager spare parts and extra materials prior to date of Substantial Completion for materials and equipment associated therewith.
   2. Do not deliver spare parts and extra materials before commencing startup for associated material or equipment.
   3. Spare parts and extra materials are not eligible for payment until delivered to Owner or facility manager and Contractor's receipt of Owner's or facility manager's countersignature on letter of transmittal as required in this Specifications section.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 01 79 23
## INSTRUCTION OF OPERATION AND MAINTENANCE PERSONNEL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for instruction of operation and maintenance personnel.
   2. Qualifications requirements for Suppliers' training personnel.
   3. General requirements for training.
   4. Schedule of required training sessions.

B. Scope:
   1. Contractor shall furnish services of Suppliers' operation and maintenance training specialists to instruct Owner's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
   2. Each Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
      Owner reserves the right to record training sessions on video for Owner's later use in instructing Owner's personnel.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Scheduling of Training Sessions:
   1. General:
      a. Contractor shall coordinate training services with checkout, startup, and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner, in accordance with the Contract Documents.
      b. Training may be required outside of normal business hours to accommodate schedules of operation and maintenance personnel. Provide training services at the required days and times at no additional cost to Owner.
   2. Prerequisites to Training:
      a. Training of facility operation and maintenance personnel shall commence after preliminary operation and maintenance data has been submitted and accepted by Engineer, and the Work required in Section 01 75 00, Checkout and Startup Procedures, is complete.
      b. At option of Owner or Engineer, training may be allowed to take place before, during, or after checkout and startup of materials and equipment.
   3. Training Schedule Submittal:
      a. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer and Owner. Proposed training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.
      b. Training Schedule Coordination: When Project has multiple prime contracts, prime Contractors shall comply with this Specifications section. All prime Contractors shall coordinate with the General Contractor in developing a single training schedule Submittal for the entire Project, to be submitted by General Contractor. All prime Contractors shall implement training in accordance with the approved training schedule.

c. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with Engineer's comments, not later than 30 days prior to starting the first training session.
d. Owner reserves the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

B. Training Scheduling Conference:
1. Prior to preparing initial training schedule Submittal, schedule and hold training scheduling conference at the location where progress meetings are held, to review:
a. Training requirements indicated in the Contract Documents.
b. Work to be completed prior to commencing training.
c. Work progress and Progress Schedule relative to startup and training.
d. Scheduling constraints for Owner's personnel, relative to days and times of training sessions.
e. Preferred days for training.
f. Location where training will be performed and facilities available.
g. Required Submittals relative to training.
h. Other issues relative to training of operation and maintenance personnel.
2. Attendance is mandatory for the following:
a. Contractor's project manager.
b. Contractor's Site superintendent.
c. Project manager of Subcontractors responsible for furnishing materials and equipment for which training of operation and maintenance personnel is required.
d. Suppliers invited by Contractor.
e. Engineer.
f. Resident Project Representative (RPR).
g. Owner's Site Representative (OSR).
h. Facility manager's staff responsible for training coordination, and staff responsible for scheduling operation and maintenance personnel.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. Contractor shall prepare minutes summarizing the discussions of conference, decisions made, and agreements and disagreements, and distribute the minutes to each conference attendee and others as appropriate.

## 1.3 QUALITY ASSURANCE

A. Qualifications:
1. Supplier's Instructors:
a. Shall be factory-trained by manufacturer of material or equipment.
b. Supplier's instructors shall be proficient and experienced in performing training of the types required.
c. Instructors shall be proficient, clear, and easily understandable in spoken and written English language.
d. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, provide services of replacement instructor with acceptable qualifications.

## 1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule Submittals in accordance with time frames specified in this Specifications section.

B. Informational Submittals: Submit the following:
   1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply with requirements of this Specifications section as may be supplemented by Specifications sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Submit lesson plan Submittals in accordance with time frames specified in this Specifications section.
   2. Qualifications:
      a. Credentials of Supplier's proposed operation and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Specifications section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.
   3. Minutes of training scheduling conference.

C. Closeout Submittals: Submit the following:
   1. Trainee sign-in sheets for each training session. Submit to Owner's training coordinator with copy to Engineer.

## 1.5 LESSON PLAN

A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be provided, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.

B. Submit acceptable lesson plan not less than 21 days prior to starting associated training.

C. Indicate in lesson plan estimated duration of each training segment.

D. Lesson plan shall include the following:
   1. Material and Equipment Overview (required for all types of operation and maintenance training):
      a. Describe material and equipment's operating (process) function and performance objectives.
      b. Describe material and equipment's fundamental operating principles and dynamics.
      c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
      d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
      e. Identify and describe safety precautions and potential hazards related to operation.
      f. Identify and describe in detail safety and control interlocks.
   2. Operations Personnel Training:
      a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
      b. Operation:
         1) Describe operating principles and practices.
         2) Describe routine operating, startup, and shutdown procedures.
         3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.
         4) Describe alarm conditions and responses to alarms.
         5) Describe routine monitoring and recordkeeping procedures.
         6) Describe recommended housekeeping procedures.
      c. Troubleshooting:
         1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.

3. Mechanical Maintenance Training:
    a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
    b. Material and Equipment Preventive Maintenance:
        1) Describe preventative maintenance inspection procedures required to:
            a) Inspect materials and equipment in operation.
            b) Identify potential trouble symptoms and anticipate breakdowns.
            c) Forecast maintenance requirements (predictive maintenance).
        2) Define recommended preventative maintenance intervals for each component.
        3) Describe lubricant and replacement part recommendations and limitations.
        4) Describe appropriate cleaning practices and recommend intervals.
        5) Identify and describe use of special tools required for maintenance of materials and equipment.
        6) Describe component removal, installation, and disassembly and assembly procedures.
        7) Perform "hands-on" demonstrations of preventive maintenance procedures.
        8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
        9) Define recommended torqueing, mounting, calibrating, and aligning procedures, tolerances, and settings, as appropriate.
        10) Describe recommended procedures to check and test equipment following corrective maintenance.
    c. Troubleshooting:
        1) Define recommended systematic troubleshooting procedures.
        2) Provide component-specific troubleshooting checklists.
        3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.
        4) Describe common corrective maintenance procedures with "hands-on" demonstrations.
4. Instrumentation/Controls and Electrical Maintenance Training:
    a. Materials and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
    b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems: Engineer may grant waiver(s) to allow all training for a given system to be at the location of Owner's training facility.
    c. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.5.D.3 of this Specifications section.

## 1.6 TRAINING AIDS

A. Supplier's instructor(s) shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:
    1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
    2. Equipment cutaways and samples, such as spare parts and damaged equipment.
    3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.

B. Handouts:
    1. Supplier's instructor(s) shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
    2. Photocopied handouts shall be good quality and completely legible.
    3. Handouts shall be coordinated with the instruction, with frequent references made to the handouts.
    4. Provide not less than 15 paper copies of each handout for each training session.

C. Audio-Visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. If suitable equipment is available at the Site, Owner may make available facility's existing audio-visual equipment; however, do not count on facility's existing audio-visual equipment, if any, being available. Audio-visual equipment that training provider shall provide, as required, includes:
   1. Laptop computer, presentation software, and suitable projector.
   2. Power cords, power strips/surge protectors.
   3. As required, extension cords, HDMI cables and other video cabling, and spare bulb for projector.
   4. Laser pointer/slideshow remote controller with extra batteries.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 TRAINING DELIVERY

A. Training Delivery – General:
   1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by Engineer, with lesson content appropriate for trainees. If Owner or Engineer deems that training delivery does not comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to Owner.
   2. Trainee Sign-in Sheets: In format acceptable to Owner, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name; materials, equipment, or system for which training was provided; and type of training (e.g., operations, mechanical maintenance, instrumentation/controls and electrical maintenance, or other), and full name and operator license number (when applicable) of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated in Article 1.4 of this Specifications section.

B. "Hands-on" Demonstrations:
   1. Supplier's instructor(s) shall present "hands-on" demonstrations of operation and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by Engineer.
   2. Contractor and manufacturer shall furnish tools necessary for demonstrations.

### 3.2 SCHEDULE OF REQUIRED TRAINING

A. Supplier shall provide not less than the hours of training and number of sessions indicated in Table 01 79 23-A of this Specifications Section. Travel time and expenses are responsibility of Supplier and are excluded from required training time indicated in the Contract Documents.

B. Shifts and Training Sessions Required:
   1. Operations staff at the water treatment plant work in two groups with each group working three days/week and 11 hours/day with Wednesday as the fifth day where all staff are on site for a four hour period..
   2. Training Sessions per Shift:
      a. Operators: Provide two identical training sessions during normal working hours, one for each work group, each session in a separate week. Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days.
      b. Mechanical Maintenance: Provide two identical training sessions during normal working hours, one for each work group, each session in a separate week, for indicated materials and equipment. Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days.

c. Instrument/Controls and Electrical Maintenance: Provide two identical training sessions during normal working hours, one for each work group, each session in a separate week, for indicated equipment. Maximum training per day is four hours; sessions longer than four hours will be spread over multiple, preferably consecutive, days.

d. Training shall be completed for all equipment and systems specified. Refer to individual specification sections for minimum required time for training. If no duration is specified a minimum recommended time shall be provided by the equipment or system vendor and reviewed with the Owner a minimum of 21 days prior to the training.

**TABLE 01 79 23-A, TRAINING SUMMARY TABLE**

| Material or Equipment | Section | Total Training (HRS) | Training Sessions Required | | |
|---|---|---|---|---|---|
| | | | Operations | Mechanic Maint. | Instrument/ Controls & Electrical Maint. |
| Switchboards | 26 24 13.20 | 4 | X | X | x |
| Panelboards | 26 24 16 | 2 | X | | X |
| MCCs | 26 24 19 | 2 | X | | x |
| VFDs | 26 29 23 | 4 | X | | x |
| Generator | 26 32 14 | 4 | X | x | x |
| Microgrid Controller | 26 37 19 | 8 | X | | x |
| Solar Panels | 26 99 00 | 2 | X | X | x |
| Inverters | 26 99 03 | 4 | X | | x |
| PLCs | 40 63 43 | 8 | X | | x |
| Networks | 40 62 16 | 8 | X | | x |

**END OF SECTION**

# SECTION 01 81 10
## WIND AND SEISMIC DESIGN CRITERIA

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. The following types of design criteria for the Project, including Work designed by (a) Engineer and (b) delegated design professional(s) retained by Contractor, Subcontractor, or Supplier and submitted for Engineer's approval under the Contract:
      a. Wind loading.
      b. Seismic.
      c. Snow loading.

B. Scope:
   1. Certain Work, expressly indicated, shall be designed, fabricated, and installed in accordance with the wind, snow, and seismic requirements of this Section and Laws and Regulations (including applicable building codes) as provided in Section 01 42 00.
   2. This Section applies to all the Work. Where wind, snow, and seismic design criteria indicated in this Section conflict with wind, snow, and seismic design criteria set forth elsewhere in the Contract Documents, the more-stringent loading and requirements shall govern, unless clarified in writing by Engineer. Obtain Engineer's written interpretation or clarification of conflicts prior to performing the subject design and other associated Work.
   3. Contractor shall provide all labor, materials, equipment, tools, professional services, and incidentals to provide wind, snow, and seismic design for the Work.
   4. Such Work includes, but is not necessarily limited to, the following:
      a. Anchorage of mechanical and electrical equipment and systems.
      b. Anchorage of supports for piping, electrical conduits and cable trays, and similar Work.
      c. Work requiring delegated professional design for the final, completed Project.

C. Related Requirements: Include but are not necessarily limited to:
   1. Section 01 35 73 - Delegated Design Procedures.

### 1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate all wind, snow, and seismic design required of Contractor for the Work.

### 1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Civil Engineers / Structural Engineering Institute (ASCE/SEI):
      a. 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
   2. When referenced standards conflict, the most-stringent governs, unless specifically indicated otherwise in the Contract Documents or unless approved otherwise in writing by the Engineer.

### 1.4 SUBMITTALS

A. Action Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind, snow, and seismic delegated designs:
   1. Delegated Design Professional's "Instruments of Service" Submittals:
      a. Delegated design professional's "certification of compliance" required by Section 01 35 73 - Delegated Design Procedures, regarding structural calculations:
         1) Indicate compliance with performance and design criteria indicated in the Contract Documents.

2) Indicate compliance with specific reference standards indicated in the building code and the associated Contract Documents.
3) Indicate other information required for "certification of compliance" in accordance with Section 01 35 73 - Delegated Design Procedures.

B. Informational Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind, snow, and seismic delegated designs:
1. Delegated Design Professional's Calculations:
a. Such calculations shall include delegated design professional's seal, signature, and date and are to indicate the following, which will not be reviewed by Engineer except for the limited purposes indicated in Section 01 35 73 - Delegated Design Procedures:
1) Indicate basis of design and lateral analysis as necessary and required to derive each loading and to indicate system stability, including compatibility of deflections and compatibility with allowable soil parameters, as applicable.
2) Indicate design load to each connection to structure (where connection will attach to or interface with, or supported by, elements designed by Engineer).
3) Indicate and provide complete lateral load resisting system that transfers all wind and seismic loads through load path to ground.
2. Shop Drawings and Product Data Approved by Delegated Design Professional: The following are required but will be reviewed by Engineer only for the limited purposes indicated in Section 01 35 73 - Delegated Design Procedures:
a. Shop Drawings showing and indicating proposed wind, snow, and seismic controls Work designed by delegated design professional.
b. Product data showing and indicating proposed wind, snow, and seismic controls Work designed by delegated design professional.

## PART 2 - PRODUCTS

### 2.1 GENERAL DESIGN CRITERIA FOR WIND,SNOW, AND SEISMIC

A. This Article 2.1 applies to wind, snow, and seismic design criteria.

B. Design by delegated design professional retained by Contractor, Subcontractor, or Supplier shall comply with:
1. Performance and design criteria indicated in the applicable Contract Documents, including this Section.
2. Laws and Regulations, including applicable building code.
3. Applicable reference standards indicated in the Contract Documents.

C. Risk Category: IV.
1. Design in accordance with building code load combinations for, at Contractor's option, either service level or factored level.
2. Mechanical and electrical equipment and systems loads are dead loads, except where mechanical elements, such as piping and tanks, are filled with material such as liquid or slurry (in which case the dead load of the pipe's or vessel's contents shall also be included).

### 2.2 WIND DESIGN CRITERIA

A. Wind Design Load Criteria:
1. Basic Wind Speed: $V_{ult}$ = 106 miles per hour.
2. Allowable Stress Design wind speed: $V_{ASD}$ = 82 miles per hour
3. Exposure Category: C.
4. Topographic Factor: $K_{zt}$ = 1.0.
5. Wind Importance Factor: $I_w$ = Not applicable.
6. Building descriptions for wind design are Open or Enclosed.

B. Wind forces must be resisted by direct load transfer through fasteners to wind-resisting elements. Do not use connections that employ friction to transfer wind forces.

## 2.3 SEISMIC DESIGN CRITERIA

A. Seismic Design Load Criteria:
   1. Design spectral acceleration at short period: $S_{DS} = 0.502$.
   2. Design spectral acceleration at 1-second period: $S_{D1} = 0.339$.
   3. Importance Factor: Ie = 1.50.
   4. Seismic Design Category: D.
   5. Component or system amplification factor, ($a_P$) and component response modification factor ($R_P$): In accordance with ASCE 7-16, Tables 13.5-1 and 13.6-1.
   6. Component Importance Factor:
      a. Components required for emergency process : $I_P = 1.50$.
      b. All Other Components: $I_P = 1.00$.

B. Seismic forces must be resisted by direct load transfer through fasteners to seismic-resisting elements. Do not use connections that employ friction to transfer seismic forces.

## 2.4 SNOW DESIGN CRITERIA

A. Snow Design Load Criteria:
   1. Design ground snow load: $p_g = 37$ PSF.
   2. Design exposure factor: $C_e = 0.9$.
   3. Design slope factor: $C_s$ = varies.
   4. Design thermal factor: $C_t = 1.2$
   5. Importance Factor: $I_s = 1.20$.
   6. Minimum snow load for low-slope roofs: $p_m = 24$ PSF
   7. Minimum flat roof snow load: $p_f = 34$ PSF
   8. Design considerations for partial loading, unbalanced snow, snow drift in the vicinity of adjacent structures or projections, sliding snow, and other applicable factors shall be considered at locations required by Laws and Regulations, including applicable building codes.
   9. In no event shall snow design load criteria or minimum snow load be less than required by authority having jurisdiction.

# PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

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# DIVISION 03

**CONCRETE**

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# SECTION 03 05 05
## CONCRETE TESTING AND INSPECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Contractor requirements for testing of concrete and grout.
   2. Definition of Owner provided testing.
   3. Acceptance criteria for concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 - Reinforcement.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

### 1.2 RESPONSIBILITY AND PAYMENT

A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
   1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
   3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
   4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
   5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
   6. Owner will pay for services defined in Paragraph 1.2A.1.
   7. See Specification Section 01 30 00.

B. Hire a qualified testing agency to perform the following testing and provide test results to the Engineer.
   1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
   2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
   4. Reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
   5. See Specification Section 01 30 00.

C. Duties and Authorities of Testing Agency/Service Provider:
   1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
   2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.

3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
    a. All test reports to include exact location in the work at which batch represented by a test was deposited.
    b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

## 1.3 QUALITY ASSURANCE

A. Referenced Standards:
    1. American Concrete Institute (ACI):
        a. 318, Building Code Requirements for Structural Concrete.
    2. ASTM International (ASTM):
        a. ASTM Cement and Concrete Reference Laboratory (CCRL).
        b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
        c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
        d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
        e. C94, Standard Specification for Ready-Mixed Concrete.
        f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
        g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
        h. C1019, Standard Test Method for Sampling and Testing Grout.
        i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
        j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Qualifications:
    1. Contractor's Testing Agency:
        a. Meeting requirements of ASTM E329 and ASTM C94.
        b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.

C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

## 1.4 DEFINITIONS

A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

## 1.5 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Product technical data including:
        a. Concrete materials and concrete mix designs proposed for use.
            1) Include results of all testing performed to qualify materials and to establish mix designs.
            2) Place no concrete until approval of mix designs has been received in writing.
            3) Submittal for each concrete mix design to include:
                a) Sieve analysis and source of fine and coarse aggregates.
                b) Test for aggregate organic impurities.
                c) Proportioning of all materials.

d) Type of cement with mill certificate for the cement.
e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.
f) Slump.
g) Brand, type and quantity of air entrainment and any other proposed admixtures.
h) Shrinkage test results.
i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.

3. Certifications:
   a. Testing Agency qualifications.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

A. The following concrete testing will be performed by the Service Provider/Testing Agency:
   1. Concrete strength testing:
      a. Secure concrete samples in accordance with ASTM C172.
         1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
      b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
         1) Record any deviations from requirements on test report.
         2) Cylinder size: Per ASTM C31.
            a) 4 IN cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 IN.
            b) Use the same size cylinder for all tests for each concrete mix.
         3) Quantity:
            a) 6 IN DIA by 12 IN high: Five cylinders.
            b) 4 IN DIA by 8 IN high: Six cylinders.
      c. Field cure one cylinder for the seven day test.
         1) Laboratory cure the remaining.
      d. Test cylinders in accordance with ASTM C39.
         1) 6 IN DIA cylinders:
            a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
            b) Hold remaining cylinder in reserve.
         2) 4 IN DIA cylinders:
            a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
            b) Hold remaining cylinders in reserve.
      e. Strength test result:
         1) Average of strengths of two, 6 IN DIA cylinders or three, 4 IN DIA cylinders from the same sample tested at 28 days.
         2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
         3) Should all cylinders in any test show any of above defects, discard entire test.
      f. Frequency of tests:

1) Concrete sand cement grout: One strength test for each 4 HR period of grout placement or fraction thereof.
   a) Test grout in accordance with ASTM C1019.
2) Concrete topping, concrete fill and lean concrete: One strength test for each 60 CUYD of each type of concrete or fraction thereof placed.
3) All other concrete:
   a) One strength test to be taken not less than once a day, nor less than once for each 60 CUYD or fraction thereof placed in any one day.
   b) Once for each 5000 SQFT of slab or wall surface area placed each day
   c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.

2. Slump testing:
   a. Determine slump of concrete sample for each strength test.
      1) Determine slump in accordance with ASTM C143.
   b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
      1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231, ASTM C173, or ASTM C138.
4. In-place concrete testing (if required).

## 3.2 SPECIAL INSPECTIONS

A. See Section 01 45 33.
   1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
   2. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.

B. Formwork Special Inspections:
   1. Shape, location, and dimensions.
      a. Inspect in accordance with dimensions and details on Drawings.
      b. Frequency: Inspect prior to each concrete pour.

C. Reinforcing Special Inspections:
   1. Reinforcing size, spacing, lap length and concrete cover.
      a. Inspect in accordance with Drawings and Specification.
      b. Frequency: Inspect prior to each concrete pour.
   2. Reinforcing adhesive anchoring system:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all adhesive anchors for the first 4 HRS of installation.
         2) Inspect approximately 25 PCT of adhesive anchors thereafter.
         3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
   3. Mechanical splices:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all mechanical splices prior to placing concrete.
         2) Inspect approximately 25 PCT of mechanical splices thereafter.
         3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

D. Mixing, Placing, Jointing, and Curing Special Inspections:

1. Perform concrete tests per the requirements of this Specification Section.
2. Verification of proper mix design.
   a. Frequency: Periodically, prior to each concrete pour.
3. Proper concrete placement techniques.
   a. Inspect per requirements of Section 03 31 31.
   b. Frequency: During each concrete pour.
4. Proper curing temperature and techniques.
   a. Inspect per requirements of Section 03 31 31.
   b. Frequency: Periodically, but not less than every third day.
5. Joints:
   a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
   b. Frequency: Prior to each concrete pour.
6. Waterstops:
   a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
   b. Frequency:
      1) Prior to each concrete pour.

E. Anchorage to Concrete Special Inspection:
   1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
      a. Frequency: Per ICC-ES Report.
   2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
      a. Frequency: Prior to each concrete pour.

## 3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

A. To facilitate testing and inspection, perform the following:
   1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
   2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.
   3. Take samples at point of placement into concrete member.

B. Notify Engineer and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow for assignment of personnel and for scheduled completion of quality tests.

## 3.4 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
   1. In this event, modifications may be required to assure that concrete work complies with requirements.
   2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

D. Dimensional Tolerances:
   1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
   2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.

a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.

3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
   a. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
   a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

E. Appearance:
   1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
   2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.

F. High Water-Cement Ratio:
   1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
   2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.

G. Strength of Structure:
   1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
      a. Low concrete strength:
         1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
            a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
            b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
            c) A strength test shall be the average of two, 6 IN diameter cylinders or three, 4 IN diameter cylinders from the same sample tested at 28 days.
         2) Acceptance:
            a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
               (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
               (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 PSI.
      b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.
      c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
      d. Curing time and procedure not meeting requirements of this Specification Section.
      e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.

2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
   a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
      1) Such tests shall not be used as a basis for acceptance or rejection.
   b. Core tests:
      1) Where required, test cores will be obtained in accordance with ASTM C42.
         a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DEGF, relative humidity less than 60 PCT) for seven days before test then test dry.
         b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
         c) Testing wet or dry to be determined by Engineer.
      2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
         a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
         b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
      3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85 PCT of specified strength and no single core is less than 75 PCT of specified strength.
      4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

H. Shrinkage Tests:
   1. Shrinkage tests shall be performed on all concrete with specified shrinkage limits in Specification Section 03 31 30. Shrinkage tests are required for mix design approval and for approval of concrete in the field.
      a. Mix design shrinkage test:
         1) The maximum concrete shrinkage limit for the laboratory mix design tests shall be as specified in Specification Section 03 31 30. Standard deviation shall be considered as specified in ASTM C157. The submitted mix design proportions must be the same proportions used for the laboratory mix design shrinkage test. Shrinkage test to indicate concrete meets the specified shrinkage limit.
         2) Concrete shrinkage for laboratory cast specimens for mix design approval shall conform to ASTM C157 IN its entirety.

a) Laboratory cast specimens for mix design approval shall be stored as specified by ASTM C157 for Water Storage.

3) Laboratory cast specimens for mix design approval shall be stored as specified by ASTM C157 for Water Storage.

b. Field approval shrinkage tests:
   1) Required for the first field placement of each mix of concrete that is specified as requiring shrinkage testing in Specification Section 03 31 30.
   2) If excessive cracking or other symptoms that are potentially related to shrinkage occur during construction, Engineer may require additional field shrinkage tests during construction to verify compliance with these Specifications.
   3) The initial field shrinkage testing will establish a baseline for the shrinkage of the specified mixes that represents the concrete as placed and cured in the field
   4) Concrete test specimens for field shrinkage test shall be taken to the lab in their molds prior to 24 HRS ±1/2 HR, whereupon they shall be removed from the molds and the initial comparator reading shall be taken in accordance with ASTM C157. Then the specimens shall be returned to the field and cured with the same curing method used in the field. At 28 days after casting of the field specimens, they will be considered to be cured for the purpose of this testing.
      a) Field test specimens shall be stored and comparator readings shall be made as specified for Air Storage in ASTM C157.

2. Shrinkage specimens shall be fabricated, cured, dried, and measured in accordance with ASTM C157 and as modified herein. All specimens shall 11-1/4 IN ±1/8 IN for an effective gauge length of 10 IN.
   a. Shrinkage specimens for mixes with 100 PCT of the aggregate passing the 1 IN sieve shall be 3 IN by 3 IN in cross section.
   b. For mixes with aggregates larger than 1 IN and with 100 PCT passing a 2 IN sieve, drying shrinkage specimens shall be 4 IN by 4 IN in cross section.
3. Report shrinkage test results at intervals as specified for the type of test, either laboratory or field, according to ASTM C157 and the type of storage, water or air respectively.
   a. The field test shrinkage shall not exceed the laboratory mix shrinkage requirement by more than 50 PCT on the initial placement of each class of concrete required to be shrinkage tested.
   b. If the required field shrinkage limitation is not met, all aspects of concrete mixing, placing, sampling and curing will be subject to review. If this review points toward a solution, participate in a solution of making changes as required to establish compliance. These changes may include, but are necessarily limited to the following:
      1) Changing the curing methods.
      2) Changing the source of aggregates.
      3) Changing the amount of crushed or fractured coarse aggregate.
      4) Changing cement quantity and/or admixtures.
      5) Use of a shrinkage reducing admixture.
      6) Reducing water/cement ratio.
      7) Making changes to sampling practices
      8) Possible consideration by the Engineer of modifying the field shrinkage acceptance criteria.
      9) Other actions designed to minimize shrinkage and to provide better quality assurance.
4. Once the initial field shrinkage testing requirement is met, subsequent shrinkage testing, done, if needed, during the remainder of the construction period shall use the field test result from each initial field shrinkage test as a base line for acceptance.
   a. If the base line acceptance criteria is not met, then the provisions of Paragraph 3.3 H.6.b above shall be enacted to re-establish compliance.

## END OF SECTION

# SECTION 03 11 13
FORMWORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Formwork requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 347R, Guide to Formwork for Concrete.
   2. NSF International Standard (NSF) /American National Standards Institute (ANSI):
      a. 61, Drinking Water System Components - Health Effects.

B. Qualifications:
   1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
      a. Above qualifications apply to slabs and beams not cast on the ground.

C. Miscellaneous:
   1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
   2. Design requirements:
      a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
         1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
      b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
   3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores and installation of reshores and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
      a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon. Calculations shall be performed by a licensed professional engineer.
      b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
         1) The structural system that exists.
         2) Effects of all loads during construction.
         3) Strength of concrete.

4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

### 1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for the requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer and type of proposed form ties.

B. Samples:
   1. A 12 IN SQ sample of each of the following form finishes.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
      b. Built-in-place or prefabricated type panel.
   2. Metal forms:
      a. Metal forms may be used except for aluminum in contact with concrete.
      b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:
   1. Wood or metal sufficiently tight to prevent leakage.
   2. Do not use aluminum forms.

### 2.2 ACCESSORIES

A. Form Ties:
   1. Commercially fabricated for use in form construction.
      a. Field fabricated ties are unacceptable.
   2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
   3. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
   4. Cone size:
      a. 3/4 IN minimum diameter cones on both ends.
      b. Depth of cone not to exceed the concrete reinforcing cover.
   5. Provide ties with built-in waterstops in all walls that will be in contact with process liquid during plant operation or below grade soil.
   6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with process liquid during plant operation.

B. Void Forms:
   1. Continuous void forms.

2. Specially designed and manufactured for the purpose of creating a void area directly under concrete members which will allow a space for soil vertical upward movement.
3. Able to support the weight of concrete and construction loads to be placed thereon with no decrease in required void form depth.
4. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
5. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

C. Stay-In-Place Forms:
1. Ribbed expanded metal leave-in-place concrete forms commercially fabricated to provide an intentionally rougher surface.
2. Hot-dipped galvanized.
3. Stay-in-place forms shall be sized to support wet concrete for the span and thickness indicated.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Form Surface Treatment:
1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
   a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. For water treatment plants provide form oil that conforms to NSF/ANSI Standard 61.
3. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

### 3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
1. Conform to ACI 117.
2. Variation from plumb:
   a. In lines and surfaces of columns, piers, walls, and in risers.
      1) Maximum in any 10 FT of height: 1/4 IN.
      2) Maximum for entire height: 1/2 IN.
   b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
      1) Maximum in any 20 FT length: 1/4 IN.
      2) Maximum for entire length: 1/2 IN.
3. Variation from level or from grades specified:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
      1) Maximum in any 10 FT of length: 1/4 IN.
      2) Maximum in any bay or in any 20 FT length: 3/8 IN.

3) Maximum for entire length: 3/4 IN.
b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
1) Maximum in any bay or in 20 FT length: 1/4 IN.
2) Maximum for entire length: 1/2 IN.
4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
a. Maximum in any bay: 1/2 IN.
b. Maximum in any 20 FT of length: 1/2 IN.
c. Maximum for entire length: 1 IN.
5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.
7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.
8. Footings and foundations:
a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
b. Misplacement or eccentricity:
1) 2 PCT of footing width in direction of misplacement but not more than 2 IN.
c. Thickness:
1) Decrease in specified thickness: 5 PCT.
2) Increase in specified thickness: No limit except that which may interfere with other construction.
9. Variation in steps:
a. In a flight of stairs:
1) Rise: +1/8 IN.
2) Tread: +1/4 IN.
b. In consecutive steps:
1) Rise: +1/16 IN.
2) Tread: +1/8 IN.
10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.
1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
   1. Securely brace forms against lateral deflection.
   2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

K. Void Forms:
   1. After void forms are in place and before concrete is placed thereon, cover joints between abutting form sections and cover ends of forms to prevent intrusion of soil, concrete or any other materials.
   2. Install void forms in accordance with manufacturer's instructions.

L. Stay-In-Place Forms:
   1. Support stay-in-place forms as required to maintain the formwork in proper position.
   2. Hold the edge of stay-in-place forms back a minimum of 2 IN from all smooth formed concrete surfaces.
   3. Stay-in-place forms may be used at the Contractor's option at:
      a. Surfaces that will be backfilled with soil.
         1) Maintain a minimum of 3 IN of concrete cover over all reinforcing.
      b. Roughened construction joints.
      c. Other locations approved by Engineer.

## 3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
   1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
   1. For walls of water containing structures, leave forms in place for a minimum of 72HRS.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28 day compressive strength.
   1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

## 3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
   1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
   2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

## 3.5 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 45 33.
   2. See Section 03 05 05.

**END OF SECTION**

# SECTION 03 15 19
## ANCHORAGE TO CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing adhesive anchorage, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
   2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
      a. Structural members and accessories.
      b. Metal, wood, and plastic fabrications.
      c. Architectural components.
      d. Mechanical and electrical equipment and components.
      e. Plumbing, piping, and HVAC work.
      f. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 09 96 00 - High Performance Industrial Coatings.
   5. Section 40 05 07 - Pipe Support Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
      a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
   3. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
   4. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      i. F436, Standard Specification for Hardened Steel Washers.
      j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      k. F594, Standard Specification for Stainless Steel Nuts.

l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

5. ICC Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   c. ESR-1545, Hilti HSL-3 Carbon Steel Heavy Duty Expansion Anchors for Cracked and Uncracked Concrete.
   d. ESR-1546, Hilti HDA Carbon Steel and Stainless Steel Undercut Anchors for Cracked and Uncracked Concrete.
   e. ESR-1917, Hilti Kwik Bolt TZ Carbon and Stainless Steel Anchors in Cracked and Uncracked Concrete.
   f. ESR-2302, Hilti Kwik Bolt 3 (KB3) Concrete Anchors.
   g. ESR-2272, Dewalt Snake+ Anchors in Cracked and Uncracked Concrete.
   h. ESR-2502, Dewalt Power-Stud+ SD2 Carbon Steel Anchors, Power-Stud+ SD4 Stainless Steel Anchors, and Power-Stud+ SD6 Stainless Steel Anchors in Cracked and Uncracked Concrete.
   i. ESR-2582, Dewalt AC100+ Gold Adhesive Anchor System in Uncracked Concrete.
   j. ESR-2713, Titen HD Screw Anchor and Titen HD Rod Hanger for Cracked and Uncracked Concrete.
   k. ESR-2818, Dewalt Power-Stud+ SD1 Expansion Anchors for Cracked and Uncracked Concrete.
   l. ESR-3027, Hilti Kwik HUS-EZ (KH-EZ) and Kwik HUS-EZ 1 (KH-EZ 1) Carbon Steel Screw Anchors for Use in Cracked and Uncracked Concrete.
   m. ESR-3037, Simpson Strong-Tie Strong-Bolt 2 Wedge Anchor for Cracked and Uncracked Concrete.
   n. ESR-3067, Dewalt Atomic+ Undercut Anchors in Cracked and Uncracked Concrete.
   o. ESR-3187, Hilti HIT-HY200Adhesive Anchors and Post-Installed Reinforcing Bar Connections in Concrete.
   p. ESR-3260, Dewalt Power-Bolt+ Heavy Duty Sleeve Anchors for Cracked and Uncracked Concrete.
   q. ESR-3298, Dewalt PURE110+ Epoxy Adhesive Anchor System and Post-Installed Reinforcing Bar Connection System in Cracked and Uncracked Concrete.
   r. ESR-3814, Hilti HIT-RE500 V3 Adhesive Anchors and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete.
   s. ESR-3889, Dewalt Screw-Bolt+ Screw Anchors and Hangermate+ Rod Screw Anchors in Cracked and Uncracked Concrete.
   t. ESR-3912, Dewalt Mini-Undercut+ Anchors in Cracked and Uncracked Concrete.
   u. ESR-4027, Dewalt AC200+ Adhesive Anchor System and Post-Installed Reinforcing Bar System in Cracked and Uncracked Concrete.
   v. ESR-4057, Simpson Strong-Tie SET 3G Epoxy Adhesive Anchors and Post-Installed Reinforcing Bar Connections in

B. Qualifications:
   1. Anchor designer for Contractor-designed post-installed anchors and cast in place anchorage shall be a professional civil engineer licensed in the State that the Project is located in.
   2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
   3. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Post-installed anchors and related materials shall be listed by the following agencies:

1. ICC-ES.
2. Engineer approved equivalent.

## 1.3 DEFINITIONS

A. Adhesive Anchors:
   1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
   2. Includes anchors using acrylics, epoxy and other similar adhesives.

B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.

C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.

D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

E. Galvanizing: Hot-dip galvanizing per ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

F. Hardware: As defined in ASTM A153.

G. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

H. MPII: Manufacturer's printed installation instructions.

I. Mechanical Anchors:
   1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
   2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
   3. Drop-in anchors and other similar anchors are not allowed.

J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that submitted products meet requirements of referenced standards.
      b. Manufacturer material data sheet for each anchor.
         1) Clearly indicate which products on the data sheet are proposed for use on the Project.
      c. Manufacturer's printed installation instructions.
      d. Current ICC-ES report for each post-installed anchor system indicating the following:
         1) Certification that anchors meet all requirements indicated in this Specification.
         2) Performance data showing that anchor is approved for use in cracked concrete.
         3) Seismic design categories for which anchor system has been approved.
         4) Required installation procedures.
         5) Special inspection requirements for installation.
      e. Anchorage layout drawings and details:
         1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
         2) Drawings showing location, configuration, spacing and edge distance.
      f. Contractor Designed Post-Installed Anchors:

1) Show diameter and embedment depth of each anchor.
2) Indicate compliance with ACI 318, Chapter 17 or ACI 350 Appendix D as applicable to the structure.
3) Design tension and shear loads used for anchor design.
4) Engineering design calculations:
   a) Indicate design load to each anchor.
   b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
   c) Sealed and signed by contractor's professional engineer.
   d) Calculations will be submitted for information purposes only.
5) Type of post-installed anchor system used.
   a) Provide manufacturer's ICC-ES report for the following:
      (1) Mechanical anchorage per ICC-ES AC193.
      (2) Adhesive anchorage per ICC-ES AC308.

B. Samples:
   1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is exclusively the responsibility of the Contractor.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certification of qualifications for each installer of post-installed anchors.
      a. Indicate successful completion or certification for each type of approved post-installed anchor as required by the Contract Documents.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer's or distributor's packaging undamaged and complete with installation instructions.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

C. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Cast-in-place Concrete Anchors:
   1. Building, nonbuilding structures, and equipment:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized or non-galvanized threaded rods.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. All other cast-in-place concrete anchors:
      a. Stainless steel with matching nut and washer.
      b. Submerged application: ASTM F593, Type 316.
      c. Non-submerged application: ASTM F593, Type 304 or Type 316.

B. Post-Installed Mechanical and Adhesive Concrete Anchors:
   1. Stainless steel with matching nut and washer.

2. Submerged application: ASTM F593, Type 316.
3. Non-submerged application: ASTM F593, Type 304 or Type 316.
4. Zinc coated carbon steel anchors with matching nut and washer.

C. Reinforcement: See Section 03 21 00.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

F. Washers:
1. ASTM F436 unless noted otherwise.
2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
3. Plate washers: Minimum 1/2 IN thick fabricated ASTM A36 square plates as required.
4. Follow manufacturer's requirements for all post-installed anchorage.

G. Nuts:
1. ASTM A563 for all cast-in-place anchorage.
2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
3. Follow manufacturer's requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92 PCT in dry film.
4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

I. Dissimilar Materials Protection: See Specification Section 09 96 00.

## 2.2 CONTRACTOR DESIGNED ANCHORAGE

A. Manufacturers:
1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section and if the anchor system is approved by the Engineer.
   a. Hilti.
   b. Dewalt.
   c. Simpson Strong-Tie.
2. Submit request for substitution in accordance with Specification Section 01 25 13.

B. Design the anchorage when any of the following occur:
1. Design load for concrete anchorage is shown on the Drawings.
2. When specifically required by the Contract Documents.
3. When an anchorage is required but not specified in the Drawings.
4. When anchorage is shown on Drawings other than Structural Drawings.

C. Anchorage Design Loads:
1. Determine all of the design loads, including wind and seismic loads, per the building code.
   a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.
   b. Additional support requirements for utilities: See appropriate Specification Section.
   c. Pipe hangers and pipe support steel: See additional requirements listed in Specification Section 40 05 07.

D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Contractor design shall incorporate these as "minimums."

E. Cast-in-Place Concrete Anchors:
   1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the building code including ACI 318, Chapter 17 or ACI 350 Appendix D as applicable to the structure.
   2. Design assuming cracked concrete.

F. Post-installed Concrete Anchors:
   1. Provide the manufacturer's system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified or calculated load based on requirements given in the building code, ACI 318, Chapter 17 or ACI 350 Appendix D as applicable to the structure and current ICC-ES report, for the anchor to be used.
   2. Design assuming cracked concrete.

## 2.3 ENGINEER DESIGNED ANCHORAGE

A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required unless otherwise indicated.

B. Manufacturers:
   1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by the Engineer.
   2. Mechanical Anchors:
      a. Hilti:
         1) Kwik Bolt TZ2 (ICC-ES ESR-4266).
         2) Kwik Bolt 3 (ICC-ES ESR-2302).
         3) HSL-3 Heavy Duty Expansion (ICC-ES ESR-1545).
         4) HDA Undercut (ICC-ES ESR-1546).
         5) Approved Equal See 2.3.B.5.

      b. Dewalt:
         1) Power-Stud+ SD1 (ICC-ES ESR-2818).
         2) Power-Stud+ SD2, Power-Stud+ SD4, and Power-Stud+ SD6 (ICC-ES ESR-2502).
         3) Atomic+ Undercut (ICC-ES ESR-3067).
         4) Power-Bolt+ Heavy Duty Sleeve (ICC-ES ESR-3260).
      c. Simpson Strong-Tie:
         1) Strong-Bolt 2 (ICC-ES ESR-3037).
   3. Adhesive Concrete Anchors:
      a. Hilti:
         1) HIT RE 500 V3 (ICC ESR-3814).
         2) Approved Equal See 2.3.B.5.
         3) HIT-HY 200 (ICC-ES ESR-3187).
      b. Dewalt:
         1) PURE110+ (ICC-ES ESR-3298).
         2) AC100+ Gold (ICC-ES ESR-2582).
         3) AC200+ (ICC-ES ESR-4027).
      c. Simpson Strong-Tie: SET-3G (ICC-ES ESR-4057).
   4. Concrete Screw Anchors:
      a. Hilti:
         1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
         2) Approved Equal See 2.3.B.5.
      b. Dewalt:
         1) Screw-Bolt+ (ICC-ES ESR-3889).
         2) Hangermate+ Rod Screw Anchor (ICC-ES ESR-3889).
         3) Snake+ (ICC-ES ESR-2272).

c. Simpson Strong-Tie:
   1) Titen HD (ICC-ES ESR-2713).
   2) Titen HD Rod Hanger (ICC-ES ESR-2713).

5. Submit request for substitution in accordance with Specification Section 01 25 13.
   a. Substitution request to indicate the proposed anchor has the at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
   b. Calculations to be stamped by a Professional Engineer registered in the state that the Project is located in.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Cast-in-Place Anchorage:
   1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.
   2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.

B. Adhesive Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. May be used where subjected to vibration or where buried or submerged.
   3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

C. Mechanical Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. Do not use where subjected to vibration.
   3. May be used in overhead applications.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

### 3.2 PREPARATION

A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
   1. Notify Engineer of conditions detrimental to proper and timely completion of work.
   2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

C. Special Inspection is required in accordance with the building code for all concrete anchorage.
   1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
   2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.

D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional expense to the Owner.

1. Follow such procedures to assure acceptable installation.
2. Adhesive anchors must be installed in concrete aged a minimum of 21 days.

## 3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
   1. Tack welding of anchorage is prohibited.
   2. Coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
   3. Anchorage location tolerance shall be in accordance with AISC 303.
   4. Provide steel or durable wood templates for all column and equipment anchorage.
      a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.

B. Unless noted or specified otherwise:
   1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
      a. Provide dissimilar materials protection per Specification Section 09 96 00.
   2. Provide washers for all anchorage.
   3. Where exposed, extend threaded anchorage a maximum of 3/4 IN and a minimum of 1/2 IN above the top of the fully engaged nut.
      a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.

C. Do the following after nuts are snug-tightened down:
   1. If using post-installed anchorage, follow MPII.
   2. Upset threads of anchorage to prevent nuts from backing off.
      a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
   3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off.
   4. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to "lock" the two nuts together.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Secure architectural components such that it will not be aesthetically distorted nor fasteners overstressed from expansion, contraction or installation.

F. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.

H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
   1. Use hammer drills to create holes.
   2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Section 01 45 33.
   2. See Section 03 05 05.

## 3.5 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings when specified in Specification Section 09 96 00.

**END OF SECTION**

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# SECTION 03 21 00
REINFORCEMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 15 19 - Anchorage to Concrete.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP 66, ACI Detailing Manual.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
      d. 318, Building Code Requirements for Structural Concrete.
      e. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A767, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
      f. A775, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
      g. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
      h. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   3. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. ICC reports for manufactured mechanical splice and adhesive anchor.
      e. Manufacturer and type of proprietary reinforcing mechanical splices.
      f. Manufacturer and type of reinforcing adhesive anchor including installation instructions.
   3. Qualifications of welding operators, welding processes and procedures.

4. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
5. Sufficient reinforcing details to permit installation of reinforcing.
6. Reinforcing details in accordance with ACI SP 66 and ACI 315.
7. Locations where proprietary reinforcing mechanical splices are required or proposed for use.
8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
    a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
    b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Reinforcing adhesive anchors:
    a. See Specification Section 03 15 19.
2. Reinforcing mechanical splices:
    a. Lenton Rebar Splicing by Erico, Inc.
    b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
    c. Bar-Grip Systems by Barsplice Products, Inc.
3. Headed Deformed Bars:
    a. Lenton Rebar Splicing by Erico, Inc.
    b. Dayton Superior, Inc.
    c. Barsplice Products, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.

C. Welded Wire Reinforcement: ASTM A1064 or ASTM A1022 where noted on Drawings.

D. Smooth Dowel Bars:
1. Water containing structures: ASTM A276, Type 316.
2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.

E. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125 PCT of the yield strength of the reinforcing bars being spliced.

F. Headed Deformed Bars:
1. ASTM A970, Class B.

G. Reinforcing Adhesive Anchors:

1. See Specification 03 15 19.

### 2.3 ACCESSORIES

A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
   1. Metal fabrications with plastic-coated tips in contact with forms.
      a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
   2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
      a. 100 PCT non-metallic, non-corrosive.
      b. Required for all walls and elevated construction exposed to liquid containing structures.

B. Protective plastic caps at mechanical splices.

### 2.4 FABRICATION

A. Tolerances:
   1. Conforms to ACI 117, expect as modified herein.
   2. Sheared lengths: +1 IN.
   3. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
   4. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship reinforcing to jobsite with attached plastic or metal tags.
   1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
   2. Mark numbers on tags to be so placed that the numbers cannot be removed.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Tolerances:
   1. Conform to ACI 117, except as modified herein.
   2. Reinforcing placement:
      a. Clear distance to formed surfaces: +1/4 IN.
      b. Minimum spacing between bars: -1/4 IN.
      c. Top bars in slabs and beams:
         1) Members 8 IN deep or less: +1/4 IN.
         2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
         3) Members more than 2 FT deep: -1/4 IN, +1 IN.
      d. Crosswise of members: Spaced evenly within +1 IN.
      e. Lengthwise of members: +2 IN.
   3. Minimum clear distances between reinforcing bars:
      a. Beams, walls and slabs: Distance equal to bar diameter or 1 IN, whichever is greater.
      b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 IN, whichever is greater.
      c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Minimum concrete protective covering for reinforcement, unless indicated otherwise on Drawings:
   1. Concrete deposited against earth: 3 IN.
   2. Formed surfaces exposed to weather or in contact with earth:
      a. 2 IN for reinforcing bars #6 or larger.
      b. 1-1/2 IN for reinforcing bars less than #6.

3. Formed surfaces exposed to or located above any liquid: 2 IN for all reinforcing sizes.
4. Interior surfaces:
   a. 1-1/2 IN for beams, girders, and columns.
   b. 3/4 IN for slabs, walls and joists.

D. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
   1. For reinforcing: Class B splice meeting the requirements of ACI 318 and/or ACI 350 as applicable to the structure.
   2. For welded wire reinforcement:
      a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
      b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318 and/or ACI 350. as applicable to the structure.
   3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
      a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

E. Welding:
   1. Welding reinforcing is not permitted.

F. Placing Reinforcing:
   1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
   2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
   3. Reinforcing support:
      a. Uncoated reinforcing:
         1) Support reinforcing and fasten together to prevent displacement by construction operations.
            a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
            b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
            c) Reinforcement shown on the Contract Documents may not be repositioned for use a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
         2) Reinforcing supported on ground:
            a) Slab on grade and other members with only one mat of reinforcing:
               (1) Provide metal bar supports with bottom plate.
               (2) Do not use concrete blocks to support slab-on-grade reinforcing.
            b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
         3) Reinforcing supported on formwork:
            a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
            b) All other formed surfaces:
               (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
               (2) Only tips in contact with the forms need to be plastic coated.

4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 IN.
    a. Place spacer bars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
5. Extend reinforcement to within 2 IN of concrete perimeter edges.
    a. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
6. To assure proper placement, furnish templates for all column vertical bars and dowels.
7. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
    a. Do not bend reinforcing by means of heat.
8. Do not tack weld reinforcing.
9. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
    a. See Specification Section 03 15 19.

## 3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
    1. Notify Engineer whenever the specified clearances between bars cannot be met.
    2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
    3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
    4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
    5. No cutting of reinforcing shall be done without written approval of Engineer.

B. Special Inspection:
    1. See Section 01 45 33.
    2. See Section 03 05 05.

**END OF SECTION**

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# SECTION 03 31 30
## CONCRETE, MATERIALS AND PROPORTIONING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. As specified and indicated in the Contract Document.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 05 05 - Concrete Testing and Inspection.
   4. Section 03 11 13 - Formwork.
   5. Section 03 15 19 - Anchorage to Concrete.
   6. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   7. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   8. Section 07 16 16 - Crystalline Cementitious Waterproofing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
      c. 212.3R, Chemical Admixtures for Concrete.
      d. 232.2R, Use of Fly Ash in Concrete.
      e. 318, Building Code Requirements for Structural Concrete.
      f. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
      d. C150, Standard Specification for Portland Cement.
      e. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
      f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
      g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
      h. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
      i. C494, Standard Specification for Chemical Admixtures for Concrete.
      j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
      k. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
      l. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
      m. C1116, Standard Specification for Fiber-Reinforced Concrete.
      n. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.

o. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
p. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
q. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.
r. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
s. C1579, Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert).
t. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).

3. Steel Deck Institute (SDI):
   a. 31, Design Manual for Composite Decks, Form Decks and Roof Decks.

## 1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. Water-Bearing Concrete: Any concrete surface to be in contract with process fluids during normal operation of the facility, including, but not limited to, tank, channels, wet wells and distribution chambers.

C. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions.
      c. Concrete mix designs as required by Specification Section 03 05 05.
      d. Manufacturer and type of proposed admixtures.
      e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
   3. Certifications:
      a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
      b. Certification that the SCM meet the quality requirements stated in this Specification Section, and SCM supplier's certified test reports for each shipment of SCM delivered to concrete supplier.
      c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
      d. Certification of aggregate gradation.
      e. Certification of coarse aggregate impurities as it relates to alkali-silica reactivity per ASTM C33, Appendix X.
      f. Certification of shrinkage test results.
   4. Test reports:
      a. Cement and SCM mill reports for all cement to be supplied.
      b. Provide test results for alkali-silica reactive impurities on coarse aggregates per referenced ASTM standards.

## 1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:

1. Store cement and SCM in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
4. Do not use frozen or partially frozen aggregates.
5. Do not use bottom 6 IN layer of stockpiled material in contact with ground.
6. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
    a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
    b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:
    1. Non-shrink grout:
        a. BASF Corporation.
        b. Euclid Chemical Company.
        c. Five Star Products, Inc.
        d. Sika Corporation.
        e. Sauereisen, Inc.
        f. Set Products, Inc.
        g. Upco.
        h. L & M Construction Chemicals, Inc.
    2. Epoxy grout:
        a. BASF Corporation.
        b. Five Star Products, Inc.
        c. Euclid Chemical Company.
        d. Sika Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Cement:
    1. ASTM C150, Type I or II.
    2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. SCM:
    1. Fly Ash:
        a. ASTM C618, Class F or Class C.
        b. Non-staining.
        c. Suited to provide hardened concrete of uniform light gray color.
        d. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
        e. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
        f. Evaluate and use in accordance with ACI 232.2R.
    2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
    1. Air entraining: ASTM C260.

2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. All concrete mixes require the use of water reducers to maintain the specified water-to-cement ratios without additional cement.
5. SCM: Per above.
6. Admixtures to be chloride free.
    a. Do not use calcium chloride.
7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
8. Provide admixtures certified by manufacturer to be compatible with other admixtures.
9. Shrinkage reducing admixtures:
    a. Admixture used to reduce the shrinkage of Portland Cement concrete.
    b. Utilize at dosage necessary to help achieve required shrinkage value stated herein.
    c. Similar to:
        1) Eclipse 4500 by GCP Applied Technologies, Inc.
        2) Conex by Euclid Chemical Co.
        3) MasterLife SRA 20 or MasterLife CRA 007 by BASF Corporation.

D. Crystalline Cementitious Waterproofing: See Specification Section 07 16 16.
    1. Dosage per manufacturer's recommendations.
    2. See Drawings for concrete requiring crystalline cementitious waterproofing.

E. Water:
    1. Potable.
    2. Clean and free from deleterious substances.
    3. Free of oils, acids and organic matter.

F. Aggregates for Normal Weight Concrete:
    1. ASTM C33.
    2. Fine and coarse aggregates to be regarded as separate ingredients.
    3. Provide aggregates approved for bridge construction by the Department of Transportation of the State the project is located.
    4. Coarse aggregate:
        a. Use only washed aggregates.
        b. Coarse aggregate sieve analysis:
            1) Per Table 1 IN the PART 2 MIXES Article.
    5. Fine aggregates to be natural, not manufactured.
    6. Do not use aggregates that may be deleteriously reactive when combined with alkalis in cement.
        a. Evaluate proposed aggregates for potential deleterious expansion due to alkali silica reactivity per ASTM C33 (Appendix X), ASTM C227, ASTM C1260, ASTM 1293, or ASTM C1567.

G. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218:
    1. All other concrete: 0.10.

H. Sand Cement Grout (referred to as "Grout" on the Drawings):
    1. Approximately three parts sand, one part Portland cement, 6 ±1 PCT entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
        a. Provide sand in accordance with requirements for fine aggregate for concrete.
    2. Minimum 28 day compressive strength:
        a. 3000 PSI.
        b. Shall be at least strength of parent concrete when used at construction joints.

I. Non-shrink Grout:

1. Non-shrink, nonmetallic, noncorrosive, and nonstaining.
    a. Conform to ASTM C1107.
2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
3. Grout to produce a positive but controlled expansion.
    a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28 day compressive strength: 7,000 PSI.
5. Acceptable manufacturers:
    a. BASF Admixtures, Inc. "Masterflow, 713".
    b. Euclid Chemical "NS Grout".
    c. Sika Corporation "Sika Grout 212".
    d. Sauereisen, Inc. "F-100 Level Fill Grout".

J. Epoxy Grout:
1. Three-component epoxy resin system:
    a. Two liquid epoxy components.
    b. One inert aggregate filler component.
2. Adhesive acceptable products:
    a. BASF "Masterflow 648".
    b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
    c. Euclid Chemical "E3 Flowable."
    d. Sika "Sikadur Hi-Mod."
3. Aggregate acceptable products:
    a. BASF "Masterflow 648".
    b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
    c. Euclid Chemical "Euclid aggregate."
    d. Sika aggregate.
4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.

K. See Specification Section 03 31 31 for Grout Schedule of use.

## 2.3 MIXES

A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94/C94M.
3. All concrete to be normal weight concrete, except where lightweight concrete is noted on Drawings, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Concrete Mixes: Refer to Table 1 below.

C. Air Entrainment:
1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
    a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.

D. Slump:
1. Measure slump at point of discharge into concrete members.
2. Walls and columns:
    a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
    b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.
3. All other members:

a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.

4. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
5. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
   a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ration is not exceeded.
6. Slump may be adjusted in the field through the use of water reducers.
   a. Coordinate dosage and mixing requirements with concrete supplier.
7. Slump tolerances shall comply with the requirements of ACI 117.

E. Proportioning:
   1. General:
      a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
      b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
   2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
      a. Target cementitious materials contents are intended to provide a crack free, durable finished product, not one with excessive strength
   3. SCM:
      a. Fly ash:
         1) For cast-in-place concrete only, a maximum of 25 PCT by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
         2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.

         .
   4. Water reducing, retarding, and accelerating admixtures:
      a. Use in accordance with manufacturer's instructions.
      b. Add to mix at batching plant.
      c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
         1) Water reducers are required to maintain specified maximum water to cement ratios.
   5. High range water reducers (superplasticizers):
      a. Use required for:
         1) All concrete to be pumped except slabs on grade.
         2) All concrete for water containing structures.
         3) Other concrete members at Contractor's option.
      b. Maximum concrete slump before addition of admixture to be 3 IN, maximum slump after addition to be 8 IN.
      c. Reference Specification Section 03 31 31 for additional requirements.
   6. Concrete mix proportioning methods for normal weight concrete:
      a. Method 1:
         1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
         2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three different water cement ratios or cement contents which will

produce a range of compressive strengths encompassing the required average strength.

3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 PCT specified.
4) For each water cement ratio or cement content, make at least three trial strength tests for specified test age, and cure in accordance with ASTM C192.
    a) Cylinder size: Per ASTM C31.
    b) Test for strength at 28 days in accordance with ASTM C39.
        (1) Quantity of cylinders per trial strength test:
            (a) 6 IN DIA cylinders: Two.
            (b) 4 IN DIA cylinders: Three.
5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
6) From this curve select water cement ratio or cement content to be used to produce required average strength.
7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
9) See paragraph hereafter for definition of required average strength.

b. Method 2:
    1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
    2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
    3) Field test records to represent materials, proportions and conditions similar to those specified.
        a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
        b) Field test records shall meet the requirements of ACI 301, Article 4.2.3, ACI 318, Paragraph 5.3 and/or ACI 350 as applicable to the structure.
        c) Required concrete proportions may be established by interpolation between the strengths and proportions of two or more test records each of which meets the requirements of this Specification Section.

7. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with ACI 318 and or ACI 350, Chapter 5 as applicable to the structure using the standard deviation of the proposed concrete production facility as described in ACI 318 and ACI 350, Chapter 5.

F. Flowable Fill/Controlled Low-Strength Material (CLSM):
1. A mixture of cement, fly ash, fine sand, water and air having a consistency which will flow under a very low head.
2. Approximate quantities of each component per cubic yard of mixed material:
    a. Cement (Type I or II): 50 LBS.
    b. Fly ash: 200 LBS.
    c. Fine sand: 2,700 LBS.
    d. Water (approximate): 420 LBS.
    e. Air content (approximate): 10 PCT.
3. Actual quantities shall be adjusted to provide a yield of 1 CUYD with the materials used.
4. Approximate compressive strength should be 85 to 175 PSI.
5. Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.

G. Allowable Shrinkage:
1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.

2. Continue testing to 64 weeks for informational purposes.

| TABLE 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| TYPE OF CONCRETE | 28 DAY COMPRESSIVE STRENGTH | MAX. W/C RATIO | TARGET TOTAL CEMENT | SCM | ASTM C33 Size No. | AIR CONTENT | ALLOWABLE SHRINKAGE LIMIT |
| Normal weight concrete for civil structures | 3000 PSI | 0.45 | 517 | Note 1 | 57 | 4-1/2 to 7-1/2 | None |
| Normal weight precast concrete | 5000 PSI | 0.42 | 611 | | 57 | 4-1/2 to 7-1/2 | 0.042 PCT |
| Normal weight concrete w/ power trowel finish | 4500 PSI | 0.45 | 564 | Note 1 | 57 | 0 to 2 | 0.048 PCT |
| Normal weight structural concrete | 4500 PSI | 0.45 | 564 | Note 1 | 467 | 4-1/2 | 0.042 PCT |
| Normal weight water-bearing concrete | 4500 PSI | 0.42 | 564 | Note 1 | 57 | 4-1/2 to 7-1/2 | 0.042 PCT |
| Lightweight concrete | 4000 PSI | 0.45 | 564 | Note 1 | | | |

Table 1 Notes:

1. If fly ash or GGBFS is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.
2. Use both of the following:
   a. Fly Ash: 35 PCT maximum by weight of Portland cement content per cubic yard shall be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
   b. GGBFS: 20 to 30 PCT by weight of Portland cement content per cubic yard shall be replaced with GGBFS at a rate of 1 LB GGBFS for 1 LB cement.

### 2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

A. Special Inspection:
   1. See Specification Section 01 45 33.
   2. See Specification Section 03 05 05.

B. Perform concrete tests per Specification Section 03 05 05.
   1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
      a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

**END OF SECTION**

# SECTION 03 31 31
## CONCRETE MIXING, PLACING, JOINTING, AND CURING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 45 33 – Special Inspections and Testing Program.
   4. Section 03 05 05 - Concrete Testing and Inspection.
   5. Section 03 11 13 - Formwork.
   6. Section 03 21 00 - Reinforcement.
   7. Section 03 31 30 - Concrete, Materials and Proportioning.
   8. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   9. Section 07 26 00 - Under Slab Vapor Retarder.
   10. Section 07 92 00 - Joint Sealants.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-16, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 301, Specifications for Structural Concrete.
      d. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      e. 304.2R, Placing Concrete by Pumping Methods.
      f. 305R, Guide to Hot Weather Concreting.
      g. 305.1, Specification for Hot Weather Concreting.
      h. 306R, Guide to Cold Weather Concreting.
      i. 306.1, Standard Specification for Cold Weather Concreting.
      j. 308.1, Specification for Curing Concrete.
      k. 309R, Guide for Consolidation of Concrete.
      l. 318, Building Code Requirements for Structural Concrete and Commentary.
      m. 350, Code Requirements for Environmental Engineering Concrete Structures.
      n. 360R, Guide to Design of Slabs-on-Ground.
   2. ASTM International (ASTM):
      a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
      b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   3. Corps of Engineers (COE):
      a. CRD-C572, Specifications for Polyvinylchloride Waterstop.
   4. National Ready Mixed Concrete Association (NRMCA):

a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
5. NSF International (NSF).

B. Qualifications:
1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.
2. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost to Owner.

C. Pre-Concreting Conference:
1. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 30 days after the Notice to Proceed.
a. Schedule the meeting to occur no later than five days in advance of the first scheduled date of concrete placement.
2. All parties involved in the concrete work shall attend the conference, including:
a. Contractor's representative.
b. Testing laboratory representative/inspectors.
c. Concrete subcontractor.
d. Reinforcing steel installer.
e. Concrete supplier.
f. Admixture manufacturer's representative.
g. Owner.
h. Resident Engineer or Project Representative.
i. Design Engineer.
j. Building Code Official.
3. The conference shall be held at a mutually agreed upon time and location.
4. The agenda shall include but not be limited to the following:
a. Scheduling, sequence and notification of concrete placements.
b. Contractor's concrete pre-placement plan checklist.
c. Delivery time from batch plant, maximum time in truck, and approved exceptions to the limits.
d. Review of approved design mix including the limits of water that can be added and who is authorized to add water, if water has been withheld at the plant.
e. Additional test cylinders to be made for any load in which water exceeding the water/cement ratio of the approved mix design has been added on site.
1) Review and discuss Field Quality Control requirements.
5. Additional test cylinders for structural elements the Contractor intends to subject to live loads earlier than 28 days.
6. Duties and authority of testing and inspection agency.
7. Curing procedures.
8. Temperature/weather issues.
9. Test cylinder storage and protection.
10. Approval and rejection of work.
11. Mock-up panels as the standard.

## 1.3 DEFINITIONS

A. Words and terms used in this Specification Section are defined in ACI CT-16.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's printed installation instructions.
    1) Procedure for adding high-range water reducer at the jobsite.
c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
d. Manufacturers and types:
    1) Joint fillers.
    2) Curing agents.
    3) Construction joint bonding adhesive.
    4) Waterstops.
        a) Drawing indicating location, size and type of prefabricated PVC waterstop joints.
e. Thermal monitoring control plan for mass concrete.

3. Certifications:
    a. Ready mix concrete plant certification.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Copies of concrete delivery tickets.
3. Description of proposed curing methods.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Concrete Delivery:
1. Prepare a delivery ticket for each load of ready mixed concrete.
2. Truck operator shall hand ticket to Contractor at the time of delivery.
3. Ticket to show:
    a. Mix identification.
    b. Quantity delivered.
    c. Amount of material in each batch.
    d. Outdoor temperature in the shade.
    e. Time at which cement was added.
    f. Time of delivery.
    g. Time of discharge.
    h. Amount of water that may be added at the site without exceeding the specified water-cement ratio.
    i. Amount of any approved water added at the site.

### 1.6 PROJECT CONDITIONS

A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
1. Do not use revised concrete mixes until submitted to and approved by Engineer.

### 1.7 SEQUENCING AND SCHEDULING

A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
1. Approval of concrete mix design does not relieve Contractor of his responsibility to provide concrete that meets the requirements of the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS

A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Neoprene Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. Permaglaze.
      b. Rubatex.
      c. Williams Products.
   2. Materials:
      a. Closed cell neoprene.
      b. ASTM D1056, Type 2, Class A or C.
      c. Grade: Compression deflection as required to limit deflection to 25 PCT of joint thickness under pressure from concrete pour height.

D. Asphalt Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. W.R Meadows.
      b. J and P Petroleum Products.
   2. Materials: ASTM D994.

E. Fiber Expansion Joint Fillers:
   1. Materials: ASTM D1751.

F. Waterstops, PVC Type:
   1. Acceptable manufacturers:
      a. Sika Greenstreak Plastic Products.
      b. W.R Meadows.
      c. Vinylex Corporation.
      d. Bometals, Inc.
   2. Materials:
      a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
      b. Cast-in-place type: COE CRD-572.
   3. Approved profiles as listed.
      a. Construction joints:
         1) Ribbed: 6 IN wide by 3/8 IN.
         2) Sika Greenstreak Plastic Products Style #679, or equal.
      b. Control joints:
         1) 6 IN wide by 3/8 IN thick with ribs and center bulb.
         2) Sika Greenstreak Plastic Products Style #705, or equal.
      c. Expansion joint:
         1) 9 IN wide by 3/8 IN thick center bulb 2 inch OD.
         2) Sika Greenstreak Plastic Products Style #739, or equal.
   4. In expansion joints:
      a. 6 IN wide by 1/8 IN thick tear web type waterstop.
      b. 2 IN minimum horizontal movement without rupturing.
      c. Sika Greenstreak Plastic Products Style #698.
      d. 9 IN by 3/8 IN, with center bulb 3/4 IN ID, 1-1/4 OD.
         1) Sika Greenstreak Plastic Products Style #718, or equal.
      e. Split rib: 3/8 IN by 6 IN, similar to Sika Greenstreak Plastic Products Style #724, or 3/8 IN by 4 IN, similar to Sika Greenstreak Plastic Products Style #721, or equal.
      f. Base seal: Style #771 by Sika Greenstreak Plastic Products, or approved equal.
      g. Retro-fit waterstop: Use at interface between existing construction and new concrete.
      h. Sika Greenstreak Style 609.
      i. Bometals RF638.
      j. Vinylex RET638.

5. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum 6 IN clear of the intersection.
6. Factory prepunched (less than 18 IN centers, each edge, staggered) for wire supports.
   a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
7. See Drawings for application and other requirements.

G. Waterstops, Preformed Strip Type:
1. Acceptable manufacturers:
   a. Sika Greenstreak Plastics, Inc. (Hydrotite).
   b. Adeka Ultra Seal USA (MC-2010MN).
   c. DeNeef (Swellseal 2010).
2. Hydrophilic, non-bentonite composition.
3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
4. Volumetric expansion limited to 3 times maximum.
5. See Drawings for application and other requirements.

H. Water Swelling Sealant:
1. Required adhesive for use with strip-type waterstop.
2. Compatible with strip-type waterstop.
3. Single component, gun applied.
4. Moisture cured.
5. Minimum 70 PCT volumetric expansion swelling capability.

I. Curing Products to conform to one or more of the following:
1. Absorbent Covers.
2. Moisture Retaining Covers.
   a. Moisture Retaining Fabric.
3. Dissipating curing compound:
   a. Fugitive dye, waterborne, membrane-forming.
   b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions so as to not impair the later addition and performance of applied finishes.
   c. Acceptable Products:
      1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
      2) Euclid Chemical Company (The); Kurez DR VOX.
      3) L&M Construction Chemicals, Inc.; L&M Cure R.
4. Clear, water or solvent-borne, membrane-forming curing and sealing compound:
   a. ASTM C1315, Type 1, Class A.
   b. Moisture loss shall be not more than 0.40 KG/M$^2$ when applied at 300 SQFT/GAL.
   c. Manufacturer's certification is required.
   d. Subject to project requirements, provide one of the following products:
   e. Products:
      1) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
      2) L&M Construction Chemicals, Inc.; Lumiseal Plus.
      3) Meadows, W.R., Inc.; CS-309/30.
      4) Euclid Chemical Company; Super Diamond Clear VOX.
      5) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
      6) Meadows, W.R., Inc.; Vocomp-30.

J. Vapor Retarder: See Specification Section 07 26 00.

K. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03 31 30 for this non-structural material and use.

### 2.2 SOURCE QUALITY CONTROL

A. The concrete plant shall conform to the Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. General:
   1. All materials and construction shall conform to the tolerances as specified in ACI 117.
   2. Complete formwork.
      a. See Specification Section 03 11 13.
   3. Remove earth, snow, ice, water, and other extraneous/foreign materials from areas that will receive concrete.
   4. Secure reinforcement in place.
      a. See Specification Section 03 21 00.
   5. Position expansion joint material, anchors and other embedded items.
   6. Obtain approval of formwork, reinforcement installation and placement prior to placing concrete.
   7. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and prior Engineer approval is obtained.
      a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
      b. Do not allow rainwater to increase mixing water nor to damage surface finish.
   8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
   9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
      a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
   1. Granular subgrade to be wetted without standing water immediately prior to placing concrete.
   2. Obtain approval of granular subgrade compaction density prior to placing slabs on ground.

C. Edge Forms and Screeds:
   1. Set accurately to produce designated elevations and contours of finished surface.
   2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
   3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

### 3.2 CONCRETE MIXING

A. General:
   1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
   2. Batch, mix, and transport in accordance with ASTM C94/C94M.

B. Control of Admixtures:
   1. Control at the batch plant:
      a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.
      b. Charge admixtures into mixer as solutions.

1) Measure by means of an approved mechanical dispensing device.
2) Liquid considered a part of mixing water.
3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.

c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.

d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

2. Control of Admixtures in the field:
   a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
      1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
      2) Addition of each admixture to be documented on the delivery ticket.
      3) Provide additional mixing per ASTM C94.

C. Tempering and Control of Mixing Water:
   1. Mix concrete only in quantities for immediate use.
   2. Discard concrete which has set.
   3. Discharge concrete from ready mix trucks within time limit stated in ASTM C94.
   4. Addition of water at the jobsite:
      a. See Specification Section 03 31 30 for specified water cement ratio and slump.
      b. Do not exceed maximum specified water cement ratio or slump.
      c. Incorporate water by additional mixing equal to at least half of total mixing required.

## 3.3 PLACING OF CONCRETE

A. General:
   1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
      a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
   2. Comply with ACI 304R and ACI 304.2R.
   3. Do not begin placing concrete during rain, sleet, or snow.
      a. Protect fresh concrete from ensuing inclement weather.
   4. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   5. Begin work only when work of other trades affecting concrete is complete.
   6. Do not use excess grout or mortar to lubricate lines when pumping concrete.
   7. Do not use excess water for workability or any reason when placing concrete by freefall.
   8. Deposit concrete continuously to avoid cold joints.
   9. Locate construction joints at locations specified or approved by Engineer.
      a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
   10. Spreaders:
      a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
      b. Embedded:
         1) Obtain approval of Engineer for their use.
         2) Materials: Concrete or metal.
         3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
   11. Deposit concrete as nearly as practicable in its final position to avoid segregation.
      a. Maximum free fall: 4 FT.
      b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface.

12. Perform the following operations before bleeding water has an opportunity to collect on surface:
    a. Spread.
    b. Consolidate.
    c. Straightedge.
    d. Darby or bull float.
13. No water shall be added to the concrete surface to ease finishing operation.
14. Do not discharge water into forms.
15. Consider use of form vibrators for certain placement situations.

B. Cold Weather Concrete Placement:
1. Comply with ACI 306.1.
2. Do not place concrete on forms or subgrades that are below 32 DEGF or contain frozen material.
3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
4. Temperature of concrete when discharged at site: Per ACI 306.1.
5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DEGF, when temperature of surrounding air is 40 DEGF or below at time concrete is placed.
    a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DEGF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DEGF.
8. Follow ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

C. Hot Weather Concrete Placement:
1. Comply with ACI 305.1.
2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
    a. Not to exceed 90 DEGF.
    b. Not so high as to cause:
        1) Shrinkage cracks.
        2) Difficulty in placement due to loss of slump.
        3) Flash set.
4. Temperature of forms and reinforcing when placing concrete:
    a. Not to exceed 90 DEGF.
    b. May be reduced by spraying with water to cool below 90 DEGF.
        1) Leave no standing water to contact concrete being placed.
5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.

D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
    a. Ensure no displacement of reinforcing or other embeds from final position.
    b. Eliminate:
        1) Air or stone pockets.
        2) Honeycombing or pitting.
        3) Planes of weakness.
3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
    a. Size and coordinate external vibrators to specifically match forming system used.

4. Internal vibrators:
    a. Minimum frequency of 8000 vibrations per minute.
    b. Insert and withdraw at points approximately 18 IN apart.
        1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
    c. Use in:
        1) Beams and girders of framed slabs.
        2) Columns and walls.
        3) Vibrating concrete around all waterstops.
    d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
6. Do not use vibrators to transport concrete within forms.
7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the work.
8. Provide sufficient spare vibrators on jobsite during all concrete placing operations to assure continuous vibration.
9. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
10. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
    1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
    2. Horizontal belt conveyors:
        a. Mount at a slope which will not cause segregation or loss of ingredients.
        b. Protect concrete against undue drying or rise in temperature.
        c. Use an arrangement at discharge end to prevent segregation.
        d. Do not allow mortar to adhere to return length of belt.
        e. Discharge conveyor runs into equipment specially designed for spreading concrete.
    3. Metal or metal lined chutes:
        a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
        b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
        c. Provide end of each chute with a device to prevent segregation.
    4. Pumping or pneumatic conveying equipment:
        a. Designed for concrete application and having adequate pumping capacity.
        b. Control pneumatic placement so segregation is avoided in discharged concrete.
        c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
        d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
        e. Provide pumping equipment without Y sections.

F. Placing of Concrete on Metal Deck:
    1. Prior to concrete placement, the metal deck shall be free of soil, debris, standing water, loose mill scale, and all other foreign matter.
    2. Care shall be exercised when placing concrete so that the deck will not be subject to construction loads or impact that exceed the design capacity of the deck.
    3. Concrete shall be placed in a uniform manner and spread toward the center of the deck span.
    4. If buggies are used to place concrete, runways shall be planked, and the buggies shall only operate on planking.

a. Planks shall be of adequate stiffness to transfer loads to the steel supports without damaging the deck.

5. Deck damage caused by careless placement of concrete shall be repaired or replaced.
6. Pour concrete to the thickness noted on Drawings.

## 3.4 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:

1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
   a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Specification Section.
2. Unplanned construction joints will not be allowed.
   a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
   a. At Contractor's option, beam pockets may be formed into concrete walls.
   b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Place corbels monolithically with their supporting members.
   a. Locate wall vertical construction joints midway between corbels.
   b. Where only a single corbel is located, place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
8. Provide the following joints unless noted otherwise on Drawings:
   a. Roughen joints: horizontal construction joints.
   b. Keyed joints: vertical construction joints.
9. Roughen construction joints:
   a. Clean the previously hardened concrete interface and remove all laitance.
   b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
10. Keyways:
    a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or as directed by Engineer.
    b. Wall keys:
       1) Keyway width, not less than 1/3 and not more than 1/2 the wall thickness measured perpendicular to wall faces.
       2) Keyway depth to be not less than 1-1/2 IN.
       3) Continuous along length of wall.
       4) Place keyway in wall center unless shown otherwise on Drawings.
    c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
       1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
       2) Keyway depth not less than 1-1/2 IN.
       3) Continuous along footing or slab.
       4) Keyway in footing or slab center unless shown otherwise on Drawings.
    d. Beam keyways:
       1) Full width of beam.
       2) Keyway height not less than 5-1/2 IN.
       3) Keyway depth not less than 1-1/2 IN.
       4) Keyway located in initial beam pour, directly above the bottom reinforcing, unless shown otherwise on Drawings.

11. Minimum time before placement of adjoining concrete construction:
    a. All concrete: 72 HRS, unless otherwise noted.

B. Construction Joints - Spacing Unless Otherwise Specified:
    1. Structures not intended to contain liquid:
        a. Wall vertical construction joints:
            1) 50 FT maximum centers.
            2) At wall intersections, 4 FT minimum from corner.
        b. Base slab, floor, and roof slab construction joints:
            1) Placements to be approximately square and not to exceed 4000 SQFT.
            2) Maximum side dimension of a slab pour to be 90 FT.
        c. Floor slab control joints:
            1) Placements to be approximately square and not to exceed 600 SQFT.
            2) Maximum side dimension to be less than:
                a) Twice the length of the short side.
                b) 35 FT.
    2. Water retaining structures:
        a. Wall vertical construction joints:
            1) 30 FT maximum centers.
            2) At wall intersections, 6 FT minimum from corner.
        b. Wall horizontal construction joints: 18 FT centers.
        c. Walls that are thicker than 18 IN may be poured up to 30 FT tall in one pour provided the following requirements are satisfied:
            1) A test wall of similar size, height and thickness will be poured to demonstrate the quality of the concrete work.
            2) The test wall will be located as a portion of a non-water retaining wall.
                a) The test wall will include a waterstop at the bottom of the wall.
                b) Alternatively, a separate test wall, not part of the final work, may be constructed.
            3) The concrete placement and concrete quality of the test wall will be observed by the Engineer.
                a) Concrete will be judged on the following:
                    (1) Ability to keep bottom of the pour clean and free from trash and debris.
                    (2) Ability to protect the waterstop from folding over due to the force of falling concrete.
                    (3) Ability to properly consolidate all concrete in the wall pour, including below formed openings.
            4) Engineer will evaluate the Contractor's work and may recommend taller concrete wall pours if concrete quality is acceptable.
            5) Preparation for all subsequent wall pours over 18 FT tall must be the same as the preparation of the test wall.
            6) Should the quality of concrete work on subsequent wall pours be judged inadequate, when compared to the original accepted test wall, the Contractor may be directed to limit wall pour heights to 18 FT as originally specified.
            7) Should the quality of concrete work on the test wall be judged inadequate, additional test walls will not be observed and judged to allow pour heights greater than 18 FT unless approved by Engineer.
        d. Floor slab, construction joints:
            1) Placements to be approximately square and not to exceed 2000 SQFT.
            2) Maximum side dimension of a slab pour to be less than:
                a) Twice the length of the short side.
                b) 60 FT.
        e. Elevated slab construction joints:
            1) Placements to be approximately square and not to exceed 4000 SQFT.
            2) Maximum side dimension of a slab pour to be less than:

a) Twice the length of the short side.
b) 70 FT.

C. Construction Joints - Bonding:
1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as outlined below:
3. Roughen construction joints:
   a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 1/4 IN minimum amplitude.
      1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
4. Keyed construction joints:
   a. Thoroughly clean construction joints and remove all laitance.
   b. Dampen the hardened concrete immediately prior to placing of fresh concrete.

D. Slab On Grade Joints:
1. Locate construction and control joints in slabs on grade as indicated on Drawings.
2. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
   a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
   b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
3. Seal expansion joints as shown on Drawings.
   a. See Specification Section 07 92 00 for requirements.

F. Waterstops - General:
1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
3. Preformed strip type:
   a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
      1) Maintain at least 3 IN from edge of concrete or as recommended by manufacturer.
   b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
   c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
   d. Use in joints against existing concrete where indicated on Drawings.
4. PVC waterstops:
   a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
   b. Secure waterstops in correct position using hog rings or grommets spaced no more than 18 IN maximum staggered along each edge full length and passed through the edge of the waterstop.
      1) Tie wire to adjacent reinforcing.
   c. Hold horizontal waterstops in place with continuous supports.
   d. Install according to manufacturer's instructions.
      1) Do not displace reinforcement from required location.

e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
   1) Use factory fabricated "T" and corner intersection fittings.
   2) Field splice straight runs of material.
f. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.

G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
   a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.
2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

H. Placing Embedded Items:
1. Support against displacement.
2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
3. Provide adequate means for anchoring waterstop in concrete.
   a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

## 3.5 FINISHING

A. See Specification Section 03 35 00.

B. Coordinate mixing and placing with finishing.

## 3.6 INSTALLATION OF GROUT

A. Grout Schedule:
1. Sand cement grout:
   a. Fill keyways in precast HCU.
   b. Construction joint bedding (base of wall pours with comparable compressive strength to wall).
   c. General use.
   d. As noted on Drawings.
2. Non-shrinking non-metallic grout:
   a. Filling form tie holes.
   b. Under column and beam base plates.
   c. Other uses indicated on the Drawings.
3. Epoxy grout:
   a. Patching cavities in concrete.
   b. Grouting of dowels and anchor bolts into existing concrete.
   c. Grouting of rotating or oscillating equipment base plates where driving motor is 500 HP and above.
   d. As noted on the Drawings.

B. Grout Installation:
1. Sand cement grout:
   a. Fill wetted keyways between precast concrete hollow core slabs with sand cement grout.
   b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
   c. Cure grout by one of methods specified.
2. Non-shrink non-metallic grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 HRS prior to grouting.
   c. Mix in a mechanical mixer.

d. Use no more water than necessary to produce flowable grout.
e. Place in accordance with manufacturer's instructions.
f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast slabs, and in other locations indicated on the Drawings.
g. Completely fill all spaces and cavities below the top of base plates.
h. Provide forms where base plates and bed plates do not confine grout.
i. Where exposed to view, finish grout edges smooth.
j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.

3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill all cavities and spaces around dowels and anchors without voids.
   d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as required to assure proper placement.

## 3.7 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308.1 except as modified herein.
   2. All traffic shall be kept from the surface as necessary to protect the concrete but not less than the first 48 HRS of curing.

B. For surfaces of non-water bearing structures, apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
   1. Ponding or continuous sprinkling. Take care to avoid eroding the surface of freshly placed concrete.
   2. Application of wet Absorbent Covers:
      a. Minimum lap: 12 IN.
      b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as required to keep concrete surface continuously wet.
      c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
   3. Continuous application of steam (not exceeding 150 DEGF) or mist spray.
   4. Application of Moisture Retaining Cover sheet materials.
      a. Place as soon as possible after final finishing and without marring the surface.
      b. Minimum lap: 12 IN.
      c. Seal all edges to make water-tight.
      d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
      e. Hold cover and edges in place as required to prevent wind from displacing the cover.
      f. Moisture Retaining Fabric:
         1) Install in accordance with manufacturer's written recommendations.
         2) Saturate concrete surface and fabric side of cover immediately prior to placing.
      g. Monitor continuously during the curing period:
         1) Repair any holes, tears or displaced cover.
         2) Rewet as required to keep concrete moist under cover.
   5. Application of other moisture retaining covering as approved by Engineer.
   6. Water used for curing shall be within 20 DEGF of the concrete temperature.
   7. Application of a curing compound.

a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
    1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
    2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
    3) Allow the preceding coat to completely dry prior to applying the next coat.
    4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
d. Curing compounds used in water treatment plant construction shall be non-toxic and taste and odor free, and NSF approved.
    1) Alternately, all tank surfaces shall be cleaned to remove non-NSF approved curing compound without damaging the concrete finish.

8. Surfaces In Contact with Forms:
    a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
        1) See Section 03 11 13.
    b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
    c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
    d. After form removal, cure concrete until end of time prescribed.
    e. Use one of the methods listed above.
    f. Forms left in place shall not be used as a method of curing in hot weather.
    g. The term "hot weather", where used in these specifications, is defined in ACI 305.1.
    h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

C. For Surfaces of Water Bearing Structures:
1. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
    a. Follow recommendations of ACI 308.1 except as modified herein.
    b. Use Evaporation Retardant to reduce surface moisture evaporation of slabs during concrete placement. Comply with all the manufacturer's instructions of use as required to obtain the intended results.
2. Apply one of the following moist curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
    a. Ponding or continuous sprinkling.
    b. Application of absorptive mats or fabric kept continuously wet and in intimate contact with concrete.
    c. Surfaces shall be covered with a double layer of absorptive mats or fabric, wetted before placing, and overlapped at least 6 IN.
    d. Application of sand kept continuously wet.
    e. Continuous application of steam (not exceeding 150 DEGF) or mist spray.
    f. Ponding and sprinkling in conjunction with application of waterproof sheet materials, conforming to ASTM C171 and only with a program as approved by the Engineer that will keep the surface continuously wet.

g. Ponding and sprinkling in conjunction with application of other moisture retaining covering as approved and only with a program as approved by the Engineer that will keep the surface continuously wet.

3. After seven full days of moist curing, application of a curing compound conforming to ASTM C309 or ASTM C1315 may be substituted for moist curing.
    1) Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen which may develop during moist curing has disappeared from concrete surface.
    2) Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
    3) Where a surface is cured with a curing compound, the surface shall be covered with a minimum of two coats of the curing compound, 30 MILS thick each coat.
        a) Apply the first coat of curing compound immediately after form removal or discontinued moist curing and before the surface displays water loss. Apply in one direction only, covering uniformly to a minimum thickness of 30 MILS.
        b) The concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
        c) Allow the preceding coat to completely dry prior to applying the next coat.
        d) Apply second coat in direction perpendicular to the first coat application direction, covering uniformly to a minimum thickness of 30 MILS.
    4) Curing compounds used in water treatment plant construction shall be non-toxic and taste and odor free and be NSF approved.
        a) Alternately, all tank surfaces shall be cleaned to remove non-NSF approved curing compound without damaging the concrete finish.
4. Curing Concrete In Contact with Forms:
    a. Minimize moisture loss of concrete placed in forms by keeping forms wet and cool until they can be safely removed.
    b. Moist cure the top surface of concrete placed in forms as specified.
    c. After form removal, cure concrete until end of time prescribed.
        1) Use one of methods listed above.
        2) When approved by the Engineer, placement of the second pour at joints may occur prior to the end of the curing period.
    d. Forms left in place shall not be used as a method of curing in hot weather.
    e. The term "hot weather", where used in these specifications, is defined in ACI 305R.
    f. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete and commence moist curing as specified.

D. Curing Period:
1. Continue curing for at least 14 days for all water bearing concrete except high early strength concrete for which period shall be at least three days.
2. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
    a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.

E. Cold Weather:
1. Follow recommendations of ACI 306.1.
2. Maintain temperature of concrete per ACI 306.1 for a minimum of 72 HRs after concrete is placed, when outdoor temperature is 40 DEGF, or less.
    a. Maximum temperature rate of decrease: Per ACI 306.1.
3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.

5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

F. Hot Weather:
   1. Follow recommendations of ACI 305.1 and ACI 308.1.
   2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
   4. Maximum temperature rate of decrease: Per ACI 305.1.

G. Rate of Temperature Change:
   1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.

H. Protection from Mechanical Injury:
   1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
   3. Do not load self-supporting structures in such a way as to overstress concrete.

## 3.8 FIELD QUALITY CONTROL

A. Special Inspections per building code:
   1. See Section 01 45 33 and 03 05 05.
   2. Special Inspection is required for:
      a. Concrete tests per Specification Section 03 05 05.
      b. Verification of proper mix design.
         1) Frequency: Periodically, prior to each concrete pour.
      c. Proper reinforcing installation per Specification Section 03 21 00 and Drawings.
      d. Proper concrete placement techniques.
         1) Inspect per requirements of this Section.
         2) Inspect mass concrete per approved thermal monitoring plan.
         3) Frequency: During each concrete pour.
      e. Proper curing temperature and techniques.
         1) Inspect per requirements of this Section.
         2) Frequency: Periodically, but not less than every third day.
      f. Cast-in-place anchors: Per Section 03 15 19.

B. Inspections, Non-Code Required.
   1. Joints:
      a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
      b. Frequency: Prior to each concrete pour.
   2. Waterstops:
      a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
      b. Frequency:
         1) Prior to each concrete pour
      c. Testing PVC Waterstop Joints:
         1) Samples of field fabricated waterstop butt joints may be selected at random by the Engineer for testing by a laboratory at the Owner's expense.
            a) When tested, they shall have a tensile strength across the joints equal to at least 600 PSI.

**END OF SECTION**

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# SECTION 03 35 00
## CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Concrete finishing and repair of surface defects.
2. Chemical Sealers.
3. Polymer Modified Cementitious Coating.
4. Resurfacing Mortar.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 03 11 13 - Formwork.
4. Section 03 31 30 - Concrete, Materials and Proportioning.
5. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
   d. 308, Standard Practice for Curing Concrete.
2. ASTM International (ASTM):
   a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
   b. C150, Standard Specification for Portland Cement.
   c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
   h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   i. D4259, Standard Practice for Abrading Concrete.
   j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
   k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
3. International Concrete Repair Institute (ICRI):
   a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
4. National Council Highway Research Program (NCHRP):
   a. 244, Concrete Sealers for the Protection of Bridge Structures.
5. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:

1. Chemical Sealer CS-2:
    a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
    b. Applicator shall have a minimum of five years of experience successfully applying materials specified.

### 1.3 DEFINITIONS

A. Vertical Surface Defects:
1. Any void in the face of the concrete deeper than 1/8 IN, such as:
    a. Tie holes.
    b. Air pockets (bug holes).
    c. Honeycombs.
    d. Rock holes.
2. Scabbing:
    a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
3. Foreign material embedded in face of concrete.
4. Fins 1/16 IN or more in height.

B. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. Other words and terms used in this Specification Section are defined in ACI CT-13.

### 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
3. Certifications:
    a. Certification of aggregate gradation.
    b. Certification of manufacturer experience qualifications and performance history.
    c. Certification of applicator's qualifications.
        1) Refer to Qualifications paragraph.
        2) Provide manufacturer's written approval of applicators.
        3) Provide references substantiating specialty experience.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Bonding Agents:
    a. BASF Master Builders Solutions.
    b. Euclid Chemical Co.

c. Laticrete - L&M Construction Chemicals.

2. Chemical Sealers:
   a. BASF Master Builders Solutions.
   b. Euclid Chemical Co.
   c. Laticrete - L&M Construction Chemicals.
   d. Tnemec Chemprobe.
3. Polymer Modified Cementitious Coating:
   a. Aquafin International.
   b. BASF Master Builders Solutions.
   c. Euclid Chemical Co.
4. Patching Mortar:
   a. BASF Master Builders Solutions.
   b. Euclid Chemical Co.
   c. Laticrete - L&M Construction Chemicals.
   d. Sika Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Chemical Sealer CS-1:
1. High solids, water-based solution containing acrylic copolymers.
   a. ASTM C1315, Type I, Class A.
   b. Non-yellowing UV resistant.
   c. VOC Content: <200 G/L.
2. USDA approved as a concrete floor sealer.
3. Euclid Chemical Super Diamond Clear VOX.

B. Chemical Sealer CS-2:
1. Water-based chemical solution containing a blend of silicate and siliconate polymers designed to seal, harden and dustproof concrete floors.
2. VOC Content: 0 G/L.
3. Performance of treated concrete floor:
   a. Coefficient of Friction:
      1) Dry: 0.81.
      2) Wet: 0.72.
   b. Liquid repellency, RILEM Method 11.4:
      1) ≥ 1 mL.
4. Euclid Chemical Euco Diamond Hard.

C. Chemical Sealer CS-3:
1. Clear, penetrating, breathable, waterborne silane-siloxane solution.
2. VOC content: ≤50 G/L.
3. Odorless.
4. Flash point: >200 DEGF.
5. Water absorption: 85 PCT reduction per NCHRP 244.
6. Chloride penetration: 82 PCT reduction per NCHRP 244.
7. Euclid Chemical Baracade WB 244.

D. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.
1. Portland cement-based, rapid set repair mortar for interior or exterior use.
2. Compressive Strength, ASTM C109:
   a. Minimum 3000 PSI at 7 days.
   b. Minimum 5000 PSI at 28 days.
3. Freeze Thaw Durability, ASTM C666: 96.75 PCT at 300 Cycles.
4. Shrinkage, ASTM C157: 0.069 PCT.
5. Euclid Chemical Speed Crete Red Line.

E. Bonding Agents:
   1. For use only on concrete surfaces not receiving liquid water repellent coating:
      a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
         1) BASF Master Builders MasterEmaco A 660.
         2) Euclid Chemical Co. Flex-Con.
         3) Laticrete L&M Everbond.
   2. For use only on concrete surface receiving liquid water repellent:
      a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

F. Cement:
   1. ASTM C150, Type I or II Portland.

G. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

H. Water: Potable.

I. Polymer modified cementitious coating:
   1. Polymer modified Portland cement based coating for concrete and masonry.
      a. Waterproof.
      b. Resistant to both positive and negative hydrostatic pressure.
      c. Breathable.
   2. BASF MasterSeal 581 or Euclid Chemical Tamoseal.
      a. Color:
         1) Interior surfaces: Standard gray.
         2) Exterior surfaces: Standard gray.
      b. Texture: Fine.

J. Nonshrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

### 2.3 MIXES

A. Bonding Grout: One part cement to one part aggregate.

B. Patching Mortar:
   1. One part cement to 2-1/2 parts aggregate by damp loose volume.
      a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. For methods of curing, see Specification Section 03 31 31.

B. Surface Preparation:
   1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
   2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
      a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
         1) Areas to receive Repair Mortar:
            a) Areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
      b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
      c. No feather edges will be permitted.

d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.

C. Preparation of Bonding Grout Mixture:
1. Mix cement and aggregate.
2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
3. Add bonding agent/water mixture to cement/aggregate mixture.
4. Mix to consistency of thick cream.
5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

D. Preparation of Patching Mortar Mixture:
1. Mix specified patching mortar per manufacturer's published recommendations.
2. For repairs exceeding 2 IN in depth, mix with clean, pre-dampened 3/8 IN pea gravel in accordance with the manufacturer's recommendations.

E. Polymer modified cementitious coating:
1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

## 3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DEGF.
1. If necessary, enclose and heat area to between 50 and 70 DEGF during repair of surface defects and curing of patching material.
a. Use only clean fuel, indirect fired heating apparatus.
b. Exhaust combustion byproducts outside of work area.

B. Chemical Sealer Application:
1. General:
a. Immediately prior to Substantial Completion, thoroughly clean floor in accordance with ASTM D4258 and prepare to receive chemical sealer.
1) Remove previously applied membrane curing compounds.
2) Remove soil, oils, stains, discoloration, or any other imperfection having a negative impact on the appearance of the finished floor.
b. Apply product to floor areas indicated on the Drawings.
c. Apply in accordance with manufacturer's published installation instructions.
2. Chemical Sealer (CS-1):
a. Apply two uniform coats at rate recommended by manufacturer.
1) Apply using manufacturer's recommended equipment with a fan-tip nozzle.
2) Do not allow material to puddle.
b. Allow first coat to completely dry before applying second coat.
c. Spotted or mottled appearances will not be accepted.
d. Provide this sealer for dry areas not subject to frequent wetting.
3. Chemical Sealer (CS-2):
a. Apply two uniform coats at rate recommended by manufacturer.
1) Scrub the material into the floor using a mechanical scrubber.
a) Keep the surface wet for not less than 30 minutes.
b) Continue scrubbing in accordance with manufacturer's application instructions.
c) After material has thickened, but not more than 60 minutes after application, remove all excess liquid.
2) Thoroughly rinse with clean water to remove all residue.
a) Damp mop with clean water to remove any streaks.
b) Do not allow residue to dry on floor surface.
3) Do not track material onto untreated surfaces.

b. After rinsing, allow floor to dry completely and apply second coat following the same procedures.
c. Final floor finish shall have uniform sheen without streaking, stains or white residue.
d. Provide this sealer for interior areas subject to heavy traffic, frequent wetting and or mild to moderate chemical exposure.

4. Chemical Sealer (CS-3):
   a. Apply uniform coats at rate recommended by manufacturer.
      1) Apply with fine, uniform spray or microfiber pad.
   b. Allow floor to dry completely and remove any dried residue using hot water and mild citric acid.
   c. Final floor finish shall be uniform, free of residue, and shall repel water.
   d. Apply additional coat(s) as necessary to achieve water repellent finish.
   e. Provide this sealer for all exterior areas that are not otherwise coated.

C. Repairing Surface Defects:
1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
   a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
      1) High Performance Industrial Coatings: See Specification Section 09 96 00.
2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
   a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
   b. Scrub bond coat:
      1) Wet substrate to a saturated surface dry (SSD) condition.
      2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire area.
   c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
   d. Patching Mortar Application:
      1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
      2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.
3. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
4. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
   a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
5. Cure patching mortar in accordance with ACI 308.

D. Concrete Finishes for Vertical Wall Surfaces:
1. General:
   a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
   b. Finish numbers not listed are "Not Used".
2. Finish #1 - As cast rough form finish:
   a. Selected forming materials are not required.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
   c. Repair the following surface defects using patching mortar specified in PART 2:
      1) Tie holes.
      2) Honeycombs deeper than 1/4 IN.
      3) Air pockets deeper than 1/4 IN.

4) Rock holes deeper than 1/4 IN.
d. Chip or rub off fins exceeding 1/4 IN in height.
e. Provide at unexposed surfaces such as:
1) Foundations.
2) Below-grade walls not to be waterproofed.
3) Concealed surface of concrete back-up wythe in cavity wall construction.

3. Finish #2 - As cast form finish:
a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
1) Chip or rub off fins exceeding 1/8 IN in height.
2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
(1) For contiguous repair areas larger than 1 SF or deeper than 1/4 IN Abrasive blast, scarify or needle scale to CSP No. 6-8.
b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
c) No feather edges will be permitted.
3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
4) Repair the following surface defects using patching mortar specified in PART 2:
a) Tie holes.
b) Honeycombs deeper than 1/4 IN or larger than 1/4 IN DIA.
c) Air pockets deeper than 1/4 IN or larger than 1/4 IN DIA.
d) Rock holes deeper than 1/4 IN or larger than 1/4 IN DIA.
e) Scabbing.
5) Brush blast repaired areas to match adjacent surface texture.
c. Provide this finish for:
1) Interior walls of pipe galleries, pump rooms.
2) Underside of horizontal elements adjacent to the finished surface.
3) Exposed surfaces not specified to receive another finish.

E. Related Unformed Surfaces (Except Slabs):
1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float surface to a texture consistent with that of formed surfaces.
a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
3. Continue treatment uniformly across unformed surfaces.

F. Concrete Finishes for Horizontal Slab Surfaces:
1. General:
a. Tamp concrete to force coarse aggregate down from surface.
b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
a. When type of finish is not indicated, use following finishes as applicable:
1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
2) Surfaces intended to receive roofing, except future floors, or waterproofing membranes: Floated finish.

3) Floors and roof surfaces which are future floors intended as walking surfaces or for reception of floor coverings: Troweled finish.
4) Garage floors and ramps: Broom or belt finish.
5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
6) All slabs to receive a floated finish before final finishing.

3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
   b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
      1) Use wood or cork float.
   c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
   a. Refloat slab immediately to a uniform texture.
6. Troweled finish:
   a. Float finish surface to true, even plane.
   b. Power trowel, and finally hand trowel.
   c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
   d. Perform additional trowelings by hand after surface has hardened sufficiently.
   e. Final trowel when a ringing sound is produced as trowel is moved over surface.
   f. Thoroughly consolidate surface by hand troweling.
   g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
      1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
   h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.
7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
8. Underside of concrete slab finish:
   a. Match finish as specified for adjacent vertical surfaces.
   b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

## 3.3 FIELD QUALITY CONTROL

A. Tolerances:
   1. Finished floor slabs:
      a. Provide Floor Flatness ($F_F$) and Floor Levelness ($F_L$) in accordance with ACI 117.
         1) Measure in accordance with ASTM E1155.
      b. Slabs not indicated to be sloped:
         1) $F_F$: Equal or greater than 35.
         2) $F_L$: Equal or greater than 25.
      c. Slabs indicated to be sloped or curved:
         1) Measure in accordance with ASTM E1486.
         2) Provide slopes or curves as indicated on the Drawings.
      d. Slabs indicated to receive polished concrete floor:
         1) $F_F$: Equal or greater than 45.
         2) $F_L$: Equal or greater than 35.
         3) Refer to Room Finish Schedule on Drawings.

2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
   a. Gap between a 10 FT straightedge placed anywhere and the finished surface shall not exceed:
      1) Class A tolerance: 1/4 IN.
      2) Class B tolerance: 3/8 IN.
      3) Class C tolerance: 1/2 IN.
   b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 IN.

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
   1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

C. Provide services of manufacturer's technical representative:
   1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
   2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
   3. Manufacturer's representative shall be present for installation of:
      a. Dry-shake Hardener.
      b. Heavy-duty Metallic Aggregate Topping.

## 3.4 PROTECTION

A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 HRS following installation of sealer.

**END OF SECTION**

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# DIVISION 05

**METALS**

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# SECTION 05 12 00
STRUCTURAL STEEL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Structural steel, including the fabrication and erection of support and bracing members, including connections.
   2. Connection detail design as required.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 341, Seismic Provisions for Structural Steel Buildings.
      c. 360, Specifications for Structural Steel Buildings.
      d. Quality Certification Program for Fabricators.
   2. American Society of Mechanical Engineers (ASME):
      a. B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
   3. ASTM International (ASTM):
      a. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. A36/A36M, Standard Specification for Carbon Structural Steel.
      c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      f. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      g. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      h. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      i. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      j. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      k. A992/A992M, Standard Specification for Structural Steel Shapes.
      l. A1064/A1064M, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      m. F436, Standard Specification for Hardened Steel Washers.
      n. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

o. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

4. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17/A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18/A5.18M, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23/A5.23M, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28/A5.28M, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29/A5.29M, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1/D1.1M, Structural Welding Code - Steel.
      1) Steel stud connectors and their installation to comply with requirements of AWS D1.1/D1.1M.
5. National Institute of Steel Detailing (NISD).
6. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.

B. Qualifications:
1. Steel fabricator:
   a. Minimum of 10 years of experience in fabrication of structural steel or participate in the AISC Certification program and is designated an AISC Certified Plant, Category BU (formally known as STD), SBR at time of bid.
   b. Fabricator plant quality control and inspection program: Meet requirements of the building code and/or be an Approved Fabricator.
   c. Plants that are not an Approved Fabricator may be acceptable, provided:
      1) Plant meets all remaining qualifications.
      2) Contractor reimburses the Owner the cost of required Special Inspection services.
2. Steel erector:
   a. Minimum of 10 years of experience in erection of structural steel similar in the scope of this project or certified as CSE under the AISC Quality Certification Program.
   b. With an active and enforced quality assurance program in place, as described in the applicable Codes.
3. Qualify welding procedures and welding operators in accordance with AWS.

## 1.3 DEFINITIONS

A. Owner: May mean the Owner's Designated Representative for Construction as defined by the AISC 303.

B. Galvanizing: Hot-dipped galvanizing per ASTM A153/A153M and/or ASTM A123/A123M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by aforementioned standards.

C. Approved Fabricator: Approved by the Building Official to perform the building code required Special Inspections.

## 1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Detailed supplemental specification relating to load indicator washers or high-strength bolts.
        1) Alternate design for Engineer approval (submitted at Contractor's option if desired by Contractor for use).
    d. Source and certification of quality for high-strength bolts, nuts and washers.
3. Fabrication and/or layout drawings:
    a. Prepare Shop Drawings under NISD Quality Procedures Program certification.
    b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
        1) All Shop Drawings must be checked and signed "approved" before submittal.
        2) Show all cuts, copes, and holes.
        3) Indicate all shop and field bolts.
        4) Indicate all shop and field welds using AWS symbols.
    c. Prepare complete erection drawings showing the location and marks of all pieces.
        1) Copies of up-to-date erection drawings shall accompany the Shop Drawings.
        2) Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
    d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
4. Certifications:
    a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
    b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
    c. Welder qualification data and prequalified procedures.
    d. Special Inspections reports.
    e. Source Quality Control Documentation, including certificate of compliance stating that the work performed in the fabrication shop was done in accordance with the approved construction documents.
        1) Certification is required only if the fabricator is fabricator approved by the Building Official.
5. Test reports:
    a. Certified copies of mill tests.
    b. Manufacturer's load test and temperature sensitivity data for post-installed anchor bolts.
    c. Test reports for all structural steel work.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members above ground on skids or other supports.
    1. Keep free of dirt and other foreign material and protect against corrosion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. High-strength bolts:
        a. Portland Bolt and Manufacturing Company.
        b. Lewis Bolt & Nut Company.
        c. Nucor Fasteners.

d. St. Louis Screw and Bolt Company.

2. Alternate design high-strength bolts:
   a. T. C. Bolt Corporation.
   b. Construction Fastener Systems Division of Bristol Machine Company.
   c. LeJuene Bolt Co.
3. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Division, TRW, Inc.
   b. Stud Welding Products, Inc.
4. Mechanical anchor bolts:
   a. See Section 03 15 19.
5. Adhesive anchors bolts:
   a. See Section 03 15 19.
6. Anchor bolt sleeves:
   a. Sinco/Wilson.
7. Galvanizing repair paint:
   a. Clearco Products Co., Inc.
   b. ZRC Products.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
   1. All W-shapes and WT-shapes: ASTM A992/A992M.
   2. All other plates, bars and rolled shapes: ASTM A36/A36M.

B. Pipe: ASTM A53/A53M, Grade B (Type E or S) (Fy=35).

C. Hollow Structural Sections (HSS):
   1. Round: ASTM A500/A500M, Grade C (Fy=50).
   2. Square or rectangular: ASTM A500/A500M, Grade B (Fy=46).

D. High-Strength Bolts, Nuts and Washers:
   1. ASTM F3125, Grade A325, Grade F1852 with ASTM A563 nuts (galvanized).
   2. High-strength bolts:
      a. Provide two ASTM F436 washers for all bolts (galvanized).
      b. Provide beveled washers at connections of sloped/tapered sections.
   3. Alternate high-strength design: Provide at Contractor's option and subject to approval of Engineer.

E. Bolts, Non-high Strength:
   1. ASTM A307, Grade A.
      a. Galvanized, ASTM A153/A153M, to match connecting members.

F. Threaded Rod: ASTM F1554, Grade 36.

G. Washers, Plain (for Non-high Strength Bolts): ASME B18.22.1, Type B.

H. Welding Electrodes:
   1. Shielded metal arc: AWS A5.1/A5.1M or AWS A5.5/A5.5M, E70XX or E801X-X.
   2. Submerged arc: AWS A5.17/A5.17M or AWS A5.23/A5.23M, F7XX-EXXX or F8XX-EXXX-XX.
   3. Gas metal arc: AWS A5.18/A5.18M, E70S-X or E70U-1 or AWS A5.28/A5.28M, ER80S-XX, E80C-XXX.
   4. Flux cored arc: AWS A5.20/A5.20M, E7XT-X (except 2, 3, 10, GS), AWS A5.29/A5.29M, E7XT-X or E8XTX-X, E8XTX-XM.

I. Anchor Rods and Bolts:
   1. See Section 03 15 19.

J. Headed Studs and Deformed Bar Anchors:

1. Headed studs:
   a. ASTM A108, complying with AWS D1.1/D1.1M, Section 7, Type B; minimum yield strength 50,000 PSI, minimum tensile strength 60,000 PSI.
   b. Uniform diameter.
   c. Heads: Concentric and normal to shaft.
   d. Weld end: Chamfered and solid flux.
2. Deformed bar anchor:
   a. ASTM A1064/A1064M, complying with AWS D1.1/D1.1M, Section 7, Type C.
   b. Minimum yield strength: 70,000 PSI.
   c. Minimum tensile strength: 80,000 PSI.
   d. Straight, unless indicated otherwise.
   e. Solid flux.
3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

K. Non-shrink Grout: See Specification Section 03 31 30.

L. Mechanical and Adhesive Anchor Bolts for Fastening to Concrete:
   1. See Specification Section 03 15 19.

M. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92% in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

## 2.3 FABRICATION

A. Comply with requirements of applicable building code and AISC 360 with modifications and additional requirements specified herein.
   1. Identify high-strength steel material in fabricated members in accordance with ASTM A6/A6M.

B. Minimize the amount of field welding.
   1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
   2. Shop connections: Bolted with high-strength bolts or welded.

C. Connection Details:
   1. Provide as a minimum, two, 3/4 IN DIA, high-strength bolts for all bolted connections unless otherwise specified.

D. Provide bearing type connections for all bolted connections, unless otherwise noted.

E. Field Connections:
   1. Provide bolts for all field connections except where shown otherwise on the Drawings.
   2. Use high-strength bolts unless shown or specified otherwise.
   3. Use of high-strength bolts: Conform to RCSC Specification for Structural Joints Using High-Strength Bolts.
   4. Unfinished bolts may be used for attaching stair treads to stringers.
   5. If structural steel details (field welds versus shop welds, etc.) shown on design Drawings are not compatible with selected erection procedures, submit proposed modifications for review.
   6. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.

F. Accurately mill column end bearing surfaces to true plane.

G. Fabricate and erect beams with non-specified camber in accordance with AISC 360, Chapter L1.

H. Cut, drill, or punch holes at right angles to surface of metal.

1. Do not make or enlarge holes by burning.
2. Make holes clean cut, without torn or ragged edges.
3. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
4. Provide holes in members to permit connection of work of other trades or contractors.

I. Make allowance for draw in all cross bracing to provide small amount of initial tension in members.

J. Make splices only where indicated or where approved.

K. Cope at 45 DEG, corners of stiffener plates at junction of member flanges with webs.

L. Flame cut bevels for welds, provided such cutting is done automatically.
1. Leave free of burrs and slag by grinding or planing the cut edges.

M. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8 IN radius.

N. Tolerances (unless noted otherwise on Drawings):
1. When material received from the mill does not satisfy ASTM A6/A6M tolerances for camber, profile, flatness or sweep, Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC 360.
2. Fabrication tolerance:
   a. Member length:
      1) Both ends finished for contact bearing: 1/32 IN.
      2) Framing members: 30 FT or less: 1/16 IN, Over 30 FT: 1/8 IN.
   b. Member straightness:
      1) Compression members: 1/1000 of axial length between points laterally supported.
      2) Non-compression members: ASTM A6/A6M tolerance for wide flange shapes.
   c. Specified member camber (except compression members):
      1) 50 FT or less: -0/+1/2 IN.
      2) Over 50 FT: -0/+1/2 IN (+1/8 IN per 10 FT over 50 FT).
      3) Members received from mill with 75 PCT of specified camber require no further cambering.
      4) Fabricate beams/trusses without specified camber so after erection, camber is upward.
      5) Measure camber in fabrication shop in unstressed condition.
   d. Use filler plates at bolted splices to take up depth deviation.
      1) At welded joints, adjust weld profile to conform to variation in depth.
      2) Slope weld surface per AWS requirements.
   e. Free finished members from twists, bends and open joints.
      1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

## 2.4 WELDING

A. Comply with AWS D1.1/D1.1M, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS D1.1/D1.1M for position and type of welding to which they will be assigned.
1. Conduct tests in presence of approved testing agency.
2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:

1. Carefully plumb and align members in compliance with specified requirements.
2. Fully tighten all bolts.
3. Comply with AWS D1.1/D1.1M, Section 5 for assembly and surface preparation.
4. Preheat base metal to temperature stated in AWS D1.1/D1.1M.
    a. When no preheat temperature is given in AWS D1.1/D1.1M and base metal is below 50 DEGF, preheat base metal to at least 70 DEGF.
    b. Maintain temperature during welding.
    c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
    d. Maintain this temperature during welding.
5. Mark welds with an identifying mark unique to each welder.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three passes with 1/8 IN round electrodes.
    1. Use backup plates in accordance with AWS D1.1/D1.1M, extending minimum of 1 IN either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld.
    1. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS D1.1/D1.1M.

I. Do not perform welding when ambient temperature is lower than 0 DEGF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:
    1. Automatically end welded in accordance with the AWS D1.1/D1.1M and manufacturer's recommendations.
    2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.

K. Test in-place studs in accordance with requirements of AWS D1.1/D1.1M to ensure satisfactory welding of studs to members.
    1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.
    1. Do not shop paint or galvanize metal surfaces to receive field applied studs.

## 2.5 SHOP COATING

A. Refer to Specification Section 09 96 00 and coordinate shop primer, surface preparation and coating with field applied primers and coatings where specified.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Do not coat following surfaces:
    1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
    2. All other members for which no coating is specified.
    3. Contact surfaces at bolted slip-critical connections, unless surface condition conforms to the RCSC Specification for Structural Joints Using High-Strength Bolts, Part 3.2.2.

D. Clean thoroughly all surfaces not coated before shipping.
    1. Remove loose mill scale, rust, dirt, oil and grease.
    2. Protect machined surfaces.

## 2.6 SOURCE QUALITY CONTROL

A. Special Inspection and Testing:
   1. See Specification Section 01 45 33.
   2. If the fabricator is not an Approved Fabricator, Owner will employ the services of an independent testing agency to inspect and test structural steel shop work for compliance with Specifications.
      a. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
   3. Contractor responsible for testing to qualify shop welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.

B. Approved Fabricator or Testing Agency Responsibilities:
   1. Inspect shop and field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant.
      c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
   3. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.
   4. Prepare and submit inspection and test reports to Engineer.

## 2.7 GENERAL

A. Contractor is solely responsible for safety.
   1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
   2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
   3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
   4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment, is the responsibility of the Contractor.
   1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   3. Design of the temporary bracing system and consideration of the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades, is the Contractor's responsibility.
      a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
   4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
   1. Report defects in work-in-place which may influence satisfactory completion of the work.
   2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:
   1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
   2. Contractor is responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
   1. Notify Engineer of any errors or deviations found by such checking.

## PART 3 - EXECUTION

### 3.1 ERECTION

A. Framing member location tolerances after erection shall not exceed the framing tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

D. Welding:
   1. Conform to AWS D1.1/D1/1M and requirements of this Specification Section.
   2. Join two (2) sections of steel of different ASTM designations using welding techniques in accordance with a qualified AWS D1.1/D1.1M procedure.

E. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on non-shrink grout.
   1. Set and anchor each base plate to proper line and elevation.
   2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
      a. Use same metal as base plate.
      b. Cut off protrusions of wedges and shims flush with edge of base plate.
   3. Fill sleeves around anchor bolts with nonshrink grout.
   4. Pack grout solidly between bottom of plate and bearing surface.
   5. Refer to Specification Section 03 31 30 for nonshrink grout requirements.

I. Cast-in-place Anchor Bolts:
   1. See Specification Section 03 15 19.

J. Install high strength bolts with hardened washers.
   1. Install and tighten in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.
   2. Coordinate installation with inspection.
      a. Do not start installation until coordination with Testing Agency is complete.
   3. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
   4. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors.

1. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt.
    a. Drill new holes if the connections require new holes.
    b. Make no such corrections without prior approval of the Engineer.
2. Burning of holes is not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of non-high strength bolts and anchor bolts to prevent nuts from backing off.

P. After Erection:
1. Grind smooth all sharp surface irregularities resulting from field cutting or welding.
2. Power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

Q. Repair damaged galvanized surfaces in accordance with ASTM A780.
1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

R. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

## 3.2 FIELD QUALITY CONTROL

A. Special Inspection and Testing:
1. See Specification Section 01 45 33.
2. Special Inspection to be in accordance with the building code and AISC 360.
    a. Special Inspector to perform all quality assurance inspections required by AISC 360, Chapter N.
3. Special Inspection is required for:
    a. Inspection of welds before, during and after welding.
    b. Nondestructive Testing of Welded Joints.
    c. Inspection of High Strength Bolts before, during and after bolting.
    d. Other inspection tasks:
        1) Anchor rods and embedded items.
        2) Inspect structural steel which has been erected.
    e. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.

B. Erected Framing Tolerance, unless noted otherwise on the Drawings:
1. Do not exceed cumulative effect of rolling, fabrication and erection tolerance for overall finished dimensions.
2. Erection tolerances are defined relative to member working points and working lines as follows:
    a. Actual centerline of top flange or surface at each end for horizontal members.
    b. Actual center of member at each end for all other members.
    c. Other points may be used, providing they are based on these definitions.
    d. Working line is straight line connecting member working points.
3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified.
    a. Provide "adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members with adjustable connections to supporting structural framing.
4. Certification by steel erector:

a. Certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified.
b. Provide certification upon completion of any part of work.
c. Provide certification prior to start of work by other trades that may be supported; attach to structural steel work.

## 3.3 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
   1. Touchup coatings to comply with Specification Section 09 96 00.

**END OF SECTION**

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# SECTION 05 50 00
## METAL FABRICATIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
   2. Design of all temporary bracing not indicated on Drawings.
   3. Design of systems and components, including but not limited to:
      a. Stairs.
      b. Landings.
      c. Ladders.
      d. Grating.
      e. Checkered plate.
      f. Modular framing system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 05 12 00 - Structural Steel.
   6. Section 05 52 02 - Welded Aluminum Railings.
   7. Section 06 82 00 - Fiberglass Reinforced Plastic Fabrication.
   8. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM 1, Aluminum Design Manual.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   3. American Institute of Steel Construction (AISC):
      a. 325, Manual of Steel Construction.
      b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   4. The American Ladder Institute (ALI):
      a. A14.3, Ladders - Fixed - Safety Requirements.
   5. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads for Buildings and Other Structures.
   6. ASTM International (ASTM):
      a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. A36, Standard Specification for Carbon Structural Steel.
      c. A47, Standard Specification for Ferritic Malleable Iron Castings.
      d. A48, Standard Specification for Gray Iron Castings.
      e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
      g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
i. A197, Standard Specification for Cupola Malleable Iron.
j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
o. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
q. A536, Standard Specification for Ductile Iron Castings.
r. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A992, Standard Specification for Steel for Structural Shapes.
z. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
aa. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
ee. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ff. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
gg. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
hh. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
ii. F467, Standard Specification for Nonferrous Nuts for General Use.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ll. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.
mm. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
nn. F1789, Standard Terminology for F16 Mechanical Fasteners.

oo. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.2, Structural Welding Code - Aluminum.
   d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
   c. MBG 531, Metal Bar Grating Manual.
9. NACE International (NACE).
10. Nickel Development Institute (NiDI):
    a. Publication 11 007, Guidelines for the welded fabrication of nickel-containing stainless steels for corrosion resistant services.
11. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
   2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of Oregon.
   4. NACE certified inspector shall have minimum of two years of experience performing inspections as indicated.
      a. Have a current Level III coating inspector certification.

## 1.3 DEFINITIONS

A. Fasteners: As defined in ASTM F1789.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Hardware: As defined in ASTM A153/A153M.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Qualifications:
      a. NACE inspector qualifications.
   3. Fabrication and/or layout drawings and details:
      a. Submit drawings for all fabrications and assemblies.
         1) Include erection drawings, plans, sections, details and connection details.
      b. Identify materials of construction, shop coatings and third party accessories.
   4. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.
c. Provide manufacturer's standard allowable load tables for the following:
1) Grating and checkered plate.
2) Castings, trench covers and accessories.
3) Modular framing systems.

5. Contractor designed systems and components:
a. Certification that manufactured units meet all design loads specified.
b. Shop Drawings and engineering design calculations:
1) Indicate design live loads.
2) Sealed by a licensed professional engineer, registered in the State of Oregon.
3) Engineer will review for general compliance with Contract Documents.
c. Contractor designed systems and components include the following:
1) Metal Stairs, associated landings and support framing.
2) Ladders and associated landings.
3) Steel checkered plate.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Certification of welders and welding processes.
a. Indicate compliance with AWS.
3. NACE certification of surface preparation.
4. NACE certification of paint application.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Abrasive stair nosings (embedded in concrete stairs):
a. American Safety Tread.
b. Balco.
2. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Div., TRW Inc.
b. Stud Welding Products, Inc.
3. Mechanical anchor bolts:
a. See Section 03 15 19.
4. Epoxy adhesive anchor bolts:
a. See Section 03 15 19.
5. Concrete screw anchors:
a. See Section 03 15 19.
6. Castings, trench covers and accessories:
a. Neenah Foundry Co.
b. Deeter Foundry Co.
c. Barry Craft Construction Casting Co.
d. McKinley Iron Works.
7. Galvanizing repair paint:
a. Clearco Products Co., Inc.

b. ZRC Products.
8. Modular framing system:
   a. Unistrut Building Systems.
   b. B-Line Systems.
   c. Kindorf.
   d. Superstrut.
9. Ladder safety extension post:
   a. Bilco.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Steel:
1. Structural:
   a. W-shapes and WT-shapes: ASTM A992, Grade 50.
   b. All other plates and rolled sections: ASTM A36.
2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
3. Structural tubing:
   a. ASTM A500, Grade C (50 KSI minimum yield).
4. Bolts, high strength:
   a. ASTM F3125, Grade A325.
5. Nuts, high strength:
   a. ASTM A563.
6. Washers (hardened):
   a. ASTM F436.
   b. Provide two (2) washers with all bolts.
7. Bolts and nuts (unfinished):
   a. ASTM A307, Grade A.
8. Welding electrodes: AWS D1.1, E70 Series.
9. Steel forgings: ASTM A668.

B. Stainless Steel:
1. Stainless steel in welded applications: Low carbon 'L' type.
2. Minimum yield strength of 30,000 PSI and minimum tensile strength of 75,000 PSI.
   a. Bars, shapes: ASTM A276, Type 304.
   b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
   c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
   d. Bolts and nuts: ASTM F593, Type 304 or 316.
3. Minimum yield strength of 25,000 PSI and minimum tensile strength of 70,000 PSI.
   a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
4. Welding electrodes: In accordance with AWS for metal alloy being welded.

C. Washers: Same material and alloy as found in accompanying bolts and nuts.

D. Embedded Anchor Bolts:
1. See Specification Section 03 15 19.

E. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

F. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

G. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

H. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

I. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 PCT in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

J. Dissimilar Materials Protection: See Specification Section 09 96 00.

## 2.3 MANUFACTURED UNITS

A. Ladders:
   1. General:
      a. Fully welded type.
         1) All welds to be full penetration welds, unless otherwise specified.
      b. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings.
      c. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and the building code.
      d. Ladders shall be designed to support a minimum concentrated live load of 300 LBS at any point to produce the maximum stress in the member being designed.
         1) Apply additional 300 LB loads for each section of ladder exceeding 10 FT.
      e. Maximum allowable stresses per AISC Specification.
      f. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
   2. Material:
      a. Galvanized steel.
      b. Finish:
         1) Steel: Galvanized after fabrication.
   3. Rails:
      a. Round pipe or rectangular tubing:
         1) Round pipe:
            a) 1-1/2 IN nominal diameter.
            b) Schedule 40.
         2) Rectangular tubing:
            a) Cross-section: 3 by 2 IN maximum.
            b) Thickness: 0.125 IN minimum.
      b. Spacing:
         1) Minimum clear distance between rails to be 18 IN.
         2) Step-through ladder extensions: 24 IN, centerline to centerline.
      c. Provide cap at exposed top and bottom of side rails.
         1) Provide weep holes as necessary to prevent the accumulation of moisture within hollow members.
      d. Extend side rails of step-through ladders a minimum of 42 IN above the landing.
   4. Rungs:
      a. Minimum 1 IN DIA or 1 IN square solid bar.
         1) Integral non-slip finish on all sides.
            a) Non-slip finish: Coarse knurling or extruded serrations.
            b) Shop or field-applied grit tape and cap type non-slip finishes are not acceptable.
      b. Rungs shall penetrate inside wall of side rails.
         1) Do not extend rungs beyond the outside face of the side rail.
         2) Provide fillet weld all around rung at inside face of side rail and plug weld at outside face of side rail.
      c. Rung spacing:
         1) Equally spaced not less than 10 IN and not more than 14 IN as measured between the centerlines of the rungs.

a) Ladder rungs and steps in elevator shafts shall be spaced not less than 6 IN and not more than 16.5 IN as measured between the centerlines of the rungs.

2) Top rung shall be level with landing or platform.

a) Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 IN below, adjacent walking surface.

5. Brackets:
   a. Angle or bent plate brackets welded to side rails:
      1) 3/8 IN by 2-1/2 IN by length required.
      2) Provide punched holes for 3/4 IN bolts or anchors.
      3) Minimum distance from centerline of rung to wall or any obstruction: 7 IN.
      4) Maximum spacing: 6 FT OC.
   b. For floor supported ladders, provide 3/8 by 2-1/2 by 4 IN rectangular bracket or 3/8 by 6 by 6 IN square plate welded to rails with punched holes for 3/4 IN bolts.
      1) Provide wall brackets on floor supported units if vertical run is over 4 FT.
6. Landings:
   a. Construct landing, railing and all supports of same material as the ladder.
   b. Design live load for landing platform and supporting structure:
      1) 100 PSF, uniform load.
      2) 300 LBS concentrated load on 4 IN square area.
      3) All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
      4) Maximum deflection: 1/300 of span under a superimposed live load of 100 PSF.
   c. Grating:
      1) Per this Specification Section.
   d. Structural support: Channel or tubular sections with bracing, plates, angles, etc., to support guardrail and grating and to support landing from the side of the structure or building wall.
      1) Weld or bolt all connections using galvanized bolts, nuts and washers.
   e. Guardrails:
      1) Match ladder side rails.
         a) Space intermediate rails equally between top rail and top of kickplate.
      2) Provide 4 IN high x 3/8 IN thick toeboard each side of landing.
7. Gates:
   a. Constructed of same material and sizes as the railing system.
   b. Hinges:
      1) Stainless steel.
      2) Heavy-duty, self-closing.
   c. Gate stop:
      1) Galvanized steel.
8. Ladder safety extension post:
   a. Telescoping tubular galvanized steel section that automatically locks into place when fully extended.
   b. Non-ferrous corrosion-resistant spring and hardware.
   c. Factory assembled with all hardware necessary for mounting to ladder.
   d. Bilco "LadderUp" safety post.
9. Deflector plate:
   a. For steel ladders: Minimum 0.0625 IN steel plate, ASTM A6, galvanized.
   b. Profile as shown on Drawings.
   c. Fabricate to shapes and sizes required to meet OSHA Standards.

B. Bollards:
   1. 8 IN DIA extra strength steel pipe, ASTM A53.
      a. Galvanized.
      b. See Specification Section 09 96 00 for painting requirements.

C. Abrasive Stair Nosings:
   1. Exterior cast-in-place concrete stairs:
      a. One piece cast aluminum with wing anchors.
      b. Diamond abrasive pattern.
      c. Babcock Davis "BSTCA-C3W".
   2. Length:
      a. Concrete landings at metal stairs: 4 IN less than clear width between stringers.

D. Metal Stairs:
   1. Treads: Grating as specified.
      a. Provide integral corrugated non-slip nosing.
   2. Risers:
      a. Grating treads:
         1) Solid plate welded to trailing edge of tread or landing.
         2) Minimum 3/16 IN thick by 4 IN high.
      b. Checkered plate treads: Solid checkered plate riser integral with tread.
   3. Landings:
      a. Grating as specified.
      b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.
      c. Nosing at concrete landing:
         1) Abrasive stair nosing.
   4. Design live load for landing platform and supporting structure:
      a. 125 PSF, uniform load.
      b. 300 LBS concentrated load on 4 IN square area.
      c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
      d. Maximum deflection: 1/300 of span under a superimposed live load of 125 PSF.
   5. Design, fabricate, and install in compliance with NAAMM and applicable codes.
      a. NAAMM AMP 510:
         1) Exterior at site structures and equipment: Industrial Class.
         2) Interior or exterior at buildings: Service Class.
   6. Handrails and guardrails: Refer to Specification Section 05 52 02.
   7. Material:
      a. Steel: ASTM A36, galvanized after fabrication

E. Steel Checkered Plate:
   1. Provide galvanized checkered plate and edge supports.
   2. Conform to ASTM A786.
      a. Diamond pattern: No.3 (large) or No.4 (medium).
      b. Use one pattern throughout Project.
      c. Material: 36 KSI minimum yield strength.
   3. Design live load (unless noted otherwise on Drawings):
      a. 125 PSF, uniform load.
      b. 300 LBS concentrated load on 4 IN square area.
      c. Traffic Load: HS-20
      d. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
      e. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.
   4. Reinforce as necessary with steel angles welded to underside of checkered plate.
   5. Plate sections:
      a. Maximum 3 FT wide.
      b. Minimum 1/4 IN thick.
      c. Maximum 72 LBS per section if required to be removable.
   6. Provide joints at center of all openings unless shown otherwise.
      a. Reinforce joints and openings with additional angles to provide required load carrying capacity.

7. Unless shown otherwise, frame for opening with steel checkered plate cover:
    a. Steel support angles:
        1) 3 by 2 by 1/4 IN minimum size with long leg vertical.
        2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two anchor bolts per side.
    b. Steel concrete insert seats:
        1) 2 by 2 by 1/4 IN minimum size.
        2) Auto-welded studs or strap anchors, ASTM A108 at 18 IN OC with not less than two studs or anchors per side.
    c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two fasteners per side.
        1) Fasteners: Flat countersunk cap screws, ASTM F835.
            a) Galvanized, ASTM A153/A153M.

F. Steel Grating:
1. NAAMM MBG 531.
2. Minimum depth: 1 IN.
3. Minimum rectangular bearing bar size:
    a. 1/8 IN.
    b. Maximum 1-3/16 IN OC spacing.
4. Design live load:
    a. 125 PSF, uniform load.
    b. 300 LBS concentrated load on 4 IN square area.
    c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
    d. Maximum deflection: 1/300 of span under a superimposed live load of 125 PSF.
5. Cross bars:
    a. Welded, swagged or pressure locked to bearing beam.
    b. Maximum spacing 4 IN/OC.
6. Top edges of bars: Serrated or grooved.
7. Removable grating sections: Not wider than 3 FT and not more than 72 LBS.
8. Finish:
    a. Galvanized.
    b. Clips and bolts: Stainless steel.
    c. Seat angles: Galvanized steel.
9. Ends and perimeter edges: Banded.
10. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
11. Provide joints at openings between individual grating sections.
12. At Contractor's option galvanized steel plank type grating with skid-resistant surface may be used.
    a. Grating to have a minimum 35 PCT up to a maximum 45 PCT open area and shall meet the design loads and deflection specified in this Specification Section.

G. Heavy-Duty Castings, Trench Covers, and Accessories:
1. Prefabricated, cast iron ASTM A48 or ductile iron ASTM A536 or cast aluminum ASTM B26.
2. Design load: AASHTO HS-20 wheel loading for indicated span.
3. Machine horizontal mating surfaces.

H. Access Cover:
1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
3. Equip lid with four stainless steel screws to secure lid to frame.

I. Modular Framing System:

1. Materials:
   a. Steel: ASTM A1011, stainless steel, Grade 33.
      1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
   b. Aluminum: ASTM B221 or ASTM B209.
   c. Stainless steel: ASTM A666.
   d. Fiberglass: See Specification Section 06 82 00.
2. Channels and inserts:
   a. Steel or stainless steel: Minimum 12 GA.
   b. Aluminum: Minimum 0.080 IN.
   c. Channels to have one side with a continuous slot with in-turned lips.
      1) Width: 1-5/8 IN.
      2) Depth and configuration as necessary for loading conditions.
3. Fittings: Same material as system major components.
4. Fasteners:
   a. Nuts: Toothed groves in top of nuts to engage the in-turned lips of channel.
   b. Bolts: Hex-head cap screws.
   c. Same material as system major components.
5. End caps:
   a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 FT or less above the floor or platform.
      a) Plastic for all exposed ends 7 FT or more above floor or platform.
      b) Plastic or metallic for all other exposed ends.
6. Schedule:
   a. Interior wet areas: Stainless steel.
      1) Including the following rooms or areas:
         a) 100 building:
            (1) Pretreatment room.
         b) 300 area:
            (1) Pipe gallery.
            (2) Ballasted floc room.
            (3) Lockers.
            (4) Shower room.
            (5) Pump room.
            (6) Filters.
            (7) Unisex bathroom.
            (8) Janitor room.
            (9) Observation platform.
         c) 600 building:
            (1) Pump room.
   b. Interior corrosive areas: Fiberglass.
      1) Including the following rooms or area:
         a) 100 building:
            (1) Ozone room
            (2) THIO room.
         b) 300 building:
            (1) Chemical room 1.
            (2) Chemical room 2.
   c. Exterior areas: Aluminum.
   d. All other areas not listed above: Hot-dipped galvanized steel.
7. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.
8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

## 2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Shop Connections:
   1. Welds to be continuous fillet type unless indicated otherwise.
   2. Full penetration butt weld at bends in stair stringers and ladder side rails.
   3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
   4. Weld aluminum in accordance with AWS D1.2.
   5. Weld stainless steel in accordance with AWS D1.6 and NiDI 11 007.
      a. Treat all welded areas in accordance with ASTM A380.
   6. All headed studs to be welded using automatically timed stud welding equipment.
   7. Grind smooth welds that will be exposed.

E. Passivate stainless steel items and stainless steel welds after they have been ground smooth, where indicated on Drawings.
   1. ASTM A380.

F. Conceal fastenings where practicable.

G. Fabricate work in shop in as large assemblies as is practicable.

H. Tolerances:
   1. Rolling:
      a. ASTM A6.
      b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members:
            a) 30 FT or less: 1/16 IN.
            b) Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
      c. Specified member camber (except compression members):
         1) 50 FT or less: -0/+1/2 IN.
         2) Over 50 FT: -0/+1/2 IN (+1/8 IN per 10 FT over 50 FT).
         3) Members received from mill with 75 PCT of specified camber require no further cambering.
         4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
         5) Camber shall be measured in fabrication shop in unstressed condition.
      d. At bolted splices, depth deviation shall be taken up by filler plates.
         1) At welded joints, adjust weld profile to conform to variation in depth.
         2) Slope weld surface per AWS requirements.
      e. Finished members shall be free from twists, bends and open joints.
         1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

I. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum, galvanized steel, or stainless steel as specified in Article 2 of this Specification Section unless shown otherwise on Drawings.
   1. Finish:
      a. Aluminum or stainless steel: mill, unless noted otherwise.
      b. Coat surfaces in contact with dissimilar materials.
         1) See Specification Section 09 96 00.

J. Fabricate grating in accordance with NAAMM MBG 531.
   1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 IN.
   2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 IN.
      a. Tolerance: NAAMM MBG 531.
   3. Removable sections: Not wider than 3 FT and not heavier than 72 LBS.
   4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
      a. Provide full depth banding unless noted otherwise.
      b. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage.
   5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
   6. Provide joints at openings between individual grating sections.
   7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

K. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
   1. Workmanship: Class 2 unless noted otherwise.

L. See Specification Section 09 96 00 for preparation and painting of ferrous metals and other surfaces.

## 2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
   1. Refer to Specification Section 09 96 00 for surface preparation requirements.
   2. All miscellaneous metal fabrication item surfaces shall be inspected and approved by NACE certified coatings inspector prior to application of shop-applied coatings.
      a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
      b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Coating Application:
   1. Refer to Specification Section 09 96 00 for coating requirements.
   2. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of coatings.
   3. Application of coatings shall be observed and certified by NACE certified coatings inspector.

C. Meet structural requirements of Specification Section 01 45 33 for inspection and testing items of structural nature.

D. Shop Inspection and Testing:
   1. Owner will employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
   2. Contractor responsible for testing to qualify shop and field welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
   3. Independent testing agency shall have a minimum of five years performing similar work and shall be subject to Owner's approval.

E. Responsibilities of Testing Agency:

1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
    a. Visually inspect all welds.
    b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant or mag particle.
    c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
    a. Verify direct tension indicator gaps, if applicable.
3. Inspect structural steel which has been erected.
4. Inspect stud welding in accordance with AWS Code.
5. Prepare and submit inspection and test reports to Engineer.
    a. Assist Engineer to determine corrective measures necessary for defective work.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
    1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
    1. Field welding aluminum is not permitted unless approved in writing by Engineer.

### 3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
    1. Shim and grout as necessary.

B. Meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature:
    1. Tolerances.
    2. Inspection and testing.

C. Contractor is solely responsible for safety.
    1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
    2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
    3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
    4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

D. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
    1. Plumb, align, and set structural steel members to specified tolerances.
    2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
    3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.

4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
    a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
5. Remove and dispose of all temporary work and facilities off-site.

E. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
    1. Report defects in work-in-place which may influence satisfactory completion of the work.
    2. Absence of such notification will be construed as acceptance of work-in-place.

F. Field Measurement:
    1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
    2. Contractor responsible for the accurate fit of the work.

G. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
    1. Use surveyor's level.
    2. Notify Engineer of any errors or deviations found by such checking.

H. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

I. Erect plumb and level; introduce temporary bracing required to support erection loads.

J. Use light drifting necessary to draw holes together.
    1. Drifting to match unfair holes is not allowed.

K. Welding:
    1. Conform to AWS D1.1 and requirements of the FABRICATION Article in PART 2 of this Specification Section.
    2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

L. Shore existing members when unbolting of common connections is required.
    1. Use new bolts for rebolting connections.

M. Clean stored material of all foreign matter accumulated prior to the completion of erection.

N. Bolt Field Connections: Where practicable, conceal fastenings.

O. Field Welding:
    1. Follow AWS procedures.
    2. Grind welds smooth where field welding is required.

P. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
    1. Replace entire section.

Q. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

R. Unless noted or specified otherwise:
    1. Connect steel members to steel members with 3/4 IN DIA ASTM F3125, Grade A325 high strength bolts.
    2. Connect aluminum to aluminum with 3/4 IN DIA stainless bolts.
    3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts.
        a. Provide dissimilar metals protection.

4. Connect aluminum and steel members to concrete and masonry using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
    a. Provide dissimilar materials protection.
5. Provide washers for all bolted connections.
6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top of installed nut.
    a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

S. Install and tighten ASTM F3125, Grade A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
    1. Provide hardened washers for all Grade A325 bolts.
        a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

T. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.

U. Secure metal to wood with lag screws of adequate size with appropriate washers.

V. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
    1. Provide full penetration welded splices where continuity is required.

W. Provide each fabricated item complete with attachment devices as indicated or required to install.

X. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

Y. Set beam and column base plates accurately on non-shrink grout as indicated on Drawings.
    1. See Division 03 Specification Sections for non-shrink grout and anchorage.
    2. Set and anchor each base plate to proper line and elevation.
        a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
            1) Wedges, shims and setting nuts to be of same metal as base plate they support.
            2) Tighten nuts on anchor bolts.
        b. Fill space between bearing surface and bottom of base plate with non-shrink grout.
            1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
        c. Do not remove wedges or shims.
            1) Where they protrude, cut off flush with edge of base plate.
        d. Fill sleeves around anchor bolts solid with non-shrink grout.

Z. Tie anchor bolts in position to embedded reinforcing steel using wire.
    1. Tack welding prohibited.
        a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
    2. Anchor bolt location tolerance:
        a. Per Section 03 15 19.
        b. Provide steel templates for all column and machine anchor bolts.

AA. Install bollards as detailed on Drawings.
    1. Fill pipe with concrete and round off at top.

BB. Provide abrasive stair nosings at each concrete stair landing having metal stair structure attaching to the concrete landing.
    1. Center stair nosings in stair width.

CC. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
    1. Keep screw holes clean and ready to receive screws.

DD. Attach grating to end and intermediate supports with grating saddle clips and bolts.
    1. Maximum spacing: 2 FT OC with minimum of two per side.

EE. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

FF. Repair damaged galvanized surfaces in accordance with ASTM A780.
    1. Prepare damaged surfaces by abrasive blasting or power sanding.
    2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

GG. Anchor ladder to concrete structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.

HH. Anchor ladder to metal stud walls using minimum 1/2 IN stainless steel bolts, nuts and washers.
    1. Verify that stud wall has been provided with adequate backing to accept ladder anchors.

II. Install ladder safety extension post in accordance with manufacturer's instructions.
    1. Mount device opposite the climbing side.
    2. Provide ladder safety extension device for all ladders unless noted otherwise.

JJ. Mount ladder fall protection system with rail offset from ladder side rail approximately 3 IN.

## 3.3 FIELD QUALITY CONTROL

A. Tolerances shall meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature.

B. Tolerances (unless otherwise noted on the Drawings):
    1. Frame placement, after assembly and before welding or tightening.
        a. Deviation from plumb, level and alignment: 1 IN 500, maximum.
        b. Displacement of centerlines of columns: 1/2 IN maximum, each side of centerline location shown on Drawings.

C. Meet structural requirements of Specification Section 01 45 33 for inspection and testing items of structural nature.

D. Owner Pays for Field Inspection and Testing:
    1. Owner will employ and pay for services of an independent testing agency to inspect and test structural steel shop and field work for compliance with this Specification Section.
    2. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
    3. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.

## 3.4 CLEANING

A. After fabrication, erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. All stainless steel products in addition to Paragraph A above:
    1. Remove all heat tint, rusting, discoloration by passivation, ASTM A380, or other acceptable means as listed in NiDI 11 007 as approved by the Engineer.

C. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09 96 00.

**END OF SECTION**

# SECTION 05 52 02
## WELDED ALUMINUM RAILINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Aluminum handrail, stair rail and guardrail.
   2. Aluminum guardrail gates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 05 50 00 - Metal Fabrications.
   2. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM 1, Aluminum Design Manual.
   2. American Society of Mechanical Engineers (ASME):
      a. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   3. ASTM International (ASTM):
      a. B108, Standard Specification for Aluminum-Alloy Permanent Mold Castings.
      b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      d. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
      e. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
      f. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   4. American Welding Society (AWS):
      a. C5.5, Recommended Practices for Gas Tungsten Arc Welding.
      b. D1.2, Structural Welding Code - Aluminum.
   5. National Association of Architectural Metal Manufacturers (NAAMM):
      a. AMP 521, Pipe Railing Systems Manual.
   6. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
      a. Americans with Disabilities Act (ADA):
         1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
   7. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS and ASME Section IX.

### 1.3 DEFINITIONS

A. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

B. Handrail: A horizontal or sloping rail intended for grasping by the hand for guidance or support.

C. Railing: A generic term referring to guardrail, handrail and/or stair rails.

D. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Fabrication and/or layout drawings:
      a. Drawings showing profile, location, sections and fabrication details including all welding information of each railing.
      b. Type and details of anchorage.
      c. Location and type of expansion joints.
      d. Materials of construction, shop coatings and all third-party accessories.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation details.
   3. Certification that railings have been designed and fabricated to meet the loading requirements specified.
   4. Calculations:
      a. Calculations shall be performed, sealed, signed and dated by a registered professional structural engineer licensed in the State of Oregon.
      b. Calculations shall be specific to this Project and shall include all assumptions, references and design interpretations used to achieve the results obtained by the Engineer.
      c. Reduction in load criteria is not acceptable as reason for deviation from sizes indicated in the Specification.

B. Informational Submittals:
   1. Certification of welders and welding procedures indicating compliance with AWS requirements.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect against corrosion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Welded railing systems:
      a. Golden Railing - Welded Railing System.
      b. Moultrie Manufacturing Company - Wesrail Welded.
      c. Peak-to-Peak Engineered Railings - Welded Railing System.
      d. Tuttle Railing Systems - TABCO 3000.

### 2.2 MATERIALS

A. Alloy 6061-T6.
   1. ASTM B209 for sheets and plates.
   2. ASTM B221 and ASTM B308 for shapes - beams, channels, angles, tees, and zees.
   3. ASTM B247 for forgings.

B. Alloy 6063-T5 or T6.

1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.

C. Fittings:
   1. Cast Aluminum, ASTM B108.
   2. Machined aluminum: 6063-T5 or T6 alloy.

D. Shims: Aluminum of same alloy as component being shimmed.

E. Fasteners: See Specification Section 05 50 00.

F. Expansion and Adhesive Anchors: See Specification Section 03 15 19.

G. Electrodes for Welding:
   1. Aluminum: AWS D1.2.
   2. Filler alloy 5356 or 4043.

## 2.3 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
      a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
   3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
      a. Ease exposed edges to a radius of approximately 1/32 inches.
      b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
      c. Drill or punch holes with smooth edges.
   4. Form exposed connections with flush, smooth, hairline joints, using stainless steel or aluminum splice locks to splice sections together or by welding.
      a. Ease the edges of top rail splices and expansion joints and remove all burrs left from cutting.
   5. Provide for anchorage of type indicated on Drawings or as required by field conditions.
      a. Drill or punch holes with smooth edges.
   6. Roof-mounted guardrails:
      a. Toprail elevation constant:
         1) 42 inches above walking surface high point.
         2) Adjust vertical post length to allow for roof slopes, camber, etc.
      b. Shim plates: Aluminum.
         1) Same size and shape as base plate.
         2) Drilled to match base plate anchorage.
   7. Design railings and anchorage system in accordance with NAAMM AMP 521 to resist loading as required by the building code.
      a. Maximum allowable stresses per AA ADM 1.
   8. Design railings in accordance with accessibility requirements per the building code and ADAAG.

B. Custom fabricate railings to dimensions and profiles indicated.
   1. Guardrails:
      a. Posts: Minimum 1 1/2 inches nominal diameter Schedule 80 pipe.
         1) Space vertical posts as required by loading requirements but not more than 4 feet on center.
         2) Avoid locating vertical posts at changes in direction of railing.
         3) Hold vertical post back from corner and provide radiused corners.
      b. Rails: Minimum 1 1/2 inches nominal diameter Schedule 40 pipe.
         1) Where details are not indicated, space intermediate rails to requirements of the building code or OSHA Standards, whichever requires the more restrictive design.

2. Handrail: Minimum 1 1/4 inches nominal diameter Schedule 40 pipe.
   a. Outside diameter: 1 1/2 inches minimum, 2 inches maximum.
3. Space handrail brackets as required by loading requirements but not more than 4 feet on center.
4. Cable infill:
   a. Tensioned horizontal cables installed between horizontal guardrails where indicated; spanning length of panel from newel post to newel post.
   b. Provide cable, fittings, and accessories for complete assembly.
   c. Cable:
      1) 1 by 19 stainless steel
      2) 1/4-inch diameter
   d. Maximum spacing: 3 inches OC.
   e. Fittings: Type 316 stainless steel.
5. Space vertical posts as required by loading requirements but not more than 4 feet on center.
   a. Space vertical posts at 3 feet on center where using cable infill.
6. Space handrail brackets as required by loading requirements but not more than 4 feet on center.
7. Mounting:
   a. Welded flanges:
      1) For surface mounting to top of concrete:
         a) 3/8 x 6 x 6 inches square plate.
         b) Predrilled to accept four anchors.
      2) For mounting to flange of metal structure:
         a) 3/8 x 3 x 8 inches plate.
         b) Predrilled to accept two fasteners.
   b. Cast or machined flanges:
      1) Provide manufacturer's standard cast or machined flanges or brackets as necessary for conditions shown on Drawings.
      2) Railing posts shall be secured using socket-head stainless steel set screws.
         a) Bolts, TEK screws, rivets, or adhesive are not acceptable.
      3) Flanges and brackets shall allow for removal of railing sections where removable railings are indicated on the Drawing.
   c. Reinforce posts as necessary for loads specified.
      1) Completed assembly shall be designed to withstand the loading capacity specified.
8. Toeboards:
   a. 1/4 inches thick by 4 inches high extruded toeboard with stiffener ribs.
      1) Similar to Wagner "IR94102" kickplate.
9. Guardrail gates:
   a. Constructed of same material and sizes as the guardrail system.
   b. Width of gate as shown on Drawings.
   c. Hinges:
      1) Cast aluminum.
      2) Self-closing.
         a) Stainless steel torsion spring.
      3) Similar to Wagner, Model "IR100."
   d. Gate latch and stop:
      1) Cast aluminum.
      2) Spring-loaded pin latch.
         a) Stainless steel spring.
      3) Similar to Wagner, Model "IR101."

C. Railing Fabrication:
   1. All railings are to be welded systems.
   2. Use wire welding for all joints.
   3. All welding to be continuous in accordance with AWS C5.5 and AWS D1.2.

a. All welded railing joints shall have full penetration welds unless noted otherwise.

4. All exposed welds to be ground smooth and flush to match and blend with adjoining surfaces.
   a. NAAMM AMP 521, Type 2.
5. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
6. Finishing joints with filler is not acceptable.
7. Provide flush weld fittings using locking weld connectors or coped drive-on connectors.
8. Fit exposed ends of guardrails and handrails with solid terminations.
   a. Return ends of handrail to wall, but do not attach to wall.
   b. Where guardrail terminates at a wall, provide a vertical post or end-loop 4 inches off the wall to center of vertical member.
9. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.
10. Provide weeps to drain water from hollow sections of railing at exterior and high humidity conditions.
    a. Drill 1/4 inches weep hole in railings closed at bottom:
       1) 1 inches above walkway surface at bottom of posts set in concrete.
       2) 1 inches above base flange or reinforcing spud where applicable.
       3) At low point of intermediate rails.
    b. Do not drill weep holes:
       1) In bottom of base flange.
       2) Below top of pipe flashing when railings are installed on the roof.
11. Expansion joints:
    a. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
       1) Top rail splices and expansion joints shall be located within 8 inches of post or other support.
       2) Where railings span building, culvert wall, or tank expansion joints; provide a railing expansion joint in the span crossing the building, culvert wall, or tank expansion joint.
    b. Provide expansion joints in any continuous run exceeding 20 feet in length.
       1) Space expansion joints at not more than 40 feet on center.
    c. Provide minimum 0.10 inches of expansion joint for each 20 feet length of top rail for each 25 DEGF differential between installation temperature and maximum design temperature.
       1) Maximum expansion joint width at time of installation shall not exceed 3/8 inches.
          a) Provide additional expansion joints as required to limit expansion joint width.
    d. Provide slip-joint with internal sleeve.
       1) Extend slip joint min 2 inches beyond joint at maximum design width.
       2) Fasten internal sleeve securely to one side.
          a) Provide Allen-head set screw located in bottom of rail.
          b) Rivets or exposed screw heads are not acceptable.

D. Finish:

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1. Architectural Class 1 coating per AA DAF 45:
   a. AA-M12C22A41 clear anodized, throughout, except as noted. AA-M12C22A42 dark bronzeanodized; at culvert crossing only.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
   1. Field welding aluminum is not permitted unless approved in writing by Engineer.

## 3.2 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the building code.

B. Install products in accordance with manufacturer's instructions.

C. Set work accurately in location, alignment and elevation; plumb, level and true.
   1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
   1. Provide shims as required.

E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
   1. Lubricate expansion joint splice bar for smooth movement of railing sections.

F. Provide removable railing sections where indicated on Drawings.

G. Attach handrails to walls or guardrail with brackets designed for condition:
   1. Provide brackets which provide a minimum 1/4 inches clearance between handrail and nearest obstruction.
      a. Handrails shall not project more than 4-1/2 inches into required stairway width.
      b. Minimum clearance from wall: 1-1/2 inches.
      c. Cut material square and remove burrs from exposed edges with no chamfer.
      d. Make rails smooth with no projections preventing a hand from sliding along entire length.
      e. Make exposed joints butt tight and flush.
      f. Close exposed ends of pipes or rails with end caps.
      g. Return ends of wall mounted rails to wall.

   2. Anchor handrail brackets to concrete walls with stainless steel adhesive anchors with stainless steel hex head bolts.

H. Anchor roof-mounted guardrails to precast concrete tee or cored slab structure using stainless steel through bolts, nuts and washers with additional bottom base plate placed on bottom side of structure.
   1. Additional bottom base plate: Minimum 6 x 6 x 3/8 inches aluminum plate punched to receive four through bolts.

I. Anchor railings to concrete with stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract Documents.
   1. Where exposed, bolts shall extend minimum 1/2 inches and maximum 3/4 inches above the top nut.
      a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
      b. Bevel the top of the bolt after cutting to provide a smooth surface.

J. Anchor railings to metal structure with stainless steel bolts, nuts and washers.

K. Install toeboards to fit tight to the walking surface.
   1. Attach to railing vertical post with manufacturer's standard mounting clamp:
      a. Adjustable.
      b. Designed to engage in extruded slot on back of toeboard.
   2. Provide splice bars, corner splices and brackets:

a. Manufacturer's standard items as required for a complete installation.

3. Provide spacer bar and U-bracket where necessary for toeboard to clear mounting flange.
4. Bottom of toeboard shall not exceed 1/4 inches above walking surface.

L. Coat aluminum in contact with dissimilar metal or concrete in accordance with Specification Section 09 96 00.

M. Provide railings as required for stair construction identified in Specification Section 05 50 00.

N. Install guardrail gate plumb and level in location shown on Drawings.
1. Center gate in opening.
2. Top of gate to match top of guardrail.
3. Fasten hinges to gate and jamb post:
   a. Minimum three, 1/4 inches stainless steel countersunk machine screws per leaf.
   b. Drill and tap into railing and gate vertical posts.
4. Provide not less than two hinges per gate.
5. Install gate latch and stop on strike side of opening.
   a. Fasten to gate with 1/4 inches stainless steel countersunk machine screws.
   b. Drill and tap into gate vertical post.
   c. Drill hole in railing vertical post to receive latch pin.
6. Adjust to provide smooth operation:
   a. Self-closing and self-latching.

**END OF SECTION**

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# DIVISION 06

## WOOD, PLASTICS, AND COMPOSITES

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# SECTION 06 10 00
ROUGH CARPENTRY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Rough carpentry.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 15 19 – Anchorage to Concrete
   4. Section 07 41 13 Insulated Metal Roof Panels
   5. Section 07 61 13 - Metal Roofing.
   6. Section 07 62 00 - Flashing and Sheet Metal.
   7. Section 07 92 00 - Joint Sealants.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Engineered Wood Association (APA):
      a. PRP-108, Performance Standards and Qualification Policy for Structural Use Panels.
      b. U450, Storage and Handling of APA Trademarked Panels.
      c. Y510, Plywood Design Specification.
   2. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. D153, Standard Test Methods for Specific Gravity of Pigments.
      c. D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
      d. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
      e. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
      f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. American Wood Protection Association (AWPA):
      a. M2, Standard for Inspection of Preservative Treated for Industrial Use.
      b. M3, Standard for the Quality Control of Preservative Treated Products for Industrial Use.
      c. M4, Standard for the Care of Preservative-Treated Wood Products.
      d. P5, Standard for Waterborne Preservatives.
      e. U1, Use Category System: User Specification for Treated Wood.
   4. Environmental Protection Agency (EPA).
   5. FM Global (FM):
      a. 1-49, Property Loss Prevention Data Sheets - Perimeter Flashing.
   6. National Institute of Standards and Technology (NIST):
      a. PS 1, Quantitative NMR (Benzoic Acid).
      b. PS 20, American Softwood Lumber Standard.
   7. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

B. Qualifications:
   1. Wood Treatment Plant: AWPA M3.
   2. Treated Wood Inspection: AWPA M2.

C. Miscellaneous:
1. Factory marking:
a. Lumber:
1) Identify type, grade, moisture content, inspection service, producing mill, and other qualities specified.
2) Marking may be omitted, as allowed by the building code, if certificate of inspection is provided for each shipment.

### 1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Fabrication drawings of all fabricated items.
3. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions for all products specified.
4. Certifications:
a. Chemicals used in treatment process are registered with and approved by EPA.
b. Moisture content of material prior to treatment: 25 PCT maximum.
c. Material has been kiln-dried after treatment (KDAT) to the moisture content specified.
5. Documentation of treatment of treated material in accordance with standards referenced.

### 1.4 DELIVERY AND STORAGE

A. Delivery, storage and handling of untreated wood products:
1. Lumber: As recommended by the grading agency indicated on the grade stamp.
2. Plywood: APA U450.

B. Delivery, storage, handling and disposal of treated wood products: AWPA M4.

### 1.5 WARRANTY

A. Interior fire retardant treated wood: Manufacturer's standard 20 year warranty.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
1. Lumber (for framing, blocking, nailers, furring, grounds and similar members):
a. NIST PS 20.
b. Species:
1) Treated material: As indicated in the appropriate AWPA standard.
a) Provide species of FRTM as necessary to achieve UL rating listed.
c. Grade:
1) For nominal sizes up to and including 2 x 4: Standard and better.
2) For nominal sizes up to 2 IN thick and wider than 4 IN: #2 and better.
2. Non-structural plywood:
a. NIST PS 1.
b. C-D plugged:
1) Exposure: , , INT.
2) Thickness: 3/4 IN.

3) Touch sanded.

B. Preservative Treated Material:
   1. Moisture content:
      a. Prior to treatment: 25 PCT.
      b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
         1) Lumber: 19 PCT maximum.
         2) Plywood: 18 PCT maximum.
   2. Preservative:
      a. Waterborne: AWPA P5.
      b. As indicated in the appropriate AWPA standard.
   3. Pressure-treat material in accordance with AWPA U1.
   4. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

C. Fire-Retardant Treated Material (FRTM):
   1. Acceptable manufacturer:
      a. Hoover Treated Wood Products, Inc.:
         1) Interior: "Pyro-Guard".
         2) Exterior: "Exterior Fire-X".
   2. Maximum moisture content:
      a. Prior to treatment: 25 PCT.
      b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
         1) Lumber: 19 PCT (KDAT).
         2) Plywood: 15 PCT (KD-15).
   3. Fire-retardant preservative:
      a. Provide protection against decay:
         1) EPA registered for use as a wood preservative.
      b. Shall not bleed-through or adversely affect bond of any finish.
   4. Pressure-treat material in accordance with AWPA U1.
   5. UL Classified:
      a. FR-S, UL 723.
      b. Exterior: No increase in classification when subjected to the Standard Rain Test, ASTM D2898.
      c. Provide UL mark on each piece of FRTM.
   6. Maximum flame spread rating: 25, ASTM E84.
   7. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

D. Fasteners and Anchors:
   1. Nails and screws:
      a. Dry, non-corrosive exposure: Hot dipped galvanized meeting ASTM D153 or Type 304 stainless steel.
      b. Wet, corrosive, marine, and/or below grade: Type 316 stainless steel.
   2. Adhesive anchors, expansion anchors, self-tapping concrete anchors, bolts, nuts, and washers: See Specification Section 03 15 19.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Verify measurements, dimensions, and shop drawing details before proceeding.

B. Coordinate location of studs, nailers, blocking, grounds and similar supports for attached work.

C. Eliminate sharp projections which would puncture roofing, flashing or underlayment material.

## 3.2 ERECTION AND INSTALLATION

A. General:
   1. Provide preservative treated material for all wood used:
      a. Outside building.
      b. Below grade.
   2. Provide fire-retardant treated material for all wood used:
      a. Inside building.
      b. Exterior building walls.
      c. Roof construction.
      d. Roofing nailers.

B. Attach work securely by anchoring and fastening as indicated or required to support applied loading.
   1. Anchor wood to concrete using adhesive or expansion anchors as specified in Specification Section 03 15 19.
      a. Separate wood from direct contact to concrete with polyethylene foam gasket strip.
         1) Size: 1/4 IN by width of wood member.
         2) Owens Corning "SillSealR".
   2. Anchor wood to metal using bolts and nuts as specified in Specification Section 03 15 19.
   3. Provide flat washers under all bolt heads and nuts.
   4. Fasten plywood in accordance with APA recommendations.
   5. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
   6. Install fasteners without splitting of wood; predrill as required.
   7. Do not drive threaded friction type fasteners.
   8. Tighten bolts and lag screws at installation and retighten as required.

C. Set work to required levels and lines, plumb, true.
   1. Shim as required.
   2. Cut and fit accurately.

D. Provide wood grounds, nailers, or blocking where required for attachment of other work and surface applied items.
   1. Form to shapes indicated or required.
      a. FRTM lumber:
         1) Do not rip or mill.
         2) Cross-cutting and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
         3) Resurfacing, planing or fabrication of special shapes or profiles shall be done prior to treatment.
      b. FRTM plywood:
         1) Cross-cutting, ripping and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
      c. Light sanding of FRTM as permitted by UL to remove raised grain or prepare for finishing is allowable.
      d. Field treat cuts and holes in preservative treated material in accordance with AWPA M4 and manufacturer's published recommendations.
   2. Grounds:
      a. Dressed, key beveled lumber minimum 1-1/2 IN wide of thickness required to bring face of ground even with finish material.
      b. Remove temporary grounds when no longer required.
   3. Install roofing nailers as necessary for attachment of flashing, curbs, fascia, coping, and related accessories:
      a. Match height of nailers to insulation.
      b. Anchor nailers to resist force of 300 PLF unless required otherwise by FM Global or roofing manufacturer.

1) Metal decking attachment:
    a) Attach base nailer to metal roof deck using self-tapping stainless steel sheet metal screws (STSMS) with plate washers or with minimum 3/8 IN Type 304 stainless steel hex head bolts with nuts and washers.
    b) Countersink heads of bolts flush with top of nailer.
2) Concrete decking attachment:
    a) Attach base nailer to concrete roof deck using minimum 3/8 IN stainless steel adhesive anchors with minimum 3 IN embedment.
    b) Countersink heads of bolts flush with top of nailer.
3) Provide size and spacing of anchorage as required to meet loading criteria specified.
    a) Fasten blocking for perimeter flashing in accordance with ANSI/SPRI ES-1 and FM Global 1-49.

c. Provide 1/2 IN vent spaces between lengths of nailers.
d. Install nailers over vapor retarder.

E. When wood has been exposed to moisture allow to completely dry out prior to covering with additional wood or another material.

F. Correct or replace wood which shows bowing, warping or twisting to provide a straight, plumb and level substrate for applications of other materials.

G. Exterior Wall Sheathing Installation:
1. Install sheathing in accordance with manufacturer's installation guidelines and fastening requirements for loading requirements noted in the Contract Documents.
2. Install sheathing with "gold side" out.
3. Use maximum lengths possible.
4. Do not tape joints between panels.
5. If sheathing surface varies more than 1/8 IN from any one panel to an adjoining panel, remove the panels and reset.
    a. If the condition persists, remove the panels and correct sub framing as required so panels align properly.
6. Drive fasteners to bear tight against and flush with surface of sheathing.
    a. Do not countersink, fracture core or puncture facers with head of fastener.

**END OF SECTION**

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# SECTION 06 41 00
## ARCHITECTURAL CABINETWORK (MILLWORK)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Architectural cabinetwork.
   2. Window stools.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 07 92 00 - Joint Sealants.
   5. Section 08 81 00 - Glass and Glazing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disability Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. American National Standards Institute (ANSI):
      a. A161.2, Decorative Laminate Countertops, Performance Standards for Fabricated High Pressure.
      b. A208.1, Particleboard.
      c. A208.2, Medium Density Fiberboard (MDF) for Interior Applications.
   3. American National Standards Institute/American Hardboard Association (ANSI/AHA):
      a. A135.4, Basic Hardboard.
   4. ASTM International (ASTM):
      a. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
      b. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
   5. Architectural Woodwork Institute (AWI):
      a. Architectural Woodwork Quality Standards:
         1) Section 300, Standing and Running Trim.
   6. American Wood Protection Association (AWPA):
      a. U1, Use Category System: User Specification for Treated Wood.
   7. Builders Hardware Manufacturers Association (BHMA).
   8. Forestry Stewardship Council (FSC).
   9. Hardwood Plywood and Veneer Association (HPVA):
      a. HP-1, Standard for Hardwood and Decorative Plywood.
   10. National Electrical Manufacturers Association (NEMA):
      a. LD 3, High-Pressure Decorative Laminates (HPDL).

B. Qualifications:
   1. Fabricator shall have minimum of 10 years experience in design and fabrication of architectural cabinetwork with minimum of three successfully completed projects with similar scope in the last 2 years.

C. Miscellaneous:
   1. Construction details, fastening, tolerances and workmanship: AWI grade standards with exceptions indicated.

## 1.3 DEFINITIONS

A. Architectural Cabinetwork: Millwork.

B. Exposed Surfaces:
   1. All surfaces visible when doors and drawers are closed, inside of doors, and:
      a. Door and drawer fronts and their edges.
      b. Exposed end.
      c. Countertop and backsplash and their exposed edges.
      d. Face frame (if used).
      e. Interior of open cabinets.
      f. Toe kick not to be covered by resilient base or coved flooring.
      g. Wall mounted adjustable shelves.
      h. Bottom of wall case over 4 FT above floor.
      i. Top of wall and tall cases below 6 FT above floor.

C. Concealed Surfaces:
   1. Surfaces not visible after installation, and:
      a. Web frames.
      b. Dust panels.

D. Semi-Exposed Surfaces:
   1. All other surfaces not exposed or concealed.

## 1.4 SYSTEM DESCRIPTION

A. Fabricated cabinets including all hardware, countertops, and finishing thereof.

## 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Schedule of window stool locations indicating sizes, shape etc.
   3. Fabrication drawings and details showing compliance with this Specification Section.
   4. Certifications:
      a. FSC certification of wood products.

B. Samples:
   1. Plastic laminate color and finish samples for Engineer's selection.
   2. PVC edging: Manufacturer's complete line of color samples.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Millwork fabricator experience qualifications.
   3. Listing of millwork fabricators projects within last two years with similar scope.
   4. Solid Surface Material fabricator's qualifications.
   5. Warranty from Solid Surface Material manufacturer.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver all millwork items window stools and countertops to the Project Site and store in the area in which items will be installed.
   1. Building areas to receive millwork items shall be enclosed, weathertight and conditioned to a relative humidity between 25 PCT and 55 PCT before, during and after installation.
   2. Remove any plastic packaging or wrapping from millwork upon delivery to Project Site.
   3. Protect stored items from damage with vapor-permeable covering during storage.

4. Allow material to acclimate to the surrounding environment a minimum of 96 HRS prior to installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Plastic laminate:
      a. Formica Corporation.
      b. Nevamar by Panolam Surface Systems.
      c. Wilsonart Engineered Surfaces.
   2. Plastic overlay panel products:
      a. Simpson Timber Co.
      b. Sel-Ply Division/Medford Corp.
      c. Weyerhaeuser Company
      d. Formica Corporation.
   3. Cabinet hardware:
      a. EPCO.
      b. Faultless.
      c. Grant.
      d. Ives by Allegion.
      e. Knape & Vogt Manufacturing Company.
      f. McKinney.
      g. National Lock Co.
      h. Rockford Process Control.
      i. Stanley Black & Decker, Inc.
      j. Stylmark, Inc.
      k. Webber-Knapp Company.
   4. Solid Surface Material:
      a. Avonite by Aristech Surfaces LLC.
      b. DuPont.
      c. Formica Corporation.
      d. Wilsonart Engineered Surfaces.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Plastic Laminate:
   1. NEMA LD 3 high-pressure laminate, matte finish.
   2. Countertops and backsplashes and their edges: Grade FR50, 0.050 IN thick.
   3. All other exposed surfaces: Grade GP28, 0.028 IN thick.
   4. All other exposed and semi-exposed surfaces: Grade FR32, 0.032 IN.
   5. Semi-exposed backer sheet: Grade CL20, 0.020 IN thick; color to match plastic overlay.
   6. Concealed backer sheet: Grade BK20, 0.020 IN thick.
   7. For fire rated use Grade FR32, 0.032 IN thick backer sheet.

B. Particleboard:
   1. Three-ply, medium density industrial particleboard.
   2. ANSI A208.1: Grade M-2 or M-3.
   3. Density: 45 PCF minimum.
   4. Particleboard used for countertops:
      a. ANSI A161.2.
      b. Moisture resistant.

C. Fiberboard:

1. Medium density wood fiberboard.
2. ANSI A208.2: Interior Grade M.

D. Hardboard:
1. Tempered, smooth on both sides.
2. ANSI/AHA A135.4: Class 1, S2S.

E. Plywood: Softwood plywood, A grade.

F. PVC Edging:
1. Polyvinyl chloride edge banding, machine applied and trimmed:
a. Hot melt glue per PVC manufacturer's recommendations.
b. T-edging will not be allowed.

G. Preservative Treated Lumber:
1. Preservative: Waterborne.
2. Moisture content:
a. Prior to treatment: 25 PCT.
b. Kiln-dry after treatment (KDAT), ASTM D4442, ASTM D4444: 19 PCT maximum.
3. Pressure treat material in accordance with AWPA U1, Use Category UC2.

H. Solid Surface Material:
1. Homogeneous non-porous, polymeric material.
a. ICPA/ANSI SS-1.
b. NSF 51 approved.
2. Flammability: Class 1.
3. Joint adhesive: Manufacturer's recommended adhesive.
4. Manufacturer's standard 10 year warranty.

I. Sealant:
1. Silicone.
2. See Specification Section 07 92 00.

## 2.3 FABRICATION

A. General:
1. Custom shop or factory built casework, complete with all hardware, accessories, countertops and bases in sizes and configurations indicated.

B. Cabinetwork:
1. Style: Reveal overlay doors and drawer fronts overlapping case body with uniform reveal at all edges.
2. Case body:
a. All joints glued.
b. Top and bottom (and fixed horizontals):
1) Lock jointed and screwed.
2) Dadoed or rabbeted into ends/dividers.
3) Doweled at approximately 2-1/2 IN OC.
c. Back: Dadoed into top, sides, and bottom.
d. Fixed small compartment dividers: Dadoed.
3. Drawers (with subfront):
a. All joints glued.
b. All corners:
1) Dovetailed or doweled.
2) Front corners dovetailed and back corners lock jointed.
3) Sides dadoed for front and back and all joints nailed, stapled or screwed.
c. Bottom: Dadoed into all four sides.
d. Front: Screwed onto subfront.
e. Top edges of drawer box rounded.

4. Drawers (without subfront):
    a. All joints glued.
    b. Front corners dovetailed or doweled.
    c. Back corners:
        1) Dovetailed, doweled, or lock jointed.
        2) Sides dadoed for back and corner nailed or screwed.
    d. Bottom: Dadoed into all four sides.
    e. Top edges of drawer sides and back rounded.
5. Allow for two different cabinet face colors.

C. Countertops:
1. Solid Surface Material window stools and countertops:
    a. Use maximum size sheet to eliminate joints.
    b. Joints shall be not closer than 24 IN to sinks or other cut-outs.
    c. Refer to Drawings for special edge treatment.
    d. Ease all exposed edges.
    e. 1/2 IN thick built up to 1-1/4 IN at exposed edges.
    f. Backsplashes:
        1) Same material and thickness as countertop.
        2) 4 IN high.
        3) Provide wherever top abuts wall.
    g. Color:
        1) To be selected by Architect from manufacturer's complete offering of colors and patterns.
        2) Allow for minimum of two base color selections with two accent colors.
2. Use no blocking or fasteners in exposed or semi-exposed locations.

D. Hardware:
1. General:
    a. Provide handles, pulls, latches, locks, and other operating devices in accordance with the ADAAG.
2. Hardware for hinged doors:
    a. Hinges:
        1) Five-knuckle, wraparound type with hospital type tips.
        2) Not less than 2-1/2 IN long.
        3) Minimum three screws each leaf.
        4) For doors up to 48 IN high: Two hinges.
        5) For doors over 48 IN high: Three hinges.
        6) Finish:
            a) Stainless steel, BHMA 630.
        7) Hinge: Rockford Process Control "Overlay."
    b. Catch:
        1) Heavy duty, roller catch.
        2) Case and strike: Wrought steel.
        3) Roller: Rubber.
        4) Ives 338.
        5) Finish: Bright nickel plated, clear coated.
3. Hardware for drawers:
    a. Slides: KV 8400 series; 100 LB capacity, precision steel ball bearings, positive closing and pull out stops, drawer removable without use of tools; telescoping full extension slides, epoxy-coated with white finish.
    b. Lock: Provide where indicated.
    c. For file drawers: Label holder and file hanger frame.
4. Pulls:
    a. Stainless steel wire.
    b. 4 IN centers.

c. 5/16 IN (8 MM) DIA.
d. Provide two on drawers over 18 IN wide.
e. Finish:
1) Stainless steel, BHMA 630.
2) Color: To be selected by Architect.

5. Locks:
a. Pin tumbler cylinder cam locks.
b. Material: Brass.
c. Finish: Chrome plated, US 26D.
d. National C8100 series.
e. Provide two keys for each lock.
f. Master key as coordinated with the Owner.

6. Shelf supports (drilled hole type):
a. 5 MM holes drilled at 32 MM OC.

7. Shelf supports (recessed standard type):
a. Standards: Aluminum or zinc-coated or plated steel, slotted at 1/2 IN OC for recessed installation.
b. Shelf clips: Plated or zinc-coated steel; designed to engage securely in slots, finish to match standard.
c. KV #255 AL.

8. Countertop support brackets:
a. Cold rolled steel.
b. Size:
1) Nominal 22 IN deep by 14 IN high.
2) 3/4 IN wide.
c. Tested to meet or exceed ANSI performance standards as established by BHMA.
1) Load Rating: 1200 LBS per pair.
d. Similar to Knape & Vogt "208 Series Ultimate L-Bracket."
e. Finish:
1) Corrosion resistant powder coating.
2) Color: White .

9. Shelf supports (for wall-mounted shelves):
a. Standards:
1) Slotted steel.
2) Similar to Knape & Vogt "KV 87".
b. Shelf brackets:
1) Boltless, steel for shelf depths indicated.
2) Similar to Knape & Vogt "KV 187".
c. Finish:
1) Electroplated.
2) Color: [Almond]To be determined by Architect.

E. Plastic Laminate Casework Fabrication:
1. Finishes for non-fire-rated cabinets:
a. All exposed surfaces: Plastic laminate.
b. All semi-exposed surfaces not covered with plastic laminate backer sheet (except hardwood): Plastic overlay.

2. Edges:
a. Edges of case body members: 1 MM PVC.
b. All other exposed and semi-exposed edges: 3 MM PVC.

3. Case body members (except backs not exposed):
a. Minimum 3/4 IN thick particleboard.
b. Base unit top:
1) Use either full subtop or web frame.
2) Web frames: Hardwood.

c. Provide drawer lock rails at all drawers.
d. Provide backs on all cabinets.

4. Unexposed case back:
   a. Tempered hardboard.
   b. Minimum 1/4 IN thick.
   c. Full bound: Capture and glue back panel in dado at top, sides and bottom of case.
5. Shelves:
   a. Minimum 3/4 IN thick particleboard.
   b. 1 IN thick if over 36 IN between supports.
6. Doors:
   a. Particleboard:
      1) Up to 26 IN wide or 48 IN high: 3/4 IN thick.
      2) Up to 36 IN wide or 66 IN high: 1-1/4 IN thick.
7. Drawers:
   a. Fronts: 3/4 IN thick particleboard.
   b. Subfront, sides and back: 1/2 IN thick hardwood plywood.
   c. Bottom:
      1) Minimum 1/4 IN thick hardboard, captured four sides with 3/8 IN standing shoulder.
      2) Over 18 IN wide provide intermediate reinforcing rails.
8. Case base:
   a. Separate ladder style base.
   b. Preservative treated lumber.
   c. Provide concealed fastening of cabinet body to base.
      1) Fasteners through bottom of casework will not be accepted.
9. Filler panels and scribe pieces: Particleboard; provide as required to fit standard size units to space.

## 2.4 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install products in accordance with the ADAAG.
   1. Provide sizes, heights and clearances required for accessibility compliance.

C. Provide balanced construction on each plastic laminated item.

D. Use manufacturer's printed instructions or drawings in all cases where items or details are not indicated.

E. Provide all trim, fillers, closures, stands, supports, sleeves, collars, escutcheons, brackets, braces or other miscellaneous items required for complete installation.

F. Install extra locks where directed; deliver unused locks and keys to Owner.

G. Test and adjust for satisfactory operation.

H. Seal components with silicone sealants in accordance with AWI Standards.
   1. Seal joints in plastic laminate countertops before assembly.
   2. Seal joints between backsplashes and endsplashes and countertops.
   3. Seal joints where backsplashes and endsplashes meet adjoining surfaces.

I. Adjust hinges so doors hang straight.

J. Resilient Base:
   1. Install base after cabinets have been leveled and adjusted.
   2. Provide base at toe spaces, exposed cabinet ends, knee space panels or other intersections of floor and vertical casework surfaces, unless noted otherwise.
   3. Set base straight and true.
   4. Fit into breaks and recesses.

5. Provide factory-formed outside corners; miter inside corners.
   a. Make joints tight.
6. Install with top edge level and bottom edge in firm contact with floor.

K. Install Solid Surface Material in accordance with manufacturer's recommendations.

## 2.5 FIELD QUALITY CONTROL

A. Protect Solid Surface Material during construction with minimum 1/8 IN hardboard.

**END OF SECTION**

# SECTION 06 82 00
## FIBERGLASS REINFORCED PLASTIC FABRICATIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Fiberglass reinforced plastic (FRP) fabrications including but not limited to:
      a. Modular framing system.
      b. Supporting structure design.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

### 1.3 SYSTEM DESCRIPTION

A. All fiberglass reinforced plastic support systems shall be designed by a registered professional engineer licensed in the State of Washington.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations on reinforcing field cut openings.
   2. Fabrication and/or layout drawings.
      a. Plan showing profile, location, section and details of each item including anchorage or support system(s).
      b. Locations and type of expansion joints.
      c. Materials of construction including shop applied coatings.
      d. Listing of all accessory items being provided indicating material, finish, etc.
   3. Certifications:
      a. Certification of Engineer's qualifications.
      b. Certification that all components and systems have been designed and fabricated to meet the loading requirements specified.
   4. Manufacturer's full line of colors available for each component.

B. Informational Submittals:
   1. Complete design calculations of all supporting structure and fastening conditions.
      a. Design calculations to be for information only.
      b. Engineer will not review or take any action on submittal.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle each item to preclude damage.

B. Store all items on skids above ground.
   1. Keep free of dirt and other foreign matter which will damage items or finish and protect from corrosion and UV exposure.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Modular framing system:
      a. AICKIN.
      b. Enduro Composites.
      c. Seasafe, Inc.
      d. Unistrut by Atkore International, Inc.

### 2.2 MATERIALS

A. Fiberglass Reinforced Plastic (FRP):
   1. Vinyl ester with fiberglass reinforcing.
      a. Type V.
   2. Fire retardant.
      a. Flame spread: ASTM E84, 25 or less.
   3. Color: To be selected by Engineer when more than one color is available for any one component.

B. Fasteners, Clips, Saddles, and Miscellaneous Components:
   1. Fiberglass where possible.
   2. Stainless steel may be used if fiberglass component is not available.

C. Adhesive: Recommended by manufacturer.

D. Skid-resistant Surfacing: Manufacturer-applied abrasive grit coating.

### 2.3 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. Preassemble items in shop to greatest extent possible.
   3. All components shall be treated with UV inhibitor.
   4. Drill or punch holes with smooth edges.

B. Modular Framing System:
   1. Material: Heavy duty pultruded.
   2. Shapes as required for condition.
   3. Fasteners: Stainless steel or fiberglass.
   4. Provide end caps for all exposed terminations.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Set work accurately in location, alignment and elevation, plumb, level, and true.
   1. Measure from established lines and levels.
   2. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
   3. Tolerances:
      a. Maximum variation from plumb in vertical line: 1/8 inches in 3 feet.
      b. Maximum variation from level of horizontal line: 1/4 inches in 20 feet.
      c. Maximum variation from plan location: 1/4 inches in 20 feet.

C. Coat all exposed surfaces of stainless steel fasteners with minimum 15 mil gel coating to match component being anchored.

D. File cut ends of all fiberglass to a 1/32 inches radius.

E. Seal cut ends of all items with catalyzed resin as recommended by manufacturer.
   1. Provide same resin used in fabrication of item as a minimum.

F. Provide all modular framing components as required to suit condition.
   1. Install in accordance with manufacturer's recommendations.

**END OF SECTION**

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# DIVISION 07

## THERMAL AND MOISTURE PROTECTION

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# SECTION 07 16 16
## CRYSTALLINE CEMENTITIOUS WATERPROOFING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Crystalline cementitious waterproofing to be provided as an admixture to the concrete mix.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. NSF International (NSF):
      a. 61, Drinking Water System Components - Health Effects.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Dry side: Includes side next to soil or other dry backfill material.

C. Wet side: Includes side immersed in liquid or next to soil or other backfill material that is constantly wet due to high water table or other subsurface water condition.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's instructions for adding material to concrete mix as an admixture.
      c. Manufacturer's installation/application instructions.
      d. NSF approval.
      e. Listing of projects completed in last three years including name, location, area of waterproofing (SQFT), and contact name and telephone number.
         1) Projects are to have used product as an admixture added at the batch plant.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Master Builders Solutions by BASF: MasterSeal 500.
   2. Euclid Chemical Company: Vandex.
   3. PENETRON.
   4. Xypex Chemical Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Crystalline Cementitious Waterproofing:
   1. Factory blended dry powder compound consisting of Portland cement, treated aggregate, and active chemicals.
      a. NSF 61 listed as approved for use in contact with potable water.
      b. Formulated for use as a concrete admixture:
         1) Xypex Admix C-500.

B. Water: Potable.

## 2.3 PERFORMANCE REQUIREMENTS

A. Mix waterproofing material in proportions recommended by manufacturer.

# PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 07 17 00
## BENTONITE COMPOSITE SHEET WATERPROOFING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Bentonite composite sheet waterproofing system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D751, Standard Test Methods for Coated Fabrics.
      b. D903, Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
      c. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      d. D5887/D5887M, Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
      e. D5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
      f. D5993, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
      g. D6768/D6768M, Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

B. Qualifications:
   1. Installer(s) to have completed a minimum of three other projects of similar scope within last three years.
   2. Installer shall be approved in writing by manufacturer.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Jointing, sealing, and fastening details not shown on Drawings but required by the Project.
   2. Certification of installer's qualifications.
   3. Manufacturer authorized representative written documentation of substrate acceptability.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Carlisle Coatings & Waterproofing.
   2. Tremco Commercial Sealants & Waterproofing.

### 2.2 MANUFACTURED UNITS

A. Bentonite Composite Sheet Waterproofing:
   1. Sodium bentonite clay evenly distributed and bonded to composite geotextile fabric and HDPE film.
   2. Carlisle "CCW MiraCLAY GM".

B. Accessory Items:
   1. Flashing, sealant, termination bars, fasteners, and ancillary items as required by manufacturer for a complete, waterproof system.

C. Protection Board: Extruded Polystyrene.
   1. Thickness: Minimum 1/4 IN.
   2. Fan-fold, 4 FT by 50 FT.

### 2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Bentonite Composite Sheet Waterproofing:
   1. Bentonite mass/unit area: ASTM D5993, minimum 1 LB/SF.
   2. Swell index: ASTM D5890, minimum 24 ML.
   3. Tensile strength: ASTM D6768/D6768M, 30 LB/IN MARV.
   4. Permeability: ASTM D5887/D5887M, $5x10^{-11}$ M/SEC maximum.
   5. Elongation: ASTM D4632/D4632M, 150%.
      a. Measure at maximum peak in the weakest principle direction.
   6. Hydrostatic head pressure: ASTM D751, 228 FT.
   7. Adhesion to concrete: ASTM D903, 17.7 LB/IN.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Ensure that concrete has been cured in accordance with manufacturer's recommendations.

B. Remove free standing water, debris, and loose material.

C. Fill all voids, seal all penetrations, and remove all sharp fins and ridges.

D. Seal all penetrations in accordance with Specification Section 01 73 20.

E. Repair concrete surfaces in accordance with Specification Section 03 35 00.
   1. Fill voids and remove all sharp fins and ridges.

### 3.2 INSTALLATION

A. Install continuous waterproofing membrane to all below grade surfaces where indicated on Drawings.
   1. Terminate top of membrane within 4 IN of finished grade.
   2. Extend membrane over footings and seal to bottom edge of footing.

B. Install products in accordance with manufacturer's instructions.
   1. Provide granular bentonite cants at horizontal-to-vertical junctions.
   2. Overlap upper courses over lower courses with minimum 4 IN lap.
   3. Stagger seams minimum 12 IN.

4. Seal around all penetrations in accordance with manufacturer's recommendations.

C. Provide all waterstops, sealant, termination bars, fasteners and other accessories required for a watertight installation.

D. Avoid panel damage during pouring and vibrating of concrete for slab work and during backfilling operations for wall work.

E. Install protection board immediately prior to backfilling.
   1. Temporarily secure protection board using manufacturer's recommended tape or adhesive.
      a. Do not mechanically fasten or penetrate waterproofing in any way.

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer authorized representative shall inspect substrate for acceptability prior to application of waterproofing membrane.
   1. Provide written documentation of inspection, including identification of deficiencies and remedies provided.

B. Manufacturer authorized representative shall inspect completed installation prior to installation of protection board or backfilling.
   1. Perform flood testing of installed membrane to demonstrate water-tightness.

## 3.4 PROTECTION

A. Protect panels as required from pre-hydration caused by precipitation or other construction activities.

B. Protect system from physical damage until backfilling is completed.

C. Repair or replace damaged materials in accordance with manufacturer's recommendations as necessary to ensure a waterproof installation.

**END OF SECTION**

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# SECTION 07 19 00
## LIQUID WATER REPELLENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Liquid water repellent.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. E514, Standard Test Method for Water Penetration and Leakage through Masonry.

B. Mock-Ups:
   1. Product shall be applied to mock-up erected under Division 03.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Letter from manufacturer stating that product is suitable for intended use and is compatible with and will not cause discoloration of treated concrete surfaces.
   3. Field conducted water spray test results.

### 1.4 JOB SITE CONDITIONS

A. Material shall be stored at temperatures between 40 and 90 DEGF.

B. Do not apply Penetrating Water Repellent to frost filled surfaces.
   1. Both substrate and ambient temps shall be 45 DEGF and rising at time of application.

C. Do not apply Penetrating Water Repellent at temperatures above 90 DEGF.

D. Do not apply Penetrating Water Repellent if rain is expected within 12 HRS.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Liquid water repellent:
    a. Chemprobe by Tnemec, Inc.
    b. L&M by LATICRETE International, Inc.
    c. Master Builders Solutions by BASF.
    d. The Euclid Chemical Company.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Liquid Water Repellent (LWR-1):
1. Water Based, clear, penetrating water repellant designed for use on porous concrete surfaces.
    a. Ready to use, silane/siloxane blend.
    b. Reduction in Leakage ASTM E514:
        1) Mortar Block: >91 PCT.
    c. VOC: 50 G/L.

B. Euclid "CHEMSTOP WB HEAVY DUTY".

C. Liquid Water Repellent (LWR-2):
1. Water Based, clear, penetrating water repellant sealer designed for use on dense concrete surfaces.
    a. Ready to use, silane/siloxane blend.
    b. VOC: 50 G/L.

D. Euclid "CHEMSTOP WB REGULAR".

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect adjacent surfaces not intended to receive water repellent.

B. Clean surfaces to be covered in accordance with manufacturer's recommendations.
1. Surface shall be structurally sound, clean, dry, free of dust, dirt, paint, efflorescence, laitance and other contaminants that will prevent the proper penetration of penetrating water repellent.
2. A dry substrate is required for proper penetration of the sealer.
3. Prior to application, joints or cracks must be properly sealed.
4. If acid is used for cleaning, neutralize completely before application of penetrating water repellent.

C. Make all mortar repairs at least 72 HRS prior to application.

D. Allow masonry surfaces to cure minimum of 10 days prior to application.

E. Cure concrete surfaces in accordance with manufacturer's recommendations.
1. New concrete shall be a minimum 28 days old.
2. Concrete repairs shall be a minimum seven days old.

### 3.2 INSTALLATION AND APPLICATION

A. Install products in accordance with manufacturer's instructions.
1. At a minimum apply material in accordance with manufacturer's recommended application rates using procedures and equipment recommended by manufacturer.
2. Apply two coats of material.
    a. Second coat shall be applied “wet on wet” before the first coat dries
    b. Do not allow material to puddle on surface.
3. Using manufacturer's recommended application rates, apply as many coats of material as necessary to obtain results required by the FIELD QUALITY CONTROL Article.

B. Apply LWR-1 to exterior porous concrete surfaces.

C. Apply LWR-2 to exterior dense concrete and precast concrete surfaces and to exterior dense brick surfaces.

D. Apply liquid water repellent to interior surfaces where scheduled on Room Finish Schedule on Drawings.

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer or manufacturer's designated representative shall conduct a water spray test to an area of the mock-up wall specified in Specification Section 03 35 00 for a period of 5 HRS.
   1. Begin water spray test a minimum of seven days after application of water repellent sample.
   2. Water from the spray shall impact the wall at a 45 DEG angle to the vertical and shall cover an area of not less than 9 SQFT.
   3. Water flow shall be minimum 5 GPM at 60 PSI pressure.
   4. If, within 5 HRS, moisture appears on the inside face of the wall within the test area, the wall shall be recoated.

B. Retest as required.

C. Recoat as required until wall area remains dry within limits of testing procedure.

D. Results of this test shall be used to determine material quantity in excess of manufacturer's minimum recommended amounts to be applied per square foot to the building surface.

E. Protect adjacent materials not required to be coated.

**END OF SECTION**

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# SECTION 07 21 00
BUILDING INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Building insulation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 19 00 - Liquid Water Repellent.
   4. Section 07 21 31 / 33 - Sprayed Polyurethane Insulation.
   5. Section 07 41 13 - Insulated Metal Roofing.
   6. Section 07 42 14 - Preformed Factory- Insulated Metal Wall Panels.
   7. Section 07 54 19 - PVC Membrane Roofing - Fully Adhered.
   8. Section 07 92 00 - Joint Sealants.
   9. Section 09 29 00 - Gypsum Board.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      b. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      c. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
      d. D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
      e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      f. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   2. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations on sealants, tapes and mastics.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certification from insulation manufacturer stating that insulation proposed is acceptable for intended use per the Drawings.

### 1.4 SITE CONDITIONS

A. For purposes of this Specification Section, design frost line for this Project is 18 IN below grade.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid extruded polystyrene board insulation:
      a. Dow.
      b. DiversiFoam Products.
      c. Owens Corning.
   2. Mineral batt thermal insulation:
      a. Owens Corning.
      b. USG Corporation.
      c. CertainTeed.
   3. Sound control insulation:
      a. ROCKWOOL Group.
      b. Thermafiber by Owens Corning.
   4. Vapor retarder:
      a. Raven Industries, Inc.
      b. Reef Industries, Inc.
      c. Fortifiber Building Systems Group, Inc by Henry Company.
      d. Alumiseal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. Foam plastic insulation used in buildings and structures shall comply with the requirements of the building code.
      a. Surface burning characteristics: ASTM E84.
      b. Flame spread index: Maximum 75.
      c. Smoke developed: Maximum 450.

B. Sealant and Mastic (for setting polystyrene and/or polyisocyanurate insulation board): Manufacturer's recommended standard.

C. Mineral Batt Thermal Insulation:
   1. Glass or other inorganic fibers and resinous binders formed into flexible blankets or semi-rigid sheets.
   2. Unfaced:
      a. ASTM C665, Type 1.
   3. Minimum thickness as noted on Drawings.

D. Vapor Retarder:
   1. Fire rated, reinforced, 3 ply, Class 1 material.
   2. Perm rating: Not exceeding 0.035 grains/HR-FT$^2$-IN-Hg when determined in accordance with ASTM E96/E96M.
   3. Griffolyn "TX-1200FR."

E. Vapor Retarder Tape: As recommended by vapor retarder manufacturer.

F. Sound Control Insulation:
   1. Mineral wool batts.
      a. ASTM C665, Type I.
      b. UL listed when used in fire rated construction.

2. Formaldehyde free.
3. Density: Minimum 2.5 PCF.
4. Sound Reduction, ASTM C423.
   a. Minimum NRC for 3 IN thick material: 1.05.
5. Thickness: As noted on Drawings.
6. Thermafiber "SAFB".

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
   1. Insulate full thickness over surfaces to be insulated.
   2. Fit tightly around obstructions, fill voids.
   3. Cover all penetrations (electrical junction boxes, switch boxes, piping, conduits, etc.) with insulation, taking care not to compromise the workings of the device.
   4. Fit butted joints of batt or blanket insulations tightly together.
   5. Apply single or double layer to achieve total thickness.
      a. If double layer is provided, stagger all joints minimum 12 IN.
   6. Do not use broken or torn pieces of insulation.
   7. Install so that completed installation is vapor tight.
      a. Seal all joints.
      b. Seal to abutting materials to maintain vapor retarder integrity.
      c. Provide manufacturer's recommended vapor retarder tape for use with faced batt insulation or separate vapor retarder.
         1) If vapor retarder tape fails to adhere to any surface, apply sprayed-on adhesive as recommended by tape manufacturer to promote adhesion.
      d. Provide manufacturer's recommended solvent-free sealant compatible with insulation board for rigid board insulation.
         1) Tape is not acceptable for use with rigid board insulation.

C. Mineral Batt Insulation using Separate Vapor Retarder Sheet in Exterior Stud Wall Systems:
   1. Verify that all piping, conduit, electrical box and other in-wall work is complete prior to installing insulation and vapor retarder.
   2. Install insulation friction fit between studs.
   3. Tightly butt ends.
   4. Install vapor retarder to warm side of building exterior wall.
      a. Completely seal each wall area to surrounding construction.
   5. Install vapor retarder vertically.
      a. Use widest practical sheet.
      b. Install in continuous sheets, floor to structure above, without horizontal joints.
      c. Fold flaps of vapor retarder over studs.
      d. Tape flaps together continuously.
      e. Tape bottom and top edges to structure continuously.
      f. After installation of any additional conduit, boxes, piping or other items within wall system, repair all tears or penetrations of vapor retarder with vapor retarder tape prior to installation of gypsum board.

D. Rigid Insulation at Perimeter Below Grade and Under Slab:
   1. Install insulation below grade on outside face of foundation walls.
      a. Install in mastic with tight joints.
   2. Install insulation below grade on inside face of foundation walls.
      a. Install in mastic with tight joints.
      b. Install insulation horizontally under floor slabs.
         1) Extend minimum 24 IN from exterior foundation walls.

3. Where footings are located below the design frost line, extend insulation down to the design frost line.
    a. Where indicated on the Drawings, extend beyond the design frost line.
4. Where footings are located at the design frost line, extend insulation down to top of footing or as indicated on Drawings.
5. Protect insulation from damage and/or displacement during backfilling [and/or pouring of floor slab].

E. Sound Control Insulation:
1. Install friction fit between studs.
2. Do not obstruct ventilation spaces.
3. Fill all miscellaneous voids unless noted otherwise on Drawings.
4. After installation of conduit, boxes, piping or other items within wall system, reposition displaced insulation and fill all voids.

## 3.2 FIELD QUALITY CONTROL

A. Repair or replace damaged insulation and/or vapor retarder as directed by Engineer.

B. Provide minimum cover of 5/8 IN Type X gypsum board over foam insulation exposed to the building interior.

**END OF SECTION**

# SECTION 07 21 31
## SPRAYED POLYURETHANE FOAM (SPF) INSULATION - MEDIUM DENSITY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Sprayed Polyurethane Foam Insulation (SPF) in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Company specializing in manufacture of products specified in this section with minimum 10 years documented experience.
   2. Single-Source Responsibility:
      a. Obtain air/vapor barrier, flexible flashing and spray polyurethane foam building insulation materials from a single manufacturer regularly engaged in manufacturing the product.
      b. Provide products which comply with all federal, state and local regulations controlling use of volatile organic compounds (VOCs).

B. Applicator Qualifications:
   1. Certified to apply materials by material manufacturer.
   2. Certified Installer or Master Installer by Spray Polyurethane Foam Alliance (SPFA PCP Certification).
   3. Air Barrier Association of America (ABAA) certification.

C. References:
   1. AC377 Acceptance Criteria for Spray-Foam Plastic Insulation.
   2. ASTM C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   3. ASTM C1029 Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation
   4. ASTM D1622 Test Method for Apparent Density of Rigid Cellular Plastics
   5. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials
   6. ASTM E96 Test Methods for Water Vapor Transmission of Materials
   7. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials
   8. ASTM E 2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

D. Preinstallation Conference:
   1. See Section 01 31 19.

### 1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's product data sheets, installation details including components and accessories.
   2. Submit documentation from an approved independent testing laboratory certifying the air leakage rates of the air barrier membranes assembly, including primary membrane, primer, sealants and spray polyurethane foam building insulation have been tested to meet ASTM E 2357.

3. Submit documentation from manufacturer certifying compatibility of primary air/vapor barrier membrane and spray polyurethane foam building insulation, including transition sheets, flashings and sealants.
4. Submit two samples 6 inch x 6 inch minimum size of each air/vapor barrier material required for project.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Medium Density Sprayed Polyurethane Foam Insulation (SPF):
   1. Base:
      a. Icynene, Inc.
   2. Optional:
      a. BASF Master Builders Solutions
      b. Certainteed
      c. Demilec USA.
      d. Henry Company
      e. Johns Manville.
      f. NFCI Polyurethanes

B. Thermal Barrier Coating:
   1. Base:
      a. International Fireproof Technology, Inc.
   2. Optional:
      a. Covestro
      b. Flameseal
      c. No-Burn, Inc.

### 2.2 MATERIALS

A. Sprayed Polyurethane Foam (SPF) Insulation:
   1. Closed-cell polyurethane foam insulation: Type II
   2. Minimum density: 1.9 PSF
   3. Closed cell content: 90 PCT
   4. Thermal resistance, aged: R-6 per IN at 75 DEGF
   5. Maximum water vapor permeance: 1.0 Perm at 2 IN thickness
   6. 4 IN-thick sample:
      a. Flame spread: Less than 25
      b. Smoke developed: Less than 450
   7. Performance of installed thickness:
      a. Minimum installed thermal resistance: R-value =27.5.
      b. Maximum installed permeance: 1.0 Perm.
   8. Air leakage: Less than 0.0006 L/(s.m2) @ 75Pa, per ASTM E 2178
   9. Tested to ASTM E 2357 for the air barrier assembly
   10. Meet ICC AC377 standards
   11. Accreditation and current full system listing by ABAA as found on www.airbarrier.org.
   12. Base product: Proseal MD-C-200 by Icynene.

B. Thermal Coating:
   1. Required where insulation is not covered by gypsum or sheathing providing a minimum 15 minute protection.
   2. Thermal Coating tested to prevent ignition and approved by manufacturer for use with insulation.
   3. Installer is responsible for determining thermal coating requirements at each location.
   4. Intumescent, UL listed or ICC tested for use with SPF.
   5. Base product: DC 315 by International Fireproof Technology, Inc.

6. Minimum fire and heat protection of 15 minutes with an interface temperature not exceeding 250 DEGF.
7. Minimum bond to foam: 500 PSI.
8. Utilize Bonding Agent if required to attain specified bond properties.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify acceptability of substrate.

B. If required, clean or treat substrate for adhesion.

C. Installation of material constitutes acceptance of substrate.

D. Mask and protect adjacent surfaces from overspray or damage.

### 3.2 INSTALLATION

A. Comply with manufacturer's written instructions applicable to products and applications indicated.

B. Extend insulation to envelop entire area to be insulated.
   1. Fill tightly around obstructions and voids.
   2. Remove projections that interfere with placement.

C. Final thickness of foam insulation must be within minus 1/16 IN, plus 1/2 IN of required thickness.

D. Perform one thickness test per 100 square feet.

E. Comply with manufacturer's written instructions applicable to products and applications indicated.

F. Apply insulation to uniform monolithic density without voids.

G. Apply at voids between the ends of metal wall panels and roof panels, behind flashing and cover plates, and all other voids at building envelop.

H. Apply insulation to fill voids around doors and windows.

I. Apply insulation to fill voids around accessible service and equipment penetrations

J. Apply insulation to seal voids at truss ends.

K. Seal plumbing stacks, electrical wiring and other penetrations through surfaces to control air leakage.

L. Apply insulation to fill voids around bathtubs to point of accessibility

M. Building is designed to meet specific air-tightness standards of Energy Star Program. Apply insulation as recommended by manufacturer to provide airtight construction.

### 3.3 CLEANING

A. Remove masking and overspray from installed materials not scheduled for application.

B. Clean floor surfaces of set material resulting from trimming.

C. Protect installed materials from damage due to harmful weather exposures, physical abuse, and other causes.

D. Repair damaged areas.

## END OF SECTION

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# SECTION 07 21 33
## SPRAYED POLYURETHANE FOAM INSULATION - LIGHT DENSITY

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Sprayed Polyurethane Foam Insulation (SPF) in accordance with provisions of Contract Documents. Light Density Foam may be used in lieu of Medium Density Foam only where space allows for added thickness to attain required R-Value noted in 07 21 31.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Company specializing in manufacture of products specified in this section with minimum 10 years documented experience.

B. Applicator Qualifications:
   1. Certified by manufacturer for installation of products required on project.
   2. Air Barrier Association of America (ABAA) certification.

C. ASTM International (ASTM):
   1. ASTM C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   2. ASTM D1622 Test Method for Apparent Density of Rigid Cellular Plastics.
   3. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials.
   4. ASTM E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
   5. ASTM E96 Test Methods for Water Vapor Transmission Rate of Building Materials.

### 1.3 SUBMITTALS

A. Product Data:
   1. Manufacturers' product data sheets, insulation properties, surface burning characteristics, including components and accessories.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Light Density Sprayed Polyurethane Foam Insulation (SPF):
   1. Base:
      a. Icynene, Inc.
   2. Optional:
      a. Covestro
      b. Demilec USA.
      c. Johns Manville.
      d. NFCI Polyurethanes.

B. Thermal Barrier Coating:
   1. Base:
      a. Icynene, Inc.
   2. Optional:
      a. No-Burn, Inc.
      b. Covestro

C. Vapor Retarder (VR):
   1. Base:
      a. Griffolyn, Reef Industries.
   2. Optional:
      a. Lamtec.

D. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 MATERIALS

A. Sprayed Polyurethane Foam (SPF) Insulation:
   1. Open-cell polyurethane foam insulation.
   2. Minimum density: 0.50 PSF.
   3. Thermal resistance, aged: R-3.4 per IN at 75 DEGF.
   4. Water vapor permeance: 10 Perms at 5 IN.
   5. Hydrophobic: less 10% water absorption rate
   6. 4 IN-thick sample:
      a. Flame spread: Less than 25.
      b. Smoke developed: Less than 450.

B. Thermal Barrier:
   1. Intumescent, UL listed for use with SPF.
   2. Base product: DC 315 by Icynene.

C. Vapor Retarder (VR):
   1. Three plies of low density polyethylene, bonded with two layers of scrim reinforcing.
   2. Fire retardant type: Flame Spread 5/ Smoke developed 90 per ASTM E84.
   3. Permeance: Not exceeding 0.015 Perm 0.86 ng/Pa*s*m2.
   4. Puncture Strength: 54 LBS 240 N.
   5. Base Product: Type 90 FR by Griffolyn.
   6. Optional Product: R-3035HD by Lamtec.
   7. Seaming Tape:
      a. Self-adhering, asphaltic mastic
      b. Base Product: Fab Tape by Griffolyn.
      c. Optional Product: 491 FSK by American Biltrite, Inc.
   8. Repair Tape, for punctures and other damaged areas:
      a. Base Product: Griff Tape by Griffolyn.
      b. Optional Products: Same products listed for optional seaming tapes.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify existing conditions before starting work.

B. Verify substrate is free of foreign material that impedes application.

C. Installation of material constitutes acceptance of substrate.

D. Mask and protect adjacent surfaces from overspray or damage.

### 3.2 INSTALLATION

A. Comply with manufacturer's written instructions applicable to products and applications indicated.

B. Apply insulation to uniform monolithic density without voids.

C. Apply at voids between the ends of metal wall panels and roof panels, behind flashing and cover plates, and all other voids at building envelop.

D. Apply to minimum cured thickness of 6.5 IN +/- 1/2 IN

E. Apply insulation to fill voids around doors and windows.

F. Apply insulation to fill voids around accessible service and equipment penetrations .

G. Apply insulation to seal voids at truss ends.

H. Seal plumbing stacks, electrical wiring and other penetrations through surfaces to control air leakage.

I. Apply insulation to fill voids around bathtubs to point of accessibility. .

J. Building is designed to meet specific air-tightness standards of Energy Star Program. Apply insulation as recommended by manufacturer to provide airtight construction.

## 3.3 CLEANING AND REPAIRS

A. Remove masking and overspray from installed materials not scheduled for application.

B. Clean floor surfaces of set material resulting from trimming.

C. Protect installed materials from damage due to harmful weather exposures, physical abuse, and other causes.

D. Repair damaged areas.

**END OF SECTION**

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# SECTION 07 26 00
## UNDER SLAB VAPOR RETARDER

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Under slab vapor retarder.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.2R, Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
   2. ASTM International (ASTM):
      a. E1643, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
      b. E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Product data sheet on vapor retarder sheet and vapor retarder tape.
      c. All accessories proposed for use.
      d. Manufacturer's installation instructions.
   3. Fabrication and/or layout drawings.
   4. Certifications.
   5. Test reports.

B. Samples:
   1. Provide two, 6 IN x 6 IN samples of vapor retarder material taped together using the vapor retarder tape proposed.
   2. Provide two samples of all accessories proposed for use.

C. Informational Submittals: Manufacturer's recommendation on vapor retarder tape.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vapor retarder:
      a. Fortifiber Building Systems Group, Inc. by Henry Company.
      b. Layfield Group, Ltd.
      c. Raven Industries, Inc.
      d. Reef Industries, Inc.

e. Stego Industries, LLC.
f. W.R. Meadows, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 PERFORMANCE REQUIREMENTS

A. Vapor Retarder:
1. ASTM E1745, Class A.
2. Thickness: Minimum 15 MIL.
3. Water vapor permeance: 0.02 maximum.

### 2.3 ACCESSORIES

A. Pipe Boots: Manufacturer's standard boot fabricated to maintain the integrity of the vapor retarder system.

B. Vapor Retarder Tape: As recommended by vapor retarder manufacturers.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Base material over which vapor retarder is to be installed shall be level, compacted and free of debris, foreign objects or other deleterious materials.

B. Surfaces at perimeter and penetrations of vapor barrier shall be clean, smooth and free of sharp objects, fins or projections.

### 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions, ASTM E1643 and ACI 302.2R.

B. Provide vapor retarder where indicated on the Drawings.
1. Place continuous vapor retarder above granular fill subgrade material, unless noted otherwise.

C. Lap minimum 6 IN and seal in accordance with ASTM E1643 and manufacturer's recommendations.

D. Extend to extremities of area and seal to adjacent elements.

E. Seal all penetrations: Provide pipe boot for all pipes or conduit penetrating the floor slab.

### 3.3 FIELD QUALITY CONTROL

A. Ensure proper precautions are implemented to prevent damage to installed vapor retarder membrane prior to and during pouring of concrete floor slab.

B. Inspect vapor retarder immediately prior to placement of concrete.
1. Patch all punctures, tears, holes, etc.
a. Patch small punctures with vapor retarder tape as allowed by ASTM E1643 and manufacturer's recommendations.
b. Repair larger damage with additional layer of vapor retarder.
1) Lap repairs minimum 6 IN beyond extent of damage in all directions.
2) Seal perimeter of patch with vapor retarder tape or as recommended by manufacturer.

## END OF SECTION

# SECTION 07 41 13
## INSULATED METAL ROOF PANELS

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. Foamed-insulation-core standing seam metal roof panels, with related metal trim and accessories.

### 1.2 RELATED REQUIREMENTS

A. Division 05 Section "Structural Steel Framing" for steel framing supporting metal panels.

B. Division 05 Section "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal panels.

C. Division 07 Section "Preformed Factory Insulated Metal Wall Panels" for factory-formed metal wall, roof, and soffit panels.

D. Division 07 Section "Flashing and Sheet Metal" for sheet metal copings, flashings, reglets and roof drainage items in addition to items specified in this Section.

E. Division 07 Section "Joint Sealants" for field-appliedJoint Sealants.

F. Division 13 Section "Metal Building Systems" for steel framing supporting metal panels.

### 1.3 REFERENCES

A. American Society of Civil Engineers (ASCE): www.asce.org/codes-standards:
   1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International (ASTM): www.astm.org:
   1. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM A 755 - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   3. ASTM A 792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   4. ASTM A 924 – General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   5. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
   6. ASTM D 1621 – Compressive Properties of Rigid Cellular Plastics.
   7. ASTM D 1622 – Apparent Density of Rigid Cellular Plastics.
   8. ASTM D 6226 - Standard Test Method for Open Cell Content of Rigid Cellular Plastics
   9. ASTM C 518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   10. ASTM D 2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
   11. ASTM D 4214 - Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
   12. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
   13. ASTM E 84 - Test Methods for Surface Burning Characteristics of Building Materials.
   14. ASTM E 1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

15. ASTM E 1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
16. ASTM E 1680 - Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.
17. ASTM E 1980 - Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

C. Cool Roof Rating Council (CRRC): www.coolroofs.org/productratingprogram.html:
   1. CRRC-1-2016 – CRRC Product Rating Program.

D. FM Global (FM): www.fmglobal.com:
   1. ANSI/FM 4471 - Approval Standard for Class 1 Panel Roofs.
   2. ANSI/FM 4880 - American National Standard for Evaluating Insulated Wall and Roof/Ceiling Assemblies.

E. Canadian Standards Association (CSA)
   1. CAN/ULC S102 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
   2. CAN/ULC S107 – Method of fire test of roof coverings.
   3. CAN/ULC S126 – Fire spread under roof-deck assemblies.

F. Green Seal (GS) www.greenseal.org
   1. GS-11 – Green Seal Standard for Paints and Coatings, Edition 3.2, October 26, 2015.
   2. US Green Building Council (USGBC): www.usgbc.org:

G. Leadership in Energy and Environmental Design (LEED) Green Building Rating System

## 1.4 QUALITY ASSURANCE

A. Manufacturer/Source: Provide metal panel assemblies and accessories from a single manufacturer approved under an accredited third-party quality control program

B. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum ten years' experience in the manufacturing of similar products and successful use in similar applications.
   1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
      a. Product data, including certified independent test data indicating compliance with requirements.
      b. Samples of each component.
      c. Sample submittal from similar project.
      d. Project references: Minimum of five installations not less than five years old, with Owner and Architect contact information.
      e. Sample warranty.
      f. Certificate from an accredited third-party Quality Control Program.

C. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements

D. Approved manufacturers must meet separate requirements of Submittals Article.

E. Installer Qualifications: Experienced Installer with minimum of five years' experience with successfully completed projects of a similar nature and scope.
   1. Installer's Field Supervisor: Experienced mechanic certified by metal panel manufacturer supervising work on site whenever work is underway.

F. Buy American Compliance: Materials provided under work of this Section shall comply with the following requirements:
   1. Buy American Act of 1933 BAA-41 U.S.C §§ 10a – 10d.

2. Buy American provisions of Section 1605 of the American Recovery and Reinvestment Act of 2009 (ARRA).

## 1.5 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Prior to erection of framing, conduct preinstallation meeting at site attended by Owner, Architect, metal panel installer, metal panel manufacturer's technical representative, inspection agency, and related trade contractors.
   1. Coordinate building framing in relation to metal panel system.
   2. Coordinate openings and penetrations of metal panel system.
   3. Coordinate work of Division 07 Sections "Roof Specialties" and "Roof Accessories" and openings and penetrations and manufacturer's accessories with installation of metal panels.

## 1.6 ACTION SUBMITTALS

A. Product Data: Manufacturer's data sheets for specified products.

B. Shop Drawings: Show layouts of metal panels. Include details of each condition of installation, panel profiles, and attachment to building. Provide details at a minimum scale 1-1/2-inch per foot of edge conditions, joints, fastener and sealant placement, flashings, openings, penetrations, curbs, vents, snow guards, lightning arresting equipment, and special details. Make distinctions between factory and field assembled work.
   1. Include data indicating compliance with performance requirements.
   2. Indicate points of supporting structure that must coordinate with metal panel system installation.
   3. Include structural data indicating compliance with performance requirements and requirements of local authorities having jurisdiction.

C. Samples for Initial Selection: For each exposed product specified including sealants. Provide representative color charts of manufacturer's full range of colors.

D. Samples for Verification:
   1. Provide 12-inch- (305 mm-) long section of each metal panel profile.
   2. Provide color chip verifying color selection.

## 1.7 INFORMATIONAL SUBMITTALS

A. Product Test Results: Indicating compliance of products with requirements.

B. Qualification Information: For Installer firm and Installer's field supervisor.

C. Accreditation Certificate: Indicating that manufacturer is accredited under an accredited third-party quality control program, including IAS AC472 and based upon chapter 17 of the International Building Code (IBC).

D. Buy American Certification: Manufacturers' letters of compliance acceptable to authorities having jurisdiction, indicating that products comply with requirements.

E. Florida State Building Code Compliance: Indicating that products comply with requirements of Florida State Building Code. www.floridabuilding.org/pr/pr_app_srch.aspx

F. Warranty:
   1. Submit manufacturer's written two (2) year limited warranty providing panels to be free from defects in materials and workmanship, beginning from the date of substantial completion excluding coil coatings (paint finishes) that are covered under a separate warranty.
   2. The installation contractor shall issue a separate warranty against defects in installed materials and workmanship, beginning from the date of substantial completion of the installation.

### 1.8 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Manufacturer's Warranty: Executed copy of manufacturer's warranty.

### 1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect products of metal panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components, or other damage. Protect panels and trim bundles during shipping. Protect painted surfaces with a protective covering before shipping.
   1. Deliver, unload, store, and erect metal panels and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.
   2. Store in accordance with Manufacturer's written instructions. Provide wood collars for stacking and handling in the field.
   3. Shield foam insulated metal panels from direct sunlight until installation.

### 1.10 WARRANTY

A. Special Manufacturer's Warranty: Submit Manufacturer's two (2) year limited warranty providing panels to be free from defects in materials and workmanship, beginning from the date of substantial completion excluding coil coatings (paint finishes) that are covered under a separate warranty.

B. The installation contractor shall issue a separate warranty against defects in installed materials and workmanship, beginning from the date of substantial completion of the installation.

C. Special Panel Finish Warranty: Submit Manufacturer's limited warranty on the exterior paint finish for adhesion to the metal substrate and limited warranty on the exterior paint finish for chalk and fade.
   1.
   2. Fluoropolymer Two-Coat System:
      a. Color fading in excess of 5 for copper, silver metallic and bright red; Hunter units per ASTM D 2244.
      b. Chalking in excess of 6 for copper, silver metallic and bright red or 8 rating per ASTM D 4214.
      c. Failure of adhesion, peeling, checking, or cracking.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

A. Basis of Design Manufacturer: Metl-Span, a Nucor company; Lewisville, Texas Tel: 972.221.6656; Email: info@metlspan.com; Web: metlspan.com
   1. Provide basis of design product , or comparable product approved by Architect prior to bid.

### 2.2 PERFORMANCE REQUIREMENTS

A. General: Provide metal panel system meeting performance requirements as determined by application of specified tests by a qualified testing facility on manufacturer's standard assemblies.

B. Structural Performance: Provide metal panel assemblies capable of withstanding the effects of indicated loads and stresses within limits and under conditions indicated, as determined by ASTM E 72 or ASTM E 1592 applied in accordance with ICC AC 04, Section 4, Panel Load Test Option or Section 5, Panel Analysis Option:
   1. Wind Loads: Determine loads based on uniform pressure, importance factor, exposure category, and basic wind speed indicated on drawings.
      a. Roof Panel Wind Uplift Testing: Certify capacity of metal panels by testing of proposed assembly per ASTM E 72 or ASTM E 1592.

2. Roof Panel Snow Loads: 25 lbf/sq. ft. (1197 Pa).
3. Deflection Limits: Withstand inward and outward wind-load design pressures in accordance with applicable building code with maximum deflection of 1/180 of the span with no evidence of failure.

C. Roof Panels FM Approvals Listing: Comply with FM Approvals 4471 as part of a panel roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 construction.
1. Fire/Windstorm Classification: Class 1A-90
2. Hail Resistance Rating: SH.

D. Fire Performance Characteristics: Provide metal panel systems with the following fire-test characteristics determined by indicated test standard as applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.
1. Surface-Burning Characteristics: Provide metal panel systems with the following characteristics when tested per ASTM E 84. The core shall have:
   a. Flame spread index: 25 or less.
   b. Smoke developed index: 450 or less.
2. Fire Performance of Insulated Roof: Class 1 roof and wall panel per ANSI/FM 4880.

E. Roof Panel Air Infiltration, ASTM E 1680: Maximum 0.023 cfm/sq. ft. (0.115 L/s per sq. m) at static-air-pressure difference of 12 lbf/sq. ft. (575 Pa).

F. Roof Panel Water Penetration Static Pressure, ASTM E 1646: No uncontrolled water penetration at a static pressure of 20 lbf/sq. ft. (958 Pa).

G. Test procedure for susceptibility to leakage of discontinuous roof systems protocol TAS 114: Water applied to a depth of 6" above the lowest section of roof profile. No water infiltration observed during the seven-day test period.

H. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction. Allow for deflection and design for thermal stresses caused by temperature differences from one side of the panel to the other.

I. Thermal Performance: When tested in accordance with ASTM C 518, Measurement of Steady State thermal Transmission, the panels shall provide a k factor of 0.114 btu/sf/hr/deg F at a 35° F (1.67° C) mean temperature.

## 2.3 INSULATED METAL ROOF PANELS

A. Standing Seam, Foamed-Insulation-Core Metal Roof Panels: Structural metal panels consisting of an exterior standing seam with an interior tongue and groove joint, coupled with a vapor seal in the standing seam, and provides superior resistance to air and moisture intrusion. Attached with concealed fasteners to the structure.
1. Basis of Design: Metl-Span, CFR Insulated Metal Panel.
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, Coating Class AZ55 (Grade 340, Coating Class AZM165) unpainted Galvalume Plus coating.
3. Exterior Face Sheet: 22 gauge coated thickness, with striated surface.
   a. Finish: Fluoropolymer two-coat system.
      1) Color: As indicated or as selected by Architect from manufacturer's premium colors.
4. Interior Face Sheet: 26 gauge coated thickness, with stucco embossed surface Mesa profile.
      1) Finish: Modified silicone-polyester two-coat system.
      2) Color: White.
5. Endlaps: Provide panels with factory endlaps, notching, swedging and backer plates; where panel lengths permit.
6. Low Eave Treatment: Provide cutback for trim/gutter installation; where panel lengths permit.

7. Panel Width: as shown on drawings.
8. Panel Thickness: as shown on drawings.
9. Insulating Core: Polyurethane with zero ozone depletion potential blowing agent
   a. Closed Cell Content: 90% or more as determined by ASTM D 6226
   b. Compressive Strength: As required to meet structural performance requirements and with a minimum of 22 psi as determined by ASTM D 1621
   c. Shear Strength: As required to meet structural performance requirements and with a minimum of 36 psi as determined by ASTM C 273
   d. Tensile Strength: As required to meet structural performance requirements and with a minimum of 41 psi ASTM D 1623
   e. Minimum Density: 2.0 pcf (32 kg/m3) as determined by ASTM D 1622
   f. Thermal Resistance (R-Value): 35 deg. F * hr * sq. ft./Btu (K * sq. m/W) as determined by ASTM C 518 at 35 degrees Fahrenheit mean temperature.
10. Heat Transfer Coefficient (U-factor): 0.033 Btu/hr * sq. ft. * deg. F insert corresponding value (W/K * sq. m) as determined by ASTM C 1363 at 35 degrees Fahrenheit mean temperature. Tested specimen must include at least two engaged side joints.

## 2.4 METAL ROOF PANEL ACCESSORIES

A. General: Provide complete metal panel assemblies incorporating trim, copings, fasciae, gutters and downspouts, and miscellaneous flashings. Provide required fasteners, closure strips, and sealants as indicated in manufacturer's written instructions.

B. Flashing and Trim: Match material, thickness, and finish of metal panel face sheet.

C. Panel Fasteners: Self-tapping screws and other acceptable fasteners recommended by metal panel manufacturer. Provide corrosion-resistant fasteners with heads matching color of metal panels by means of factory-applied coating, with weathertight resilient washers.

D. Joint Sealers: Provide Tape Mastic Sealants and Concealed Joint Sealants per Section 07 92 00, "Joint Sealants".

E. Roof Accessories: Approved by metal panel manufacturer. Refer to mechanical and skylight sections for requirements for curbs, equipment supports, roof hatches, heat and smoke vents, ventilators, and preformed flashing sleeves.

F. Snow Guards: Compatible with standing seam roof and approved by metal panel manufacturer.

G. Roof Curbs: Compatible with standing seam roof and approved by metal panel manufacture.

## 2.5 FABRICATION

A. General: Provide factory fabricated and finished metal panels, trim, and accessories meeting performance requirements, indicated profiles, and structural requirements.

B. Fabricate metal panel joints configured to accept sealant tape providing weathertight seal and preventing metal-to-metal contact and minimizing noise resulting from thermal movement.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions, approved shop drawings, and project drawings.

## 2.6 FINISHES

A. Finishes, General: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. Exterior Face Sheet Coil-Coated Finish System
   1. Silicone-Polyester Two-Coat System: 0.20 – 0.25 mil primer with 0.7 – 0.8 mil color coat.
      a. Basis of Design: Metl-Span, Silicone Polyester.

2. Fluoropolymer Two-Coat System: 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat.
   a. Basis of Design: Metl-Span, Fluoropolymer.

C. Interior Face Sheet Coil-Coated Finish System:
1. Polyester Two-Coat System: 0.20 – 0.25 mil primer with 0.7 – 0.8 mil color coat
   a. Basis of Design: Metl-Span, Igloo White

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine metal panel system substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal panels.
1. Inspect framing that will support insulated metal panels to determine if support components are installed as indicated on approved shop drawings and are within tolerances acceptable to metal panel manufacturer and installer. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal panels.
2. Panel Support Tolerances: Confirm that metal panel supports are within tolerances acceptable to metal panel manufacturer but not greater than the following:
   a. 1/4 inch (6 mm) in 20 foot (6100 mm) in any direction.
   b. 3/8 inch (9 mm) over any single roof plane.
   c. At Purlin Spacing 7 feet (2133 mm) or less: 1/8 inches (3 mm), out only.

B. Correct out-of-tolerance work and other deficient conditions prior to proceeding with insulated metal panel installation.

### 3.2 METAL PANEL INSTALLATION

A. Standing Seamed, Concealed-Fastener Insulated Metal Panels: Install metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal panels in orientation, sizes, and locations indicated. Anchor panels and other components securely in place. Provide for thermal and structural movement.

B. Attach panels to metal framing using clips, fasteners, and sealants recommended for application by metal panel manufacturer.
1. Fasten metal panels to supports with fasteners at each location indicated on approved shop drawings, at spacing and with fasteners recommended by manufacturer.
2. Cut panels in field where required using manufacturer's recommended methods.
3. Provide weatherproof jacks for pipe and conduit penetrating metal panels.
4. Dissimilar Materials: Where elements of metal panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by metal panel manufacturer.

C. Attach panel flashing trim pieces to supports using recommended fasteners and joint sealers.

D. Joint Sealers: Install tape sealers and liquid sealants where indicated and where required for weatherproof performance of metal panel assemblies.
1. Seal panel side and perimeter joints using joint sealers indicated in manufacturer's instructions.
2. Seal roof panel joints utilizing tape sealer and vapor seal bead of non-curing butyl.
3. Prepare joints and apply sealants per requirements of Division 07 Section "Joint Sealants."

### 3.3 ACCESSORY INSTALLATION

A. General: Install metal panel accessories with positive anchorage to building and weathertight mounting; provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel assembly, including trim, copings, flashings, sealants, closure strips, and similar items.
2. Comply with details of assemblies utilized to establish compliance with performance requirements and manufacturer's written installation instructions.
3. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently weather resistant.

## 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage an independent testing and inspecting agency acceptable to Architect to perform field tests and inspections and to prepare test reports.

## 3.5 CLEANING AND PROTECTION

A. Remove temporary protective films immediately in accordance with metal panel manufacturer's instructions. Clean finished surfaces as recommended by metal panel manufacturer.

B. Replace damaged panels and accessories that cannot be repaired to the satisfaction of the Architect.

**END OF SECTION**

# SECTION 07 42 14
## PREFORMED FACTORY-INSULATED METAL WALL PANELS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Preformed factory-insulated metal wall panels.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 12 00 - Structural Steel.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections.
      b. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   2. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads for Buildings and Other Structures.
   3. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C1363, Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
      c. E72, Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
      d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      e. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
      f. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   4. FM Global (FM):
      a. FM Approval Guide, Building Insulations, Walls, Insulated Cores.
   5. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
      b. Building Materials Directory.
      c. Fire Resistance Directory.

B. Qualifications:
   1. Installer shall be licensed or approved in writing by manufacturer.
   2. Installer shall have minimum of 10 years experience in the installation of metal wall panel systems similar to system specified.
   3. Installer shall have successfully completed two projects of similar size, scope and complexity within past three years.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

B. PVDF: Polyvinylidene fluoride.

## 1.4 SYSTEM DESCRIPTION

A. Factory-insulated metal wall panel system consisting of exterior flat panel, foamed-in-place insulation, and interior panel.
   1. System shall have internal gutter system designed to direct condensation to the exterior of the building through weep holes.
   2. Provide fire-rated wall systems where indicated on the Drawings.

## 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Drawings, prepared by manufacturer, showing anchorage, flashing, jointing and any special detailing different from or not indicated on the Drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's complete installation and erection instructions and details showing all accessories required.

B. Samples:
   1. For initial color selection, provide 2 IN x 3 IN metal samples for each color offered by manufacturer for Engineer's color selection.
   2. After initial color selection, provide 16 x 16 IN sample of each wall system incorporating all components required for complete system in color(s) selected.
      a. Step construction of sample to allow view of all components.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Installer qualifications and listing of projects completed in past three years.
   3. Letter of acceptance of Installer from manufacturer.
   4. Instructions on proper cleaning methods and materials for Owner reference.
   5. Warranty.
   6. Product data on insulation used.
   7. Certification of UL listing.
   8. Certification of FM approval.

## 1.6 WARRANTY

A. Provide listed manufacturer's standard 20 year warranty on panel finish against fading, chipping, cracking and peeling.

B. Provide manufacturer's watertight warranty, signed by manufacturer.
   1. Installer's watertight warranty in lieu of manufacturer's warranty is not acceptable.
   2. Warranty walls to remain water and airtight for minimum of 10 years.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURER

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Factory-insulated metal wall panels:
      a. CENTRIA.
      b. MBCI.
      c. Metl-Span.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Panel Facing:
   1. General:
      a. Steel, ASTM A653, Grade A with minimum yield of 33,000 PSI.
         1) Galvanized, G90 coating.

B. Insulation (Core):
   1. Foamed-in-place rigid expanded polyisocyanurate foam or urethane modified isocyanurate foam.
   2. Minimum 95 PCT closed cell structure.
   3. Density: Minimum 3.0 PCF.

C. Perimeter Trim Pieces, Flashing and Fasteners:
   1. Extruded aluminum or stainless steel.

D. Subgirts and Miscellaneous Supports:
   1. Steel, galvanized, G90 coating.

E. Fasteners: 300 Series stainless steel.

F. Intermediate Support Items:
   1. Steel, galvanized, G90 coating.
   2. Minimum 18 GA.
   3. Panel manufacturer shall design subgirt system for loading conditions specified.

G. Sealant: Manufacturer's standard.

### 2.3 FABRICATION

A. General:
   1. Fabricate to shapes indicated on Drawings.
      a. Provide custom fabricated trim pieces as required.
   2. Completely fabricate in factory and label all items for installation in the field.
   3. System shall be designed for wind loading in accordance with ASCE 7 and the building code.

B. Panels:
   1. Thickness: Nominal 2 IN.
   2. Thermal performance: The panel shall have a minimum U-value of 0.072 BTU/HR/FT$^2$/DEGF when tested in accordance with ASTM C1363.
   3. Exterior skin:
      a. Profile: Centria Formawall Dimension Series 3 IN.
      b. Gage: Minimum 22 GA.
   4. Interior skin:
      a. Gage: Minimum 24 GA.
   5. Tongue and groove ship lap side joint design with fasteners concealed within side joint.
      a. Concealed design shall fully capture both face and liner sheets.
      b. Interior joints factory caulked.

c. Provide panels with air barrier configuration and seals.

6. Finish: PVDF based with minimum 70 PCT resin.
   a. Two-coat system with minimum 0.2 MIL urethane primer and 0.8 MIL colored PVDF top coat.
   b. Meet or exceed requirements of AAMA 2605.
   c. Smooth finish.
   d. Color: 181 Slate Gray field panels with Natural Patina accent panels where indicated on drawings.
7. Fire-rated panels: 1 HR rated per UL Fire Resistance Directory.

### 2.4 SOURCE QUALITY CONTROL

A. Performance Testing:
   1. Structural tests: Structural designs shall have been derived from witnessed tests per ASTM E72 "Chamber Method" using a 20 PSF wind load.
      a. A deflection limit of L/180 shall apply to positive load only.
   2. Air infiltration: When tested per ASTM E283 under static a pressure of 1.56 PSF, air infiltration shall not exceed 0.06 CFM per square foot of wall area.
   3. Air Barrier: Allowable leakage 0.25 CFM per square foot of wall area, maximum leakage 25 total cfm (per 100 SQFT of test area).
   4. Water infiltration: When tested per ASTM E331 at a static pressure of 6.24 PSF, there shall be no uncontrolled water penetration through the panel or joints.
   5. Condensation: Minimum condensation resistance factor (CRF) of 85 when tested in accordance with AAMA 1503.
   6. Fire-rated panels:
      a. ASTM E84.
         1) Flamespread: 10 maximum.
         2) Smoke developed: 110-145 maximum.
      b. UL 723 listed.
      c. FM Class 1 rated.

### 2.5 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Provide Owner with following extra materials:
      a. One gallon of touch-up paint for each color and each different finish specified.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine alignment of structural steel and/or panel support system prior to installation and do not proceed until any defects are corrected.

### 3.2 ERECTION AND INSTALLATION

A. Provide all closures, trim, angles, plates, sealant, gaskets, fasteners, washers, etc., as required for a complete water and air tight infiltration.
   1. Provide all closures, trim, angles, plates, sealant, gaskets, fasteners, washers, etc., as required for air barrier installation.

B. Install products in accordance with manufacturer's instructions.

C. Remove all strippable coating and provide a dry wipe-down cleaning of the panels as they are erected.

D. Provide prefinished fasteners to match finish of panels where fasteners must be exposed.

E. Touch up all damaged surfaces with paint supplied by panel manufacturer.

F. Seal all joints using sealant recommended by panel manufacturer for water- and air-tight installation.

G. Wall panel manufacturers shall be responsible for designing and installing necessary expansion joints in wall panel system.

**END OF SECTION**

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# SECTION 07 54 19
## PVC MEMBRANE ROOFING - FULLY ADHERED

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Roof insulation.
   2. Membrane roofing, cover board, and base flashings.
   3. Vapor retarder.
   4. Insulated curbs for roof penetrations of ductwork or piping.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 06 10 00 - Rough Carpentry.
   2. Section 07 62 00 - Flashing and Sheet Metal.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 40 05 07 - Pipe Support Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C642, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.
      c. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
      d. D395, Standard Test Methods for Rubber Property - Compression Set.
      e. D573, Standard Test Method for Rubber - Deterioration in an Air Oven.
      f. D638, Standard Test Method for Tensile Properties of Plastics.
      g. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
      h. D4434, Standard Specification for Poly (Vinyl Chloride) Sheet Roofing.
      i. D5147, Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
      j. D6294, Standard Test Method for Corrosion Resistance of Ferrous Metal Fastener Assemblies Used in Roofing and Waterproofing.
      k. E96, Standard Test Methods for Water Vapor Transmission of Materials.
   2. FM Global (FM):
      a. Approval Standard 4470, Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.
      b. 4470, Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.
   3. Underwriters Laboratories, Inc. (UL):
      a. 790, Standard for Standard Test Methods for Fire Tests of Roof Coverings.

B. Qualifications:
   1. Manufacturer shall have a minimum of 10 years continuous recent experience in the manufacture of membrane roofing systems similar to system specified.
      a. Manufacturer to have similar systems in place that meet or exceed warranty length as specified.
   2. Applicator factory trained and approved in writing by roofing manufacturer.
   3. Applicator shall have a minimum of 10 years of experience installing membrane roofing systems similar to system specified.

a. Minimum of five years of the 10 years of experience shall have been spent installing roof systems manufactured by company proposed for use.
b. Applicator shall have minimum of five years installation experience using heat welded seaming equipment and testing of heat welded seams for seam integrity.

4. Manufacturer's Technical Field Representative shall have minimum 10 years of experience in field installation and applicator training and approval process.

## 1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

## 1.4 SYSTEM DESCRIPTION

A. Fully adhered mechanically fastened single-ply roofing system over concrete deck, including but not limited to:
1. Vapor retarder.
2. Roof insulation.
3. Cover board.
4. Single-ply reinforced PVC membrane.
5. Flashings, expansion joints, penetrations and/or other materials necessary for a complete installation.
6. Walkway protection.

## 1.5 SUBMITTALS

A. Shop Drawings:
1. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
2. Fabrication and/or layout drawings:
a. Computer generated, scaled outline of roof areas for all buildings showing:
1) Slopes and tapered roof insulation layout.
a) Provide tapered insulation Shop Drawing illustrating installation patterns and dimensions for each tapered module.
2) Walkway protection layout.
3) Edge details.
4) Penetrations and details.
a) Identify each penetration.
5) Mechanical fastener locations.
6) Any special conditions.
7) Seam locations.
b. Minimum plan scale: 1/8 IN = 1 FT.
c. Minimum detail scale: 1-1/2 IN = 1 FT.
d. Manufacturer's complete installation drawings, including details.
e. If manufacturer's standard detail drawings are used as part of the Submittal information, the standard details shall be enhanced to show the actual project conditions of the substrate including insulation, cover board, vapor retarder, decking material, wall construction, parapet construction and height and coping condition.

B. Maintenance Information:

C. Informational Submittals:
1. Certifications prior to installation:
a. Certification of manufacturer's qualifications.
b. Certification of applicator's qualifications and letter from manufacturer acknowledging applicator as a factory trained and manufacturer's approved applicator with the

minimum number of years experience installing products specified per this Specification Section.

c. Certification of manufacturer's Technical Field Representative qualifications.
d. Letter from roofing manufacturer and insulation manufacturer stating that roof insulation being used is compatible with roofing system and will perform properly for intended use.
e. Letter from adhesive manufacturer and insulation manufacturer stating that adhesive being used is compatible with all products and will perform properly for intended use.
f. Copy of report identifying the location(s) of all seam failures and repairs made to that seam per the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
g. Copy of punch list generated by manufacturer's technical field representative during final inspection of roofing, flashing and welded seams.
h. Copy of Pre-Installation Conference meeting minutes.

2. Certifications for final close-out:
   a. Written report prepared by manufacturer's Technical Field Representative stating that roof has been inspected for deficiencies, a listing of all deficiencies and corrections that have been made, and roofing system has been properly installed and is warrantable for period required by this Specification Section.
   b. Final Warranty documents signed by manufacturer's authorized representative.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

B. Store membrane rolls lying down on pallets and fully protected from the weather with clean canvas tarpaulins.
   1. Unvented polyethylene tarpaulins are not acceptable.

C. Store adhesives at temperatures recommended by manufacturer.

D. Replace all materials that become damaged during storage prior to installation.
   1. Remove damaged material from the Site.

E. Protect insulation from direct exposure to sunlight.

### 1.7 WARRANTY

A. Manufacturer's 10 year system warranty.
   1. Warranty to cover roofing membrane, insulation, and roofing manufacturer provided accessories.
   2. Warranty to cover manufacturer's authorized applicator workmanship applied to the roof membrane identified in the preceding paragraph.
   3. Warranty period to commence on date of Owner's acceptance of the building.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. PVC roofing membrane:
      a. Sika Sarnafil, Inc.
      b. I.B. Systems.
   2. Insulation:
      a. Sika Sarnafil, Inc.
      b. Atlas Building Products.
      c. Hunter Panels.

d. I.B. Systems.

3. Vapor retarder:
   a. Sika Sarnafil, Inc.
   b. I.B. Systems.
4. Other materials:
   a. Manufacturers as noted.

## 2.2 DESIGN CRITERIA

A. Roof Assembly:
   1. Fire resistance: UL 790, Class A.
   2. Hail and wind uplift resistance: FM Approval Standard 4470, Class 1-120 minimum.

## 2.3 SYSTEM COMPONENTS

A. Membrane:
   1. Reinforced PVC (polyvinyl chloride) sheet with lacquer coating.
      a. Meet requirements of ASTM D4434, Type II, Grade 1.
      b. Thickness:
         1) 0.072 IN.
         2) Sheet width to be determined by manufacturer.
         3) Provide widest sheet possible.
         4) ASTM ± tolerance for membrane thickness is not acceptable.
            a) Provide certification of specified mil thickness.
      c. Color:
         1) White.
         2) Reflectivity: 0.83.
         3) Emissivity: 0.92.
         4) Solar reflective index (SRI): Greater than 104.
   2. Physical properties:
      a. Tensile strength, minimum psi: ASTM D638, 1600.
      b. Elongation at break, minimum: ASTM D638, 270% machine by 250% transverse.
      c. Seam strength, minimum (percent of tensile strength): ASTM D638, 80.

B. Insulation:
   1. Rigid, HCFC free, isocyanurate foam insulation boards with approved faces for adhered membrane application.
      a. Size:
         1) 4 FT x 4 FT with 2 IN thick base layer at roof drain locations and scupper openings unless noted otherwise on the Drawings.
      b. Total thickness as required to meet R-19.
      c. ASTM C1289, Class 1, Type II, faced rigid cellular polyisocyanurate.
      d. Density: 2 PCF.
      e. Compressive strength: 25 PSI.
      f. Board edges: Square.
      g. Thermal value: R value (long term thermal resistance) minimum 6.2.
      h. Moisture vapor transmission: Less than 1.0 perm.
      i. Tapered insulation: Same material as base layer of insulation tapered to provide 1/4 IN per foot of slope.

C. Vapor Retarder:
   1. Self-adhered multi-ply reinforced sheet.
      a. SBS modified bitumen with high-density polyethylene grid laminated between two layers of polyethylene film.
      b. Thickness: 32 MIL minimum.
      c. Water vapor permeance: ASTM E96, maximum 0.10 perms.
      d. Breaking strength, MD/XD: ASTM D5147, 64/88 LB/IN.

D. Cover Board:
   1. Thickness:
      a. 1/4 IN.
      b. Size: 4 x 4 FT or 4 x 8 FT.
   2. Non-structural glass mat faced, water resistant, non-combustible silicone treated gypsum core panel approved for use as a substrate under fully adhered PVC roofing membranes.
      a. Top surface shall be pre-primed to enhance adhesion.
   3. Georgia Pacific Corp. "Dens-Deck Prime" Or equal.

E. Adhesives:
   1. Proper type as required for substrate and service being adhered.
   2. Only solvent base adhesives are acceptable.
   3. Provide primers as required for all adhesives.

F. Vent Pipe Flashing, Sealants, Prefabricated Inside and Outside Flashing Corners, Termination Bars and Batten Strips:
   1. Provide manufacturer's standard premolded, prefabricated PVC product that best suits the condition encountered.
   2. Provide aluminum termination bars.
      a. Size: 2-1/4 IN deep by 0.10 IN thick extruded bar with predrilled holes at 8 IN OC.
   3. Batten strips:
      a. Minimum 14 GA channel shaped steel bar, galvanized, ASTM A653.
      b. Fastener holes predrilled prior to galvanizing process.

G. Miscellaneous Fasteners and Anchors: Provide all miscellaneous fasteners and anchors as required for a free draining, water and air tight roofing system.

H. Wood Blocking and Nailers: See Specification Section 06 10 00.

I. Fasteners:
   1. Ferrous components:
      a. Test in accordance with ASTM D6294.
      b. Meet or exceed FM 4470.
   2. Provide stainless steel for all exposed fasteners.

## 2.4 ACCESSORIES

A. Sheet metal fabrications, including but not limited to coping, scuppers and downspouts and counterflashing.
   1. See Specification Section 07 62 00.

B. Walkway Protection:
   1. Weldable, polyester reinforced PVC membrane.
      a. Minimum thickness: 96 MILS.
      b. Color: Light gray.
   2. Minimum 39 IN wide.
   3. Embossed surface.

C. Pipe, Duct and Conduit and Cable Tray Supports:
   1. 100% recycled rubber.
      a. Density: ASTM C642, minimum 0.50 OZ/CUIN.
      b. Compressive deformation:
         1) ASTM D395.
         2) 5% at 70 PSI and 72 DEGF.
      c. Brittleness at low temperature: ASTM D746, -50 DEGF.
      d. Weathering: ASTM D573, 70 HRS at 120 DEGF.
   2. Uniform load capacity: 500 LB per lineal FT.
   3. Size:
      a. Width: 6 IN.

b. Length and height as necessary for item being supported.
4. Compatible with modular framing.
5. Provide modular framing, pipe supports, pipe clamps or other accessories as necessary for items being supported.
   a. See Specification Section 40 05 07 and Specification Section 26 05 00 as applicable.
6. Similar to Cooper B-Line "DURA-BLOK."

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Pre-Installation Conference:
   1. The applicator, roofing manufacturer's Technical Installation Representative, Owner's Representative, Engineers Site Representative(s), Architect and Attend a pre-installation conference.
   2. The meeting shall discuss all aspects of the Project including but not limited to:
      a. Safety.
      b. Setup.
      c. Schedule.
      d. Material storage and handling.
      e. Replacement of unacceptable materials prior to and during installation and disposal of unacceptable materials.

B. Applicator to verify that area to be roofed is free of ice/snow, water, dirt, incompatible materials, sharp objects, and miscellaneous debris that may damage the membrane or the vapor retarder.

## 3.2 INSTALLATION

A. Install all materials in accordance with manufacturer's written instructions.

B. Manufacturer's installation procedures take precedence over this Specification Section.

C. Provide wood nailers and blocking as necessary for a complete installation.

D. Vapor Retarder:
   1. Install over metal decking or concrete decking as applicable using adhesive recommended by the manufacturer.
   2. Cut around roof penetrations and seal vapor tight.
   3. Extend vapor retarder up face of parapet wall to top of roof insulation.
   4. Lap side joints minimum 4 IN, lap end joints minimum of 6 IN and seal all laps with adhesive then tape raw edge of lap.
   5. Repair all damage, tears, holes, and nicks in accordance with vapor retarder manufacturer's recommendations.
      a. Verify compatibility of adhesive with vapor retarder patching method and materials.
   6. Do not piece vapor retarder together using scraps.

E. Installation of Insulation:
   1. Cut insulation neatly to fit around all roof penetrations, projections, and changes in thickness of concrete topping.
   2. Before installation is started, remove trash, debris, grease, oil, water, moisture and contaminants from substrate to receive insulation.
      a. Prepare all surfaces according to applicable Specification Sections.
   3. Bottom layer of insulation shall be installed with all joints tightly butted and end joints staggered 12 IN minimum.
      a. Additional layers shall be installed over preceding layers with all joints tightly butted and end joints staggered 12 IN minimum.
   4. Attach insulation using adhesive in accordance with manufacturer's recommendations for uplift rating specified.
   5. Provide tapered insulation where shown on the Drawings or where required.

6. Provide crickets behind all roof penetrations larger than 12 IN.
7. Do not install boards that have been damaged and/or broken into pieces unless the area to be insulated requires a smaller piece.
    a. Trim damaged boards prior to use to provide straight edges and square corners.

F. Provide roofing manufacturer's recommended sleeper at all duct support structures, condensing units or similar equipment.
1. Fasten sleeper to deck as necessary to resist uplift.
2. Flash sleeper to roof membrane as recommended by roofing manufacturer.

G. Installation of Cover Board:
1. Lay cover board over top of insulation tightly butted and cut to fit around all penetrations.
    a. Stagger end joints 12 IN minimum.
2. Attach cover board using adhesive in accordance with manufacturer's recommendations for uplift rating required.
3. Seal around all penetrations with sealant acceptable to insulation and roof membrane manufacturer.
4. Do not install boards that have been broken into pieces smaller than 4 FT x 4 FT unless the area to be covered requires a smaller piece.
    a. Trim damaged boards prior to use to provide straight edges and square corners.

H. Installation of Roofing:
1. Install roof membrane and flashing using adhesives recommended by roofing manufacturer.
2. Extend roofing to face of parapet wall and secure.
3. Extend flashing up parapet wall and terminate in recessed reglet.
    a. Install flashing up parapet wall over top of wood blocking on top of parapet wall and down opposite face to bottom of wood blocking unless noted otherwise.
    b. Provide in one piece with no horizontal joints.
    c. Extend flashing onto roof surface as required by manufacturer.
4. Install flashing at all vertical surfaces, roof interruptions and penetrations.
    a. Flash all roof penetrations in accordance with roofing manufacturer's standard details unless indicated otherwise on the Drawings.
5. Heat weld and test all seams the same day they are laid.
6. Install walkway protection where indicated.
    a. Heat weld into place.
    b. Use only full width pieces of walkway protection cut to fit.
        1) Torn or otherwise damaged sections of walkway protection will not be accepted.
    c. Provide breaks in walkway protection to avoid ponding of water on sloped portions of roofing.

## 3.3 FIELD QUALITY CONTROL

A. Provide for manufacturer's Technical Field Representative time during Pre-Installation Conference, job start-up, and every two weeks, with a minimum of two site visits during roofing application.
1. Manufacturer's Technical Field Representative shall inspect all roofing, flashing, and spot test welded seams at completion, generate punch list and provide copy of punch list to Engineer.
2. Include all applicable costs.

B. Protect installed insulation from water using water cut-offs in bad weather and at end of work period.

C. Remove and replace wet and/or damaged insulation and cover board.

D. On-site quality reviews of all welded seams shall be performed by Applicator prior to stopping work each day:
1. Provide subsequent report identifying the location(s) of all seam failures and repairs made to that seam.

a. Manufacturer's guidelines shall be followed and all protocol shall be maintained if a seam fails the quality review.

**END OF SECTION**

# SECTION 07 61 13
METAL ROOFING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Standing seam metal roofing.
   2. Standing seam fascia system.
   3. Soffit panels.
   4. Snow retention system.
   5. Sheet metal work required for roofing.
   .

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 06 10 00 - Rough Carpentry.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
   2. ASTM International (ASTM):
      a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. A792/A792M, Standard Specification for Steel Sheet, 55 PCT Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
      c. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. C209, Standard Test Methods for Cellulosic Fiber Insulating Board.
      e. D4833/D4833M, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
      f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      g. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
      h. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
      i. E1646, Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
      j. E1680, Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
      k. E1745, Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
      l. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Architectural Sheet Metal Manual.
   4. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.
      c. 580, Standard for Tests for Uplift Resistance of Roof Assemblies.
      d. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
      e. 790, Standard Test Methods for Fire Tests of Roof Coverings.

f. 1256, Standard for Fire Test of Roof Deck Constructions.

B. Qualifications:
1. Manufacturer shall have minimum of 10 years of experience in the production of structural standing seam metal roofing.
a. All structural components of the roof system shall be designed and sealed by registered professional structural engineer licensed in the State of Oregon.
2. Installing contractor shall be licensed or approved in writing by manufacturer.
3. Contractor and installer shall have minimum of seven years of experience in the installation of structural standing seam metal roof systems similar to system specified.
4. Contractor and installer shall have successfully completed two projects of similar size, scope and complexity within past two years.
5. All roll forming performed on-site shall be supervised by personnel trained and employed by the roofing manufacturer.
a. Roofing manufacturer shall have been engaged in field roll forming for a minimum of 15 years with experience in roll forming long panels similar to panels being used.

C. Mock-Ups:
1. Prior to start of permanent roof construction construct mock-ups of roofing system.
a. Mock-ups shall be of sufficient size to properly display all components required by the roofing system.
b. Mock-ups shall be a minimum 5 FT x 5 FT in size.
c. Provide multiple mock-ups as required.
2. Mock-ups shall incorporate all components, specified and/or required but not specified, needed for a complete water and airtight roofing fascia, and soffit system.
a. Components include, but are not limited to:
1) Vapor retarder, thermal barrier sheathing, roof insulation, ice dam membrane.
2) Roofing panels, including mounting system and seaming.
3) All fascia and soffit conditions.
4) All flashing and counterflashing conditions, including:
a) Eave, rake, hip and ridge conditions.
b) Roof/vertical wall intersections.
c) Roof penetrations.
d) All reglet conditions.
5) All miscellaneous clips, angles, plates, brackets, closures and sealants.
6) Gutter and downspouts.
7) Snow retention system.
3. Panels shall be same panels as specified or approved for Project.
a. Exact color is not necessary; however, Contractor is to label each exposed component to identify final installed color of component.
4. Step construction to allow observation of all components.
5. Construct additional mock-ups or rework existing mock-ups until acceptable to Engineer.
6. Maintain mock-ups at project site until Engineer approves removal of mock-ups.
7. Approved mock-ups to constitute minimum acceptable standard of quality for actual construction.

D. Completed roof system to be inspected by roof manufacturer's authorized factory trained representative prior to issuance of roof warranty.

## 1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Steep Slope: Having a pitch of 3:12 or greater.

C. Low Slope: Having a pitch less than 3:12 but greater than 1/4:12.

D. PVDF: Polyvinylidene fluoride.

## 1.4 SYSTEM DESCRIPTION

A. Prefinished, field-insulated, structural standing seam metal roof system, including but not limited to:
   1. Thermal barrier sheathing.
   2. Ice dam membrane.
   3. Vapor retarder.
   4. Roof insulation.
   5. Structural standing seam metal roof panels.
      a. Roof panel support and attachment system to be determined by standing seam roof manufacturer.

B. All flashing and miscellaneous trim required for a complete water and airtight system, including but not limited to:
   1. Reglets.
   2. Flashing.
   3. Counterflashing.
   4. Sealants.

C. Standing seam fascia system.

D. Prefinished gutters and downspouts.

E. Prefinished aluminum soffit panels.

F. Snow retention system.

## 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Manufacturer prepared computer generated Drawings showing anchorage, flashing, jointing and all other accessories required and all special detailing required by the system.
         1) Minimum plan scale: 1 IN = 8 FT.
         2) Minimum detail scale: 1-1/2 IN = 1 FT.
      b. Provide complete erection plan for each building structure with all details and sections referenced, all penetrations shown, expansion joints shown, detailed and referenced, and all special conditions identified, referenced and detailed.
      c. Erection plan to identify limits of each different substrate material (decking).
      d. Provide distinction between factory and field assembled work.
   3. Product technical data including:
      a. Manufacturer data sheets on each component, including masonry reglets used in the roof system.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
         1) Certification by manufacturer that roofing assembly being supplied has been successfully tested under UL 580 procedures and has achieved a Class 90 rating.
   4. Test results:
      a. UL 580, Class 90 test data.
      b. ASTM E1592 test results.
         1) Provide results of tests conducted in accordance with ASTM E1592 for panel size and gage and clip type and spacing similar to panels and clips being used.
      c. ASTM E1646 and ASTM E1680 test results.
      d. Concentrated load test data.

1) Load test to be conducted on panel size, gage and with clip spacing as required.

5. Qualifications:
   a. Manufacturer: Provide structural engineer qualifications.
   b. Contractor:
      1) Certification of approval or license to install product from manufacturer.
      2) Certification of experience.
      3) Listing of projects completed in the past two years with similar scope.
      4) Completed projects information to include, square footage of roofing installed, dollar value of roofing installed, manufacturer and type of roofing installed and contact name and telephone number of building Owner.
   c. Installer: Provide qualifications of all personnel expected to be working on the Project.
6. Roofing manufacturer's letter of approval for insulation proposed for use.
7. Warranty: Sample language of manufacturer's warranty to be provided on this Project.
8. Structural Engineer's sealed and signed calculations certifying that system structural components meet the requirements for lateral, upward and downward loads specified.

B. Samples:
   1. General: Tag, identify and provide statement regarding use for all fasteners, anchor clips, closures and sealants.
   2. Roof panel:
      a. Two samples, full width, 24 IN long.
      b. Provide color selected or specified when possible.
   3. Fasteners.
   4. Anchor clips.
   5. Closures, (both metal and non-metallic).
   6. Masonry reglet.
   7. Factory and field applied sealants.
   8. Color samples:
      a. For initial preliminary color selection, provide manufacturer's color chart showing all colors available.
      b. For final color selection, provide two 2 IN x 3 IN colored metal samples, for each color selected during the initial color selection.
   9. Snow retention system completely assembled on minimum of two roof panels.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Final warranty.

## 1.6 WARRANTY

A. Provide 20 year complete system warranty, including material material substrate for air and weather tightness of entire roof assembly signed by manufacturer.
   1. Warranty limits shall meet the minimum load capacity requirements of ASTM E1592.

B. Provide manufacturer's 20 year warranty on panel finish against fading, chipping, cracking and peeling of the panel exterior finish and/or erosion of substrate metal.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide a system with similar profile, standing seam height, spacing, construction and factory applied finish.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Metal roofing and standing seam fascia:
      a. CENTRIA by NCI Building Systems.
      b. Merchant & Evans, Inc. - ZIP-RIB.
      c. IMETCO.
      d. Other manufacturers capable of providing structural standing seam system and profiles similar to that specified will be considered.
   2. PVDF resin:
      a. PPG IdeaScapes - DURANAR.
      b. Valspar - Fluropon.
      c. Arkema - Kynar 500.
      d. Solvay - Hylar 5000.
      e. Solvay - Hylar 5000.
   3. Snow retention system:
      a. S-5! Attachment Solutions by Metal Roof Innovations, Ltd.
   4. Soffit panels: Provided by metal roofing panel manufacturer.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Roof and Fascia Panels:
   1. General:
      a. Galvalume steel, ASTM A792/A792M, Class SS, Grade 50B.
         1) Painted surfaces: AZ50.

B. Fascia Metal: 22 GA to match roof material, finish and color.

C. Perimeter Trim, Panel Closures, Flashing and Counterflashing: Material and factory applied finish to match roof panels.

D. Fasteners: 300 series stainless steel, ASTM F593.

E. Intermediate Support System:
   1. Galvanized steel: ASTM A653/A653M, Class SS, Grade 50, G90.

F. Sealant: Manufacturer's standard non-curing butyl.

G. 05 23.

### 2.3 ACCESSORIES

A. Roof Penetration Flashing:
   1. Round penetrations:
      a. Premolded EPDM boot with metal collar.
      b. Buildex "DEK-TITE."

B. Snow Retention System:
   1. Mechanical non-penetrating system for sloped metal roof systems to prevent ice and snow from sliding off roof.
      a. Provide splice fittings for a continuous installation.
   2. Snow retention system shall consist of aluminum extrusion secured to the standing seam with non-penetrating stainless steel set screws having rounded points.

3. Aluminum:
    a. Finish: Manufacturer's standard finish.
    b. Extrusion to have receptacle in face to provide for insertion of prefinished sheet metal strip to match roofing color.
4. Snow/Ice clips:
    a. Aluminum or stainless steel.
    b. Provide with rubber foot on end that sits on the metal roof pan.
5. Metal Roof Innovations, Ltd. S-5! "ColorGard" system.

## 2.4 FABRICATION

A. General:
1. Fabricate with square, true corners, mitered and welded.
2. Fabricate trim, flashings and closure pieces to match panel profile and finish.
3. Hem all edges.
4. Fabricate panels in full length with no end laps.

B. Standing Seam Metal Roof Panels:
1. Profile: Centria "SRS" System.
2. Height of standing seam: 2 IN.
3. Gage: Minimum 24.
4. Width:
    a. 16 IN.
    b. Longitudinal stiffening elements to minimize oil canning.
5. System shall be designed as a true structural standing seam shape.
6. Finish:
    a. PVDF based with minimum 70 PCT resin.
    b. Three-coat system having minimum 0.8 MIL epoxy primer coat on both sides of panel with a 0.8 MIL PVDF resin color coat and a 0.8 MIL PVDF resin clear top coat on the exterior side of the panel.
    c. Meet or exceed requirements of AAMA 621.
    d. Smooth finish.
    e. Color:
        1) To be selected from manufacturers full range of primary and secondary colors.
            a) Does not include exotic, metallic flake or iridescent colors.
7. Concealed fasteners:
    a. Provide concealed fasteners in all locations.
    b. If exposed fasteners are required by the roof panel manufacturer, because of location, constructability issues or other critical design requirement, finish of fastener shall match roof panel finish.
        1) Exposed fasteners are to be approved by Engineer.
    c. The use of deflection limiter devices is not allowed.

C. Intermediate Support System:
1. Roof panel anchor clips:
    a. Manufacturer's standard one-piece clip suitable for condition.
        1) Two-piece clips are acceptable if required by roofing manufacturer.
    b. Minimum 16 GA steel.
        1) Galvanized, ASTM A653/A653M, G90.
2. Roof panel manufacturer shall be responsible for designing and providing all necessary intermediate "Z" or "hat-shaped" or other miscellaneous support members as required to transfer roof panel loads into building roof framing members.
    a. Design in accordance with building code and loads specified.
3. Bearing plates:
    a. Sized by roofing manufacturer for roof loading indicated.
    b. Minimum 16 GA steel.
        1) Galvanized, ASTM A653/A653M, G90.

## 2.5 SOURCE QUALITY CONTROL

A. Roof assembly to be Class A roof covering assembly per UL 1256.

B. Structural Testing:
   1. The system shall be designed to safely resist the positive and negative loads per the building code and as shown on Drawings.
   2. Structural-uniform uplift load capacity of the panel system shall be determined in accordance with ASTM E1592.
      a. The factor of safety on the test results shall be 1.65 for the panel, batten or clip ultimate loads with no increase for wind.
      b. The factor of safety for fasteners shall be 3.0 for one single fastener per clip, 2.25 for two fasteners per clip and 4.0 IN masonry.
      c. Design uplift capacity for conditions of gage, span or loading other than those tested may be determined by interpolation of test results.
         1) Extrapolation of conditions outside the range of the tests is not acceptable.
      d. Deflection shall be L/180 for positive loading.

C. Water Penetration: No uncontrollable leakage at minimum 9.2 PSF when tested in accordance with ASTM E1646.

D. Fire Resistance/Wind Uplift Rating:
   1. UL 790, Class 1.
   2. UL 580, Class 90.
   3. FM 4471, 1-120.

E. The panels shall withstand a 250 LB concentrated load applied to a 4 SQIN area at the center of the panel at mid span between supports with no panel deformation, rib buckling, or panel sidelap separation which will adversely affect the weather tightness of the system.

F. Support roofing panels on top of roof insulation using bearing plates attached to the structural frame or connect to manufacturer-provided intermediate support system.
   1. Bearing plate and standing seam roof panel anchor clip attachment is to be determined by the roofing manufacturer and shall take precedent over this Specification.
      a. Provide attachment to roof structural frame or deck as required for loading criteria specified.
   2. Roof panel anchor clips shall be designed to allow thermal movement of the panels except where specific fixed points are indicated.
      a. Roof panel manufacturer shall be responsible for determining fixed point locations unless otherwise indicated.
   3. Wood blocking shown at roof edge is strictly for attachment of miscellaneous flashings and shall not be used for any structural value.
   4. Maximum spacing of roof clips shall be determined by manufacturer.

G. Roof panel manufacturer shall be responsible for designing and installing all necessary expansion joints in the roof system.
   1. Where roof expansion joints occur, provide corresponding expansion joints in fascia, soffit and gutters.

## 2.6 MAINTENANCE MATERIALS

A. Provide Owner with 4 OZ of touch-up paint to match each different color used in the system.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions, SMACNA (where referenced) and details shown on Drawings for a complete weathertight installation without waves, warps buckles or distortions.
    a. Provide all closures, trim, angles, plates, sealant, gaskets, fasteners, washers, etc., as necessary.
2. Attachments shall allow for thermal expansion and contraction.
3. Seal all joints as required for watertight installation.
4. Touch-up paint all damaged surfaces.

B. Standing Seam Roofing Panels:
1. Install in one continuous length from ridge to eave.
2. Hand crimp battens at each clip.
3. Seam panels and battens together with portable electric seaming machine supplied by the manufacturer.

C. Soffit Panels:
1. Exposed fasteners to be painted to match soffit finish.

D. Snow Retention System:
1. Install starting 2 FT from the eave edge of the roof.
2. Install system in continuous lengths using manufacturer provided splice fittings.
3. Mount to metal roofing utilizing clamps fastened to standing seam with non-penetrating bullet-nosed set-screws.
    a. Fasteners shall be compatible with roof panel system and shall not void any roof warranties.
    b. Fasteners shall not damage panel finish.
4. Install metal color strip in face of extrusion.
    a. Color strip to match color of standing seam roofing.
5. Provide snow/ice clips in each standing seam panel laterally across the roof or as recommended by manufacturer.
    a. Provide single clip for seam spacing of less than 16 IN and two clips for seam spacing 16 IN and greater.

**END OF SECTION**

# SECTION 07 62 00
## FLASHING AND SHEET METAL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Architectural flashing and sheet metal work.
   2. Factory formed fascia and coping system(s).
   3. Prefinished scuppers, conductor heads and downspouts.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 54 19 - PVC Membrane Roofing - Full Adhered.
   4. Section 07 61 13 - Metal Roofing.
   5. Section 07 41 13 – Insulated Metal Roof Panels
   6. Section 07 72 33 - Roof Hatches.
   7. Section 07 92 00 - Joint Sealants.
   8. Section 09 96 00 - High Performance Industrial Coatings.
   9. Section 13 34 19 - Metal Building Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American Architectural Manufacturers Association (AAMA):
      a. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   3. American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI):
      a. ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roof Systems.
   4. ASTM International (ASTM):
      a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
      b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      c. A792/A792M, Standard Specification for Steel Sheet 55 PCT Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
      d. B32, Standard Specification for Solder Metal.
      e. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   5. FM Global (FM).
   6. National Roofing Contractors Association (NRCA).
   7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Architectural Sheet Metal Manual.

B. Qualifications:
   1. Sheet metal fabricator shall have minimum 10 years experience in fabrication of sheet metal items similar to items specified.
   2. Sheet metal installer shall have minimum five years experience installing sheet metal items specified.

### 1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. PVDF: Polyvinylidene fluoride.

### 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Fabrication and/or layout drawings.
   a. Scaled drawing showing expansion joint locations, special conditions, profile, fastening and jointing details.
      1) Minimum plan scale: 1/8 IN = 1 FT.
      2) Minimum detail scale: 1-1/2 IN = 1 FT.
4. Fabricator qualifications.
5. Installer qualifications.

B. Samples:
1. Finish and color samples for each product specified for Architect's preliminary color selection.
2. For final color selection, provide two, 2 IN x 3 IN colored metal samples for each color selected during the preliminary color selection.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Warranty: Manufacturer's sample warranty language.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pre-finished sheet metal:
   a. Carlisle SynTec Systems.
   b. Firestone Building Products Company.
   c. Petersen Aluminum Corporation.
2. Factory-formed fascia system.
   a. OMG Roofing Products.
   b. Metal Era.
3. Factory-formed coping system.
   a. OMG Roofing Products.
   b. Metal Era.
4. Butyl sealant:
   a. Pecora Corporation.
   b. Sika.
   c. Tremco Commercial Sealants & Waterproofing.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Sheet Metal:

1. Aluminum: ASTM B209.
2. Galvanized Steel: ASTM A653/A653M.
3. Galvalume Steel: ASTM A792/A792M.
4. Stainless Steel: ASTM A666.
    a. Type 316L.

B. Fasteners: Non-ferrous compatible with sheet metal.

C. Sealants:
1. Non-curing Butyl Sealant:
    a. Pecora "BA-98".
    b. Sika "SikaLastomer 511".
    c. Tremco "TremPro JS-773".
2. Building sealants:
    a. See Specification Section 07 92 00.

D. Fasteners: Non-ferrous compatible with sheet metal.

E. Retainer Clips and Continuous Cleats: Galvanized steel or stainless steel.

F. Solder: ASTM B32.

G. Dissimilar Metal Protection: Comply with Specification Section 09 96 00.

H. Reglets: See Specification Section 04 05 23.

## 2.3 MANUFACTURED ITEMS

A. Factory Formed Fascia Systems:
1. Formed fascia cover snap locked to extruded aluminum anchor bar.
2. ANSI/SPRI ES-1 tested.
3. FM Approved.
4. Fascia cover:
    a. Aluminum.
        1) Thickness: 0.050 IN.
    b. Galvanized steel,ASTM A653/A653M, G-60.
        1) Thickness: 22 GA.
5. Factory fabricated accessories, including but not limited to:
    a. Corners, end caps, end terminations.
    b. Scuppers and spill-outs.
    c. All accessories to be factory mitered and welded.
6. Profile:
    a. Metal-Era "Anchor-Tite Extended Fascia".
    b. Height: IN.

B. Factory Formed Coping System:
1. Formed coping piece which locks to anchor plate fastened to top of wall.
2. ANSI/SPRI ES-1 tested.
3. FM approved.
4. Coping cover:
    a. Aluminum.
        1) Thickness: As indicated on manufacturer's shop drawings.
    b. Galvanized steel, G-60.
        1) Thickness: 20 GA.
5. Anchor plate: Galvanized steel, minimum 20 GA.
6. Splice plates: Aluminum, minimum 0.032 IN.
    a. Continuous, minimum 6 IN long.
    b. Front and back legs with extruded butyl seal.
    c. Finish: Match coping.
7. Factory fabricated accessories, including but not limited to:

a. Corners, end caps, end terminations.
b. All steel accessories to be factory mitered and welded.

8. Profile:
   a. Metal-Era "Perma-Tite Tapered."
   b. Front leg: 6 IN.
   c. Back leg: 5 IN.

C. Finish:
1. PVDF coating with minimum 70 PCT resin content.
   a. Meet requirements of AAMA 2605.
      1) Color:T.B.D.
2. Architectural Class 1 coating per AA DAF 45.
   a. Anodized, AA-M12C22A41 clear.
   b. Anodized, AA-M12C22A42 dark bronze.

## 2.4 FABRICATED ITEMS

A. General:
1. Shop fabricate items to maximum extent possible.
   a. Fabricate true and sharp to profiles and sizes indicated on Drawings.
      1) Shop fabricate and weld or solder all corners.
2. Pre-finished aluminum:
   a. Thickness: Minimum 0.050 IN.
   b. Texture: Smooth.
   c. Coated on exposed face with PVDF coating having a minimum 70 PCT resin content and a minimum 1.0 MIL dry film thickness.
      1) Meet requirements of AAMA 2605.
      2) Color: Match coping and fascia.
3. Anodized aluminum:
   a. Thickness: Minimum 0.050 IN.
   b. Texture: Smooth.
   c. Architectural Class 1 coating per AA DAF 45.
      1) Anodized, AA-M12C22A41 clear.
      2) Anodized, AA-M12C22A42 [light bronze]color chosen by Architect.
4. Pre-finished steel:
   a. Galvanized, G-60 or Galvalume, AZ-55.
   b. Thickness: Minimum 22 GA.
   c. Texture: Smooth.
   d. Coated on exposed face with PVDF coating having a minimum 70 PCT resin content and a minimum 1.0 MIL dry film thickness.
      1) Meet requirements of AAMA 2605.
      2) Color: From Manufacturer's available premium colors.
5. Stainless steel:
   a. Thickness: Minimum 0.050 IN.
   b. Texture: Smooth.
   c. ASTM A480/A480M, No. 4 finish.

B. Scupper and Conductor Head:
1. Roofing manufacturer's recommended through-wall scupper design.
   a. Size and location(s) as shown on Drawings.
2. Conductor head profile per SMACNA Figure 1-25F.
   a. Provide 1 IN x 4 IN overflow opening with drip edge on front face of conductor.
3. 4 IN long outlet tube.
   a. Size and shape to match downspout.
4. Debris screen:
   a. Installed in top of conductor head.
   b. 1/4 x 1/4 IN aluminum mesh screen.

c. Screen shall be removable without damage to screen or conductor head.

C. Retainer Clips and Continuous Cleats:
   1. 0.050 IN stainless steel.

D. Downspouts:
   1. Rectangular open-face style similar to SMACNA Figure 1-32C.
      a. Horizontal cross brace at 5 FT maximum spacing.
   2. Fabricated in longest practical lengths.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Provide items to be built into other construction to Contractor in time to allow their installation.

### 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions, SMACNA, and as indicated on Drawings.

B. Weld aluminum to achieve weathertight joints and required details.
   1. Do not weld slip joints.
   2. Touch-up damaged prefinished items.

C. Solder steel to achieve weathertight joints and required details.
   1. Do not solder slip joints.
   2. Touch-up damaged prefinished items.

D. Set top edges of membrane flashing and sheet metal flashing into reglets wherever practicable.
   1. Surface applied terminations will be allowed only where specifically detailed or otherwise approved in writing by the Engineer.
   2. Provide counterflashing at all reglets.
   3. Seal reglets and counterflashings in accordance with Specification Section 07 92 00.

E. Fasten materials at intervals recommended by SMACNA.

F. Install slip joints to allow for thermal movement as recommended by SMACNA and manufacturer.
   1. Maximum spacing: 10 FT OC.
   2. Provide slip joint 24 IN from corners.
   3. Provide slip joint at each vertical expansion joint location in wall.
      a. Provide break in continuous cleat at each vertical expansion joint.
      b. The above expansion joints do not include brick veneer expansion joints.

G. Seal slip joints with two beads of non-curing butyl sealant on each side of slip joint overlap.

H. Form flashings to provide spring action with exposed edges hemmed or folded to create tight junctures.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact or where sheet metal contacts mortar, concrete masonry or concrete.

J. Provide all miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weathertight installation.
   1. Provide all components necessary to create weather-tight junctures between roofing and sheet metal work.

K. Provide sheet metal liner at exposed-to-view openings through roof deck, including but not limited to:
   1. Roof hatches: See Specification Section 07 72 33.

L. Installation of Scupper and Conductor Head:
   1. Flash the opening in the parapet wall and install the scupper and conductor head as indicated in SMACNA Figure 1-27A.
   2. Seal all joints to provide complete weathertight installation.
   3. Flash roofing material onto scupper per roofing manufacturer's recommendations.

M. Installation of Gutters:
   1. Install gutters using gutter straps in accordance with SMACNA Table 1-8 (built-in gutters) and Figure 1-12 through 1-20 (hanging gutters).
      a. Provide gutter brackets or hangers at 24 IN OC maximum.
      b. Provide expansion joints in gutters per SMACNA Figure 1-5.
      c. Install gutters to provide positive drainage to downspout locations.
      d. Seal all joints in gutters to provide completely water tight system.
      e. Provide 1/4 IN x 1/4 IN aluminum mesh debris screen continuous on top of gutter.
         1) Screen shall be mounted in aluminum frame which will allow replacement of screen without damage to gutter, screen or screen frame.

N. Installation of Downspouts:
   1. Install downspouts in locations shown on the Drawings.
   2. Provide downspout anchor straps per SMACNA Figure 1-35 as appropriate for downspout style.
   3. Provide gutter to downspout connection per SMACNA Figure 1-33B, Detail 1.
   4. Seal all joints in downspout for a complete watertight system.
   5. Angle bottom of downspout out away from building to direct discharge onto concrete splashblock.
   6. Anchor hanger straps to building wall with stainless steel screws and anchor sleeves appropriate for wall construction.
      a. Provide minimum of two anchors per strap.
   7. Maximum spacing of hanger straps shall be 10 FT with minimum of two hanger straps per vertical piece of downspout.
   8. Spacing and location of hanger straps shall be consistent from downspout to downspout.

**END OF SECTION**

# SECTION 07 72 33
ROOF HATCHES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Roof hatches.
   2. Hatch railing and gate system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 07 61 13 - Metal Roofing.
   5. Section 07 41 13 Insulated Metal Roof Panels
   6. Section 07 54 19 - PVC Membrane Roofing - Fully Adhered.
   7. Section 07 62 00 - Flashing and Sheet Metal.
   8. Section 09 96 00 - High Performance Industrial Coatings.
   9. Section 13 34 19 - Metal Building Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. Occupational Safety and Health Organization (OSHA).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Scaled plan of roof showing location of all units and anchoring details.
      a. Minimum plan scale: 1/8 IN = 1 FT.
      b. Minimum detail scale: 1-1/2 IN = 1 FT.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Data sheets on cylinder locking device.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Warranty.

### 1.4 WARRANTY

A. Roof Hatches: Manufacturer's standard five year warranty.

B. Hatch Rail System: Manufacturer's standard 25 year warranty.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Products specified are manufactured by "The Bilco Company."

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Roof hatches:
      a. The BILCO Company.
      b. Dur-Red Products.
      c. Milcor by Hart & Cooley, Inc.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Sheet Metal:
   1. Galvanized steel: ASTM A653/A653M, G90, Phosphatized.

B. Insulation:
   1. 2 IN polyisocyanurate.

C. Gaskets: Extruded EPDM rubber.

D. Hardware: Type 316 stainless steel, unless noted otherwise.

E. Anchors:
   1. Stainless steel.
   2. See Specification Section 03 15 19.

F. Hatch Rail System:
   1. Posts and rails:
      a. Pultruded fiberglass.
      b. UV resistant.
      c. Fire retardant.
   2. Mounting brackets: Hot-dipped galvanized steel.
   3. Hinges and post guides: Aluminum, 6063T5 alloy.
   4. Fasteners: Type 316 stainless steel.

### 2.3 MANUFACTURED UNITS

A. General:
   1. 12 IN high.
   2. Fully welded corners.
   3. Hardware:
      a. Lifting mechanism and automatic hold-open device.
         1) Vinyl-covered grip handle.
      b. Hinges.
      c. Latch: Operating handles for inside and outside operation.
      d. Padlock hasp.
   4. Thermally enhanced design.
   5. Finish: Manufacturer's standard red oxide primer.

B. Roof Hatches:
   1. Curb:
      a. 11 GA.
      b. Integral cap flashing.
      c. Mounting flange:
         1) Minimum 3-1/2 IN wide.
         2) Punched holes for fastening to roof deck.
      d. Insulated.

2. Curb options:
    a. Fully enclosed curb with apron:
    b. Match curb material.
        1) Extend apron over edge of blocking as shown on Drawings.
    c. Metal roof modification:
        1) Fully enclosed curb.
        2) Profile to match metal roofing
            a) See Specification Sections 07 42 14 and 07 61 13
3. Cover:
    a. Exterior: 11 GA.
    b. Interior: 18 GA liner.
    c. Polycarbonate domed glazing.
    d. Internally reinforced.
        1) Minimum 40 PSF live loading.
    e. Insulated.
    f. Completely weather sealed and gasketed.
4. Finish: Mill.

C. Hatch Rail System:
1. Manufacturer's standard OSHA Compliant railing and gate fall protection system.
2. Posts and rails:
    a. Nominal 2 IN round profile.
    b. Color: Safety Yellow.
3. Railing system designed to mount to roof hatch cap flashing without penetration of roofing material.
    a. Mounting brackets: 1/4 IN thick strap anchors with aluminum post supports.
4. Gate:
    a. Same materials and construction as posts and rails.
    b. Self-closing and self-latching.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions.

B. Securely anchor units as appropriate.
1. Anchor to wood nailers with 1/2 x 3 IN lag bolts.
2. Anchor to concrete with 1/2 IN adhesive anchors.
3. Anchor to steel with 1/2 IN stainless steel bolts, nuts and washers.
4. Maximum anchor spacing: 12 IN.
5. Manufacturer's predrilled fastener locations take precedent over this specification.
6. Provide attachment at each corner as a minimum.

C. Flash and counterflash to provide weathertight installation.
1. See Specification Section 07 61 13, 07 41 13 07 54 19 for roofing.

D. For units mounted directly to concrete curbs (such as on site vault structures), flash down the sides of the units with single ply roofing membrane flashing material.
1. Extend flashing material horizontally over the unit base mounting flange and out onto the concrete surface a minimum of 3 IN beyond the unit mounting flange.
2. Adhere the membrane to the concrete using recommended adhesive and seal all membrane edges with sealant recommended by membrane manufacturer.
    a. See Specification Section 07 54 19 for membrane flashing.

E. Provide aluminum sheet metal liner at opening through roof deck as shown on the Drawings.
1. See Specification Section 07 62 00.

F. Head Deflector Plate: See Specification Section 05 50 00.

G. Fasten hatch rail system to roof hatch cap flashing in accordance with manufacturer's instructions.
   1. Fasten without penetration of roofing membrane or flashing.

H. Adjust all components to provide smooth easy operation.

I. Provide dissimilar metals protection as required.
   1. Refer to Specification Section 09 96 00.

**END OF SECTION**

# SECTION 07 81 00
FIREPROOFING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Sprayed fireproofing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 12 00 - Structural Steel.
   4. Section 07 84 00 - Firestopping.
   5. Section 09 96 46 - Intumescent Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      b. E605/E605M, Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
      c. E119, Fire Tests of Building Construction and Materials.
      d. E736, Standard Test Method of Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
      e. E759/E759M, Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
      f. E760/E760M, Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members.
      g. E761/E761M, Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members.
      h. E859/E859M, Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials Applied to Structural Members.
      i. E937/E937M, Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material Applied to Structural Members.
   2. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.
      c. 263, Fire Tests of Building Construction and Materials.
   3. Association of the Wall and Ceiling Industry (AWCI):
      a. Technical Manual 12-A, Third Edition; Standard Practice for the testing and Inspection of Field Applied Sprayed Fire-Resistive Materials, an Annotated Guide - 115.

B. Qualifications:
   1. Applicator licensed or approved in writing by manufacturer.
   2. Applicator shall have minimum five years application experience using products specified with minimum three years experience using the product proposed for use.
   3. Manufacturer's field service representative shall have minimum 10 years experience in application methods and inspection of applied product.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Qualifications for independent testing laboratory.
   4. Qualifications of manufacturer's field service representative.
   5. Applicator qualifications.
   6. Certification from manufacturer that applicator is authorized to apply material.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. As per Owner's closeout procedures.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Grace Construction Products.
   2. Carboline.
   3. ISOLATEK International (Cafco).
   4. Mandoval.
   5. Southwest Fireproofing Products.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Sprayed Fireproofing Materials:
   1. Portland cement based.
   2. Gypsum based.

B. Water: Potable.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Mark location of hangers, inserts, straps, anchorages, supports, etc., for other trades, that may be concealed by fireproofing to facilitate location after fireproofing is applied or allow time for installation of hangers, inserts, straps, anchorages, supports, etc., of other trades prior to application.

### 3.2 APPLICATION

A. Apply products in accordance with manufacturer's instructions and UL requirements.

B. Provide all primers, adhesives, tamping and sealers, etc.

C. Fireproof all items appurtenant to primary structural framing system including seismic and lateral bracing, struts, outriggers and similar items.

D. Apply only when ambient temperatures are above 50 DEGF and will remain so during cure period.

E. Cure in accordance with manufacturer's recommendations.

F. Fireproofing on Columns Supporting Composite Metal Form Floor: UL "Column Design" #X528_-__1_ HR.

G. Fireproofing on Beams Supporting Composite Metal Form Floor: UL "Beam Design" #N501_-___1__ HR.

## 3.3 FIELD QUALITY CONTROL

A. Provide manufacturer's field service representative prior to and during application to:
   1. Check surfaces to which fireproofing is to be applied to assure proper preparation.
   2. Provide instruction and technical assistance to applicator.

B. Owner Paid Testing:
   1. Arrange with qualified independent testing laboratory to take samples, conduct required tests and issue test results.
   2. Contractor's responsibilities shall include contacting laboratory, soliciting quotes and providing additional information to Owner as required.

C. Test in accordance with ASTM E605 and AWCI Technical Manual 12-A to assure conformance with applicable UL requirements for thickness and density.

D. Should any test fail, take additional tests until extent of defective area has been determined.

E. Repair or remove and replace all defective material and retest until all requirements are met.

F. Cost of all retesting due to test failure paid by Contractor.

G. After initial testing and conformance has been verified, any subsequent damage to applied fireproofing caused by work of other trades shall be repaired and retested at Contractor's expense.

**END OF SECTION**

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# SECTION 07 84 00
FIRESTOPPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Firestopping of joints, through-wall penetrations, and membrane penetrations of fire-resistance rated construction.
   2. Selection of firestopping assemblies.
   3. Engineering Judgments.
   4. Special Inspections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

### 1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      b. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
      c. E814, Standard Method of Fire Tests of Through Penetration Fire Stops.
      d. E1966, Standard Test Method for Fire Resistive Joint Systems.
      e. E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.
      f. E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
      g. E2837, Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall.
   2. International Firestop Council (IFC).
      a. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments (EJs), referred to herein as IFC Recommended Guidelines.
   3. National Fire Protection Association (NFPA).
      a. 101, Life Safety Code.
      b. 220, Standard on Types of Building Construction.
      c. 221, Standard for High Challenge Fire Walls, Fire Walls, and Fire Barriers.
      d. 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
      e. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   4. Underwriters Laboratories, Inc. (UL):
      a. 263, Fire Tests of Building Construction and Materials.
      b. 723, Surface Burning Characteristics of Building Materials.
      c. 1479, Fire Tests of Through Penetration Fire Stops.
      d. 2079, Standard for Tests for Fire Resistance of Building Joint Systems.

B. Qualifications:
   1. Firestop system installations must meet the requirements of ASTM E814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of the construction being penetrated.

2. Proposed firestop systems shall conform to applicable governing codes having local jurisdiction.
3. For those fire stop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents shall follow the requirements set forth by the International Firestop Council.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data, including:
      a. Manufacturer's listed design number.
      b. Manufacturer's installation instructions.
      c. Manufacturer's specification and technical data for each material including the composition and limitations.
      d. Data sheet for all products and accessories used.
      e. Detailed drawings of special conditions:
         1) Provide UL listing for each type of firestopping assembly to be used.
         2) When UL listing is not available, provide a written Engineering Judgment in accordance with IFC Recommended Guidelines.
            a) Engineering Judgments shall be sealed by a Fire Protection Engineer licensed in the State of Oregon.

B. Samples:
   1. Cured samples of available colors for Engineer's color selection.
   2. Color chart not acceptable.

## 1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled original, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with the manufacturer's requirements, including temperature.

D. Do not use damaged or expired materials.

## 1.6 PROJECT CONDITIONS

A. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

B. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

C. Do not proceed with the installation of firestop materials when the ambient temperature is outside the manufacturer's recommended limitations for installation and curing times as printed on the product label and product data sheet.

D. During installation provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Safing insulation:
      a. Specified Technologies, Inc.
      b. Johns Manville.
      c. Owens-Corning.
      d. Fibrex.
      e. Roxul.
   2. Expanding silicone elastomer:
      a. Any manufacturer UL listed for system used.
   3. Firestop sealant:
      a. Dow Corning.
      b. 3M Company.
      c. Specified Technologies Inc.
      d. Hilti.
   4. Moldable putty:
      a. 3M Company.
      b. Specified Technologies Inc.
      c. Hilti.
      d. Rector Seal.
   5. Fire barrier pillows:
      a. 3M Company.
      b. Specified Technologies Inc.
      c. Hilti.
   6. Collars:
      a. 3 M Company.
      b. Specified technologies Inc.
      c. Hilti.
   7. Expanding Foams:
      a. 3 M Company.
      b. Hilti.
      c. Specified Technologies, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. Use only materials that have been UL 1479 or ASTM E814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate item.

B. Safing Insulation shall be tested to ANSI/UL 263 and listed in UL product category BZJZ, Batts and Blankets.

C. Expanding Silicone Elastomer: UL listed.
   1. Fill, Void or Cavity Materials: Product category XHHW.
   2. Through Penetration Firestop Systems: Product category XHEZ.

D. Firestop Sealant: UL listed one part silicone installed as required by the listed design.

E. Moldable Putty: UL listed, product category QCSN or CLIV, Wall Opening Protective Materials.

F. Firestop collars: UL Listed.

G. Fire Barrier Pillows:
   1. UL listed.
   2. Removable and reusable.
   3. Pillows have self-locking feature.

H. Backer rod and/or compressible filler: UL listed, product category XHHW, Fill, Void or Cavity Materials.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
   1. Selection and installation of firestopping assemblies is entirely the responsibility of the Contractor.
   2. All firestopping shall be provided in accordance with the building code and UL listing requirements as necessary to provide the required fire-resistance rating.
   3. When UL listing is not available, install in accordance with approved written Engineering Judgment.
   4. All firestopping products shall be installed in accordance with the manufacturer's instructions.
   5. Where firestopping will be exposed to view, provide colors matching adjacent construction or, if approved by manufacturer, and after inspection and approval by AHJ, paint to match.
   6. Where firestopping is not exposed to view, provide manufacturer's standard color.

B. Openings and Penetrations:
   1. Provide firestopping assembly tested in accordance with ASTM E814 or UL 1479 for all openings, through-penetrations, and membrane penetrations in fire-rated construction.
      a. Provide Flame (F), Thermal (T), Smoke (L), and Water (W) rated assemblies as necessary to meet building code requirements.

C. Building Joint Systems:
   1. Provide firestopping assembly tested in accordance with ASTM E1966 and ASTM E1399, or UL 2079 for all joint assemblies in or between fire-resistance-rated walls, floors or floor/ceiling assemblies and roofs or roof/ceiling assemblies.

D. Refer to Specification Section 01 73 20 for openings and penetrations requiring fire stopping.

### 3.2 IDENTIFICATION AND DOCUMENTATION

A. Prior to acceptance by the Owner, provide written statement that all fire-rated penetrations have been sealed using products specified in accordance with UL requirements for required rating.

B. Provide documents to the Owner of all listed systems installed and all engineering judgments.

C. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. The following information shall be on the label:
   1. The words "Warning-Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
   2. Installing Contractor's name and Contact Information.
   3. Through-Penetration firestop listing designation.
   4. Date of Installation.
   5. Through-Penetration firestop system manufacturer.
   6. Installer's Name.

D. Field verify existing fire-rated construction.

## 3.3 FIELD QUALITY CONTROL

A. Provide Special Inspection of all firestopping in accordance with IBC Chapter 17 and Specification Section 01 45 33.

**END OF SECTION**

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# SECTION 07 92 00
JOINT SEALANTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Sealing all joints which will permit penetration of dust, air or moisture.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 84 00 - Firestopping.
   4. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
      a. C834, Standard Specification for Latex Sealants.
      b. C920, Standard Specification for Elastomeric Joint Sealants.
      c. C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   3. NSF International (NSF):
      a. 61, Drinking Water System Components -- Health Effects.
   4. Underwriters Laboratories, Inc. (UL).

B. Qualifications: Sealant applicator shall have minimum five years experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Engineer.
      a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.
      b. Each sample shall cure for a minimum of seven days at which time the sealant manufacturer's authorized factory representative shall perform adhesion tests on each sample joint.
         1) Perform adhesion tests per ASTM C1521.
         2) If mock-up is not acceptable or if adhesion test fails, provide additional mock-up and adhesion testing as required until acceptable to Engineer.

### 1.3 DEFINITIONS

A. Corrosive Areas Include: Chemical storage.

B. Defect(ive): Failure of watertightness or airtightness.

C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

E. "Interior wet areas": Toilets, showers, laboratories, wet wells and similar areas. Entire process area is considered wet.

F. "Seal," "sealing" and "sealant": Joint sealant work.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
   3. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
   4. Certification of applicator qualification.

B. Test Results:
   1. Provide adhesion test results for each sealant sample including adhesion results compared to adhesion requirements.
   2. Manufacturer's authorized factory representative recommended remedial measures for all failing tests.

C. Samples:
   1. Cured sample of each color for Architect's color selection.
   2. Color chart not acceptable.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in manufacturer's original unopened containers with labels intact: Labels shall indicate contents and expiration date on material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Acoustical sealant:
      a. Pecora Corporation.
      b. BASF Corporation.
      c. Tremco Commercial Sealants & Waterproofing.
   2. Compressible sealant:
      a. Schul International Company, LLC.
      b. Emseal by Sika.
      c. Norton.
      d. Sandell Moisture Protection Systems.
   3. Expanding foam sealant:
      a. M-D Building Products, Inc.
      b. DAP Products, Inc.
      c. FAI International, Inc.
   4. Fire-resistant sealant:
      a. See Specification Section 07 84 00.

5. Polyether sealants:
   a. BASF Corporation.
   b. Chem Link.
   c. Tremco Commercial Sealants & Waterproofing.
6. Polysulfide rubber sealant:
   a. Pecora Corporation.
   b. BASF Corporation.
   c. PolySpec by ITW Polymers Sealants.
7. Polyurea joint filler:
   a. Dayton Superior Corporation.
   b. Euclid Chemical Company.
   c. L&M by LATICRETE International, Inc.
   d. BASF Corporation.
8. Polyurethane sealants:
   a. Pecora Corporation.
   b. Sika.
   c. BASF Corporation.
   d. Tremco Commercial Sealants & Waterproofing.
9. Silicone sealants:
   a. Chem Link.
   b. GE Silicones.
   c. Dow.
   d. Tremco Commercial Sealants & Waterproofing.
10. Backer rod, compressible filler, primer, joint cleaners, bond breaker:
    a. As recommended by sealant manufacturer.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler:
      a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
         1) Control joint depth.
         2) Break bond of sealant at bottom of joint.
         3) Provide proper shape of sealant bead.
         4) Serve as expansion joint filler.

B. Acoustical sealant:
   1. One component siliconized acrylic latex.
   2. Nonstaining, nonbleeding.
   3. Compatible with paints specified for adjoining materials.
      a. See Specification Section 09 96 00.
   4. Meet ASTM C834.
      a. Pecora - AC20+.
      b. Tremco - Tremflex 834.

C. Compressible Sealant:
   1. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with nonreactive release agent that will act as bond breaker for applied sealant.

a. Schul "Sealtite B".
2. Fire rated where required.
3. Adhesive: As recommended by sealant manufacturer.

D. Expanding Foam Sealant:
1. One or two component fire rated moisture cured expanding urethane.
2. Shall not contain formaldehyde.
3. Density: Minimum 1.5 PCF.
4. Closed cell content: Minimum 70 PCT.
5. R-value: Minimum 5.0/IN.
6. Flame spread: Less than 25.
7. Smoke developed: Less than 25.

E. Fire-Resistant Sealant: See Specification Section 07 84 00.

F. Polyether Sealant:
1. Silyl-terminated polyether polymer.
2. ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
a. BASF MasterSeal 150.
b. Chem Link DuraLink.
c. Tremco Dymonic FC.

G. Polysulfide Rubber Sealant:
1. One or two component.
2. Meet ASTM C920.
a. Pecora Synthacalk GC2+.
b. PolySpec THIOKOL 2235.

H. Polyurea Joint Filler:
1. Two component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.
a. Dayton Superior Corporation "Joint Fill, Joint Seal, Joint Saver II" as required for condition and recommended by manufacturer.
b. Euclid Chemical Company "EUCO QWIK" joint.
c. L&M "Joint Tite 750".
d. BASF MasterSeal "CR100" control joint filler.
2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.
3. Color: Gray.

I. Polyurethane Sealant:
1. One or two components.
2. Paintable.
3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.
a. Pecora Dynatrol-IXL, Dynatrol II, Urexpan NR-200, NR-201.
b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
c. BASF MasterSeal NP-1, NP-II, SL-1 SL-2.
d. Tremco Dymonic or Dymeric, Vulkem 116,227,45,245.

J. Silicone Sealant:
1. One component.
2. Meet ASTM C920, Type S, Grade NS, Class 25, Use NT, G, A, O.
a. Chem Link DuraSil.
b. GE Silpruf, Silglaze II.
c. GE Sanitary 1700 sealant for sealing around plumbing fixtures.
d. Dow 786 for sealing around plumbing fixtures.
e. Dow 7565, 790, 791, 795.
f. Tremco Spectrem 1, Spectrem 3, Tremsil 600.

3. Mildew resistant for sealing around plumbing fixtures.

K. Exterior Wall Joint Seal:
   1. Source: Emshield WFR2 by Sika Emseal.
   2. Description: Silicone coated, ultraviolet resistant, dual-faced, fire-rated, watertight primary wall seal.
   3. Form: Precompressed to less than design joint size, packaged in shrink-wrap packaging.
   4. Fire protection rating: 2 hours, tested to UL 2079.
   5. Movement capability: Plus and minus 50% (total 100%) of nominal material size.
   6. R-value: 1.03 per inch depth at nominal joint size compression, tested to ASTM C518.
   7. STC rating: 62 in STC 68 wall, tested to ASTM E90.
   8. OITC rating: 52 in OITC 52 wall, tested to ASTM E90.
   9. Air permeability: Maximum 0.02 liter per second per square meter, tested to ASTM E283 at 75 Pa.
   10. Water penetration: No water penetration, tested to ASTM E331 at 5000 Pa test pressure.
   11. Wind loading: No deflection, tested to ASTM E330 at 4954 Pa or 200 MPH wind.
   12. VOC Emissions: CDPH-1.2-2017: Pass
   13. Color: To be selected from full color range.
   14. Adhesive: Epoxy type, furnished by joint seal manufacturer.
   15. Silicone: Field applied corner bead at face of seal to substrate interface, furnished by joint seal manufacturer, in same material and color as used in factory coating.
       a. Abrasion Resistance: Less than 1% weight loss, tested to ASTM D4060
       b. Fuel Resistance: Pass, tested to ASTM C719/C1135
   16. Intumescent Sealant: Field applied to face of joints, furnished by joint seal manufacturer.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.
   1. Limit application to surfaces to receive sealant.
   2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

### 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions and UL requirements.

B. Clean all joints.

C. Make all joints water and airtight.

D. At changes in direction of joints, joint intersections and where sealant joints interface with other construction, install continuous sealant as necessary to ensure a weather-tight seal.

E. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 IN nor more than 1/2 IN unless recommended otherwise by the manufacturer.

F. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
   1. Take care to not puncture backer rod and compressible filler.
   2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

G. Apply bond breaker where required.

H. Tool sealants using sufficient pressure to fill all voids.

I. Upon completion, leave sealant with smooth, even, neat finish.

J. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

K. Install compressible sealant to position at indicated depth.
   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

L. Install expanding foam sealant to minimum 4 IN depth or thickness of wall being penetrated if less than 4 IN or as indicated on Drawings.
   1. Provide adequate fire rated backing material as required.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.

## 3.3 SEALANT WORK

A. General:
   1. Work includes but is not limited to: Sealing all joints which will permit penetration of dust, air, or moisture.
   2. Refer to SCHEDULE for materials to be used.
   3. See Specification Section 07 84 00 for firestopping.

B. Concrete joints:
   1. Flooring joints.
   2. Isolation joints.
   3. Joints between paving or sidewalks and building.
   4. Construction, control and expansion joints.

C. Flashing, reglets and retainers.

D. Wood siding and trim.

E. Exterior Insulation and Finish System joints.

F. Openings:
   1. Perimeters of door and window frames, louvers, grilles, etc.
   2. Door thresholds shall be set in a full bed of sealant.
   3. Glass and glazing: See specification Section 08 81 00.

G. Interior finishes:
   1. Perimeter and penetrations of sound insulated walls.
   2. Casework and millwork: See Specification Section 06 41 00.
   3. Expansion and control joints in tile work.

H. Plumbing fixtures.

I. Penetrations of walls, floors and decks.

J. Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

## 3.4 FIELD QUALITY CONTROL

A. Adhesion Testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: One test per every 1000 LF of joint sealed.
      b. Exterior precast concrete wall panels: One test per every 2000 LF of joint sealed.
      c. Chemical containment areas: One test per every 1000 LF of joint sealed.
      d. Building expansion joints: One test per every 500 LF of joint sealed.
      e. All other type of joints except butt glazing joints: One test per every 3000 LF of joint sealed.
      f. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

## 3.5 SCHEDULE

A. Furnish sealant as indicated for the following areas:
   1. Exterior areas:
      a. Above grade: Polyether.
      b. Below grade: Polyurethane.
   2. Interior areas:
      a. Noncorrosive areas:
         1) Wet exposure: Polyether.
            a) Toilet rooms, locker rooms, janitor closets or similar areas: Mildew resistant silicone.
         2) Dry exposure: Polyether, unless noted otherwise.
            a) Sound insulated construction: Acoustical sealant.
      b. Corrosive areas:
         1) Wet exposure: Polysulfide.
         2) Dry exposure: Polyurethane.
      c. Fire-rated construction: See Specification Section 07 84 00.
      d. Sealant exposed to or having the potential of being exposed to concentrated chlorine gas or chlorine liquid: Polysulfide.
      e. Casework, countertops and solid surface materials: Silicone.
         1) Sinks, fixtures or other areas subject to potential splash, spillage or condensation: Mildew Resistant Silicone.
   3. Immersion:
      a. Prolonged contact with or immersion in:
         1) Potable water:
            a) Polysulfide.
            b) NSF 61 approved.
         2) Nonpotable water, wastewater or sewage: Polysulfide.
   4. Compressible sealant: Where indicated.
   5. Exterior wall penetrations: Expanding urethane foam, with finish sealant.
      a. Finish sealant:
         1) Exterior side:
            a) Above grade: Polyether.
            b) Below grade: Polyurethane.
         2) Interior side:
            a) Noncorrosive area:
               (1) Wet exposure: Polyether.
               (2) Dry exposure: Polyether, unless noted otherwise.
            b) Corrosive area:

(1) Wet exposure: Polysulfide.
(2) Dry exposure: Polyurethane.

6. Interior concrete slab formed or saw-cut control joints: Polyurea joint filler.

**END OF SECTION**

# SECTION 07 95 13
## EXPANSION JOINT COVERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Expansion joint cover assemblies.
   2. Fire barriers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 07 61 13 - Metal Roofing.
   5. Section 07 54 19 - PVC Membrane Roofing - Fully Adhered.
   6. Section 07 62 00 - Flashing and Sheet Metal.
   7. Section 07 92 00 - Sealants.
   8. Section 09 30 13 - Ceramic Tile.
   9. Section 09 96 00 - Painting and High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. ASTM International (ASTM):
      a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      b. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      c. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
      d. D2000, Standard Classification System for Rubber Products in Automotive Applications.
      e. E1399, Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
   3. Underwriters Laboratories, Inc. (UL):
      a. 2079, Standard for Tests for Fire Resistance of Building Joint Systems.
      b. Building Materials Directory.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Heavy Duty: Capable of withstanding a point load of 2000 LB without damage or permanent deformation.

C. Standard Duty: Capable of withstanding a point load of 500 LB without damage or permanent deformation.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Scaled plan and detail Drawings.
      a. Drawings shall show expansion joint cover locations, types, extents, joints, controlling dimensions, details, etc.
      b. Minimum plan scale: 1/8 IN = 1 FT 0 IN.
      c. Minimum detail scale: 3/4 IN = 1 FT 0 IN.

B. Samples:
   1. Minimum 12 IN long sample of each type of expansion joint assembly and cover specified.
      a. Actual color samples of resilient inserts for Engineer's selection.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. As per Owner's closeout procedures.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certifications:
      a. UL Certification of fire rated assemblies

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Expansion joint covers:
      a. C/S Group.
      b. MM Systems.
   2. Expansion joint fire barrier:
      a. C/S Group.
      b. MM Systems.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Aluminum:
   1. Sheet and plate: ASTM B209, alloy 6061-T6.
   2. Extrusions, bars, rods, wire, and tubes: ASTM B221, alloy 6063-T5.

B. PVC: ASTM D1784.

C. Thermoplastic Elastomer:
   1. Extrusions and sheet goods: ASTM D2000.

### 2.3 MANUFACTURED UNITS

A. General:
   1. Product numbers listed are based on MM Systems.
   2. Provide expansion joint cover assemblies of design, profile, materials and operation indicated.
      a. Factory fabricated joints, transitions, connections and intersections.

3. Provide manufacturer's standard anchors, fasteners, spacers, vapor seals, filler materials, adhesive and other accessories as required for complete installation.
4. Where expansion joint covers are located in fire-rated assemblies, include fire-barrier system to provide a UL listed joint assembly.
5. Provide units in longest practicable lengths to minimize number of end joints.
   a. Locate end joints in non-conspicuous areas; avoid locating in traffic areas.
6. Finishes:
   a. Aluminum: Clear anodized AA-M12C22A41.
   b. Elastomeric inserts: To be selected by Engineer.

B. Floor Expansion Joint Covers:
1. Continuous extruded aluminum frame assemblies with floating cover plate and seal.
   a. Provide continuous neoprene waterstop at floor-ceiling assemblies.
2. Standard duty, block-out mount:
   a. Concrete and ceramic tile floors:
      1) Floor-to-floor joints: Series HFX.
      2) Floor-to-wall joints: Series HFXE.
3. Heavy duty, block-out mount:
   a. Floor-to-floor joints: Series EHFX.
   b. Floor-to-wall joints: ALW-2HD.
4. Provide standard duty covers in administrative areas.
   a. Provide heavy duty covers in all process related areas and areas not considered as administrative or office areas.
5. Refer to Drawings for joint width.

C. Wall Expansion Joint Covers:
1. Gypsum board wall assemblies:
   a. Frame: Aluminum with square corners designed for overlay construction on finished face of gypsum board.
   b. Wall to wall: Series X-M.
   c. Corner wall: Series X-N.
2. Precast concrete, cast-in-place concrete or masonry wall assemblies:
   a. Frame: Extruded aluminum designed for recessed construction in joint.
   b. Continuous elastomeric inserts:
      1) Primary seal:
         a) Extruded thermoplastic elastomer.
         b) Color to be selected by Engineer.
      2) Secondary seal: PVC.
   c. Wall to wall joints: Series VSS.
   d. Wall to wall at corner joints: Series VSS.

D. Floor Expansion Joint Covers:
1. Continuous extruded PVC profile: HC/HCW-1
2. Concrete floors with no additional topical finishes applied:
   a. Floor to floor: Series LMS.
   b. Floor to wall: Series LMS-C.

E. Roof Expansion Joint Covers:
1. Continuous extruded aluminum curb and cover plate with elastomeric waterstop and gaskets.
2. Types:
   a. Concrete roof-to-roof: RJ-27LP.
   b. Concrete roof-to-wall: RJ-28LP.
3. See Specification Section 07 61 13 for standing seam metal roof expansion joints.

F. Fire Barriers:

1. Flexible mat material with corrugated metal facing on each face and continuous galvanized steel mounting angles.
2. Designed for required dynamic structural movement without material degradation or fatigue in accordance with ASTM E1399.
3. Prefabricated for hourly rating of adjacent floor, wall or ceiling assemblies.
   a. UL labeled: Tested in maximum joint width condition as a component of a joint assembly in accordance with UL 2079.

### 2.4 ACCESSORIES

A. Fire-rated Sealant: See Specification Section 07 92 00.

B. Fasteners:
   1. Stainless steel.
   2. See Specification Section 05 50 00.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Provide items to be built into other construction to Contractor in time to allow their installation.
   1. If such items are not provided in time for installation, coordinate block-out requirements for later installation.
   2. Where block-outs are subject to traffic or potential for damage, provide temporary fillers to protect joint until specified items can be installed.

### 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
   1. Locate end joints in non-conspicuous areas; avoid locating in traffic areas.
   2. Seal joints in accordance with manufacturer's written installation instructions.
   3. Ensure bolting joints are fastened such that the two components create a smooth flat surface with hairline jointery unless a wider joint is required by the joint cover manufacturer.

B. Set work level, true and plumb.

C. Install fire barriers in fire-rated sealant as required for UL assembly required.

D. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.

E. After installation, clean all aluminum surfaces to remove excess sealant, adhesives, etc.
   1. Repair or replace damaged inserts, patch paint coatings on components having scratched or otherwise damaged finish coatings.
   2. Replace all components that cannot be adequately repaired to satisfaction of the Engineer and the Owner.

## END OF SECTION

# DIVISION 08

**OPENINGS**

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# SECTION 08 06 71
## DOOR HARDWARE SCHEDULE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Door Hardware, as indicated, in accordance with provisions of Contract Documents.

B. Notify Architect of items which will not operate properly, attain the required fire label, or where components are physically or functionally incompatible.

C. Completely coordinate with work of other trades.

### 1.2 REFERENCES

A. Builders Hardware Manufacturers Association, BHMA:
   1. ANSI/BHMA 1301 Materials and Finishes.
   2. ANSI/BHMA 156 Series Standards.

B. Door and Hardware Institute: Architectural; Hardware Consultant Certification.

C. ICC/ANSI 117.1 Accessible and Usable Building and Facilities.

D. National Fire Protection Association, NFPA:
   1. NFPA 70 National Electrical Code.
   2. NFPA 80 Standard for Fire Doors and Other Opening Protectives.
   3. NFPA 101 Life Safety Code.
   4. NFPA252 Standard Methods of Fire Tests of Door Assemblies.

E. United Laboratories, LLC, UL Solutions:
   1. UL 10B Standard for Safety-Fire Tests of Door Assemblies.
   2. UL 10C Standard for Positive Pressure Fire Tests of Door Assemblies.
   3. UL 1784 Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.

F. U.S. Department of Justice: 2010 ADA Standards for Accessible Design.

### 1.3 SUBMITTALS

A. Action Submittals:
   1. Product Data: For each type of material and accessory.
   2. Shop Drawings: Complete Hardware Schedule by door.
      a. Complete list of products including model numbers and cut sheets.
      b. Use Heading Numbers logically derived from Architect's Hardware Set numbers.
      c. Hardware Sets shall follow the guidelines established in Door and Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule.
      d. Notify Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.
   3. Diagrammatic Elevations and Point-to-Point Wiring Diagrams of openings scheduled to receive electrified hardware and electronic access control devices.
      a. Provide detailed wiring diagrams showing connections for signaling, control and locking functions and notes pertinent to programming, operation, etc.
      b. When door hardware sets include automatic operators and locking or latching hardware on the same doors, provide detailed wiring diagrams.
      c. Submit with Hardware Schedule.

B. Informational Submittals:
   1. Project Information:
      a. Certification that items bear UL label where required.
      b. Meeting minutes from Pre-Installation Meeting.

C. Closeout Submittals:
   1. Schedule of components installed as hardware sets for each opening.
   2. Operating and maintenance data.
      a. Parts catalog for each product furnished.
      b. Keying records.
   3. Owner instruction report.
   4. Letter stating extra material has been delivered.

## 1.4 QUALITY ASSURANCE

A. Hardware Supplier Qualifications:
   1. Architectural door hardware supplier with warehousing facilities.
   2. Operating in the project's vicinity for a period of not less than 2 years.
   3. Certified Architectural Hardware Consultant (AHC) available throughout construction.

B. Electrified Hardware Supplier Qualifications:
   1. Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project and acceptable to manufacturer of materials.
   2. Prepare data for electrified door hardware based on testing and engineering analysis of manufacturer's assemblies similar to those in this project.

C. Fire Rated Door Assemblies:
   1. Provide door hardware rated for use in assemblies complying with NFPA 80.
   2. Include listed and labeled hardware from a qualified testing agency, for fire protection ratings indicated,
   3. Comply with Positive Pressure Requirements UL-10C, Category A or NFPA 252.

D. Smoke and Draft Control Assemblies:
   1. Maximum Leakage: 3 cfm/SF of door face area when tested at pressure of 0.10 inches water per UL 1784.
   2. Applicability:
      a. Doors in Smoke Partitions, Smoke Barriers, and Corridor walls.
      b. Doors forming part of an Elevator Lobby enclosure.
   3. Provide S-Labels where required.

E. Finish designations and standards: Builders Hardware Manufacturers Association (ANSI/BHMA) Standard 1301.

F. Regulatory Requirements:
   1. Barrier free design requirements of the local jurisdiction and Americans with Disabilities Act (ADA).
   2. Listing requirements of the local jurisdiction and UL listing where applicable by type.

G. Preinstallation Conference:
   1. Prior to installation of hardware, Contractor to conduct on-site meeting to instruct hardware installer personnel in the proper installation of hardware and related electronics.
      a. Manufacturer's Reps for Locksets, Closers, Exit Devices, and other major hardware devices shall be present and direct instruction of installers.
      b. Require attendance of affected parties, not limited to: Contractor, hardware installer, electrical installer, door and frame installers and security installer, where applicable, and installer working with low voltage wiring of electromechanical hardware.
      c. Discuss installation sequence of components, point-to-point wiring diagrams, and address questions raised by installers.

### 1.5 SPECIAL WARRANTY

A. Written warranty in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within 3 years from date of Substantial Completion, or 25 years from date of Substantial Completion in the case of manual surface closers.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

### 1.6 MAINTENANCE

A. Extra Materials:
   1. Provide special tools as supplied by hardware manufacturer, for each different or special hardware component.

## PART 2 -PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers listed in Related Sections:
   1. 08 71 00 - Door Hardware

### 2.2 HARDWARE SETS – EXTERIOR

A. HW-112:
   1. Offset Pivots
   2. Delayed Action Closer
   3. Exit Device
      a. Rim type
      b. Non-Fire Rated (doggable)
      c. Lever Trim
         1) Night Latch
   4. Stop
   5. Kickplate
   6. Head drip
   7. Weatherstripping
   8. Threshold

B. HW-114:
   1. Offset Pivots
   2. 2 Delayed Action Closers
   3. 2 CVR Exit Devices
      a. Non-Fire Rated (doggable).
      b. One with Lever Trim, one with Exit Only Trim
      c. Bottom Rod
   4. Cylinder
   5. 2 Stops
   6. 2 Kickplates
   7. Head drip
   8. Threshold
   9. Weatherstripping

## 2.3 HARDWARE SETS – INTERIOR

A. HW-202:
   1. Hinges
   2. Mortise Latchset, passage F01
   3. Stop
   4. Closer
   5. Kickplate

B. HW-204:
   1. Hinges
   2. Mortise Lockset, privacy with integral deadbolt F19
   3. Occupancy Indicator:
      a. Escutcheon indicator
      b. Base Product: L283 by Schlage.
      c. Emergency unlock from outside by coin turn mechanism.
   4. Stop
   5. Closer
   6. Kickplate

C. HW-207:
   1. Hinges
   2. Mortise Lockset, classroom F05
   3. StopHW-210:
   4. Hinges
   5. Mortise Lockset, storeroom F07
   6. Cylindrical Lockset, storeroom F86
   7. Stop
   8. Closer
   9. Delayed Action Closer
   10. Kickplate

D. HW-216:
   1. Hinges
   2. Exit Device
      a. Rim type
      b. Fire Rated
      c. Lever Trim
   3. Closer
   4. Stop
   5. Kickplate
   6. Cylinder

E. HW-218
   1. Spring Hinges
   2. Wall mounted Door Bumper
   3. Steel Gates: Specified in Section 05 50 00

F. HW-223:
   1. Hinges
   2. 2 Closers
   3. 2 CVR Exit Devices:
      a. One with Lever Trim; one with Exit Only Trim.
      b. Fire Rated
   4. Less Bottom Rod
   5. 2 Stops
   6. 2 Kickplates
   7. Astragal

8. Coordinator.

### 2.4 HARDWARE SETS – ELECTRIFIED

A. HWE-213:
   1. Addition to all exterior doors.
      a. Door Position Switch by Security System Installer.
      b. Electric Unlocking (EU) Lever Trim (aka: Fail Secure)
   2. Electric Strike:
      a. Fail Secure (FSE).
   3. Low voltage Power supplied by Security System.
   4. Access Device:
      a. Card Reader (by Security System Installer).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine scheduled openings for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Coordinate reinforcement or other preparation of doors and frames.

C. Installation constitutes responsibility for performance.

D. Coordinate installation power supply and communication wiring to electrically operated devices.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's installation instructions, supervised or inspected by an AHC.

B. Furnish items of hardware for proper door swing.

C. Permanently install hardware after finishing operations are complete.

D. Protect finishes by temporary coverings as required.

E. Mounting Heights:

| Item | Height [1,2] (To Item Centerline) |
|---|---|
| Mortise Locksets | 40-5/16 inches AFF to CL of Strike 3 |
| Cylindrical Locksets | |
| Patient Latches | |
| Exit Devices | |
| Door Pulls | 42 inches AFF to CL of Pull |
| Pushplates | 45 inches AFF to CL of Plate |
| Auxiliary Deadbolts | 48 inches AFF to CL of Strike |
| Butt Hinges (and Pivots) | Top Hinge: Not more than 11-3/4 inches down from frame |
| | Bottom Hinge: Not more than 13 inches above floor |
| | Equally spaced between Top and Bottom Hinges. Refer to Part 2 for quantity required. |
| Other Items | Comply with SDI and DHI Recommendations |

| Item | Height [1,2] (To Item Centerline) |
|---|---|
| **Footnotes/Additional Requirements:**<br>1. Mounting Heights shall also comply with ADA and ICC/ANSI 117.1<br>2. Mounting Heights shall also comply with Building Code and Fire Codes.<br>3. Deviation from listed height will be allowed up to + 1-1/2 inches provided it does not cause a conflict between the lock and lite cutouts. | |

F. Install hardware with fasteners concealed where not required by code to be exposed.

G. Coordinate installation of electric access control hardware.
   1. Hardware installer to be responsible for coordination with electrical installer for low voltage installations.

H. Door Position Switches (DPS):
   1. Coordinate door and frame preparations with door and frame suppliers, and Security System installer as appropriate.
   2. Locate in frame head approximately 4 inches from latching door edge, unless otherwise instructed.

## 3.3 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware to ensure proper operation or function.
   1. Lubricate moving parts with lubricant recommended by manufacturer.
   2. Replace units which cannot be adjusted and lubricated to operate smoothly.

B. Conversion of Construction Keying to Permanent (by Contractor):
   1. Convert cylinders from Construction to Permanent configuration at time of Substantial Completion.
   2. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology.

C. Approximately six months after substantial completion, check and readjust to assure proper function of doors and hardware.
   1. Clean and lubricate operational items.
   2. Replace items which have deteriorated or failed.
   3. Prepare a written report of current and predictable problems in operation of hardware.
   4. Report visit and furnish copy of report to Owner with copy to Architect.

D. When hardware is installed more than one month prior to final acceptance or occupancy, during week prior to acceptance or occupancy, make a final check and adjustment of hardware items.
   1. Remove temporary coverings.
   2. Clean and lubricate for proper function and finish.
   3. Adjust door control devices to compensate for operation of heating and ventilating equipment.

E. Instruct Owner's personnel:
   1. Operating and maintenance procedures.
   2. Key control system.
   3. Methodology used to re-key cylinders from Construction to Permanent configuration.

F. Prior to substantial completion instruct Owner's personnel in systems operation.
   1. Standard system operation and maintenance.
   2. Modification of codes.

3. Acquisition, monitoring, and scheduling of ID cards.
4. Instruction in software applications.

**END OF SECTION**

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# SECTION 08 11 00
## HOLLOW METAL DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Metal doors and frames.
   2. Metal borrowed lite window frames.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 08 71 00 - Door Hardware.
   4. Section 08 81 00 - Glass and Glazing.
   5. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. National Association of Architectural Metal Manufacturers (NAAMM):
      a. Hollow Metal Manufacturers Association (HMMA).
   3. National Fire Protection Association (NFPA):
      a. 80, Standard for Fire Doors and Other Opening Protectives.
   4. Steel Door Institute (SDI):
      a. 111C, Recommended Louver Details for Standard Steel Doors.
      b. 117, Manufacturing Tolerances for Standard Steel Doors and Frames.
      c. All SDI publications.
   5. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.6, Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
      b. A250.7, Nomenclature for Standard Steel Doors and Steel Frames.
      c. A250.8, Specifications for Standard Steel Doors and Frames.
      d. A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
      e. A250.11, Recommended Erection Instructions for Steel Frames.
   6. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. 10B, Standard for Fire Tests of Door Assemblies.
      c. 10C, Standard for Positive Pressure Fire Tests of Door Assemblies.

B. Qualifications: Manufacturer must be current member of SDI, and NAAMM (HMMA).

C. Wipe coat galvanized steel is not acceptable as substitute for galvanizing finish specified.

### 1.3 DEFINITIONS

A. As identified in SDI/ANSI A250.7.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
3. Schedule of doors and frames using same reference numbers as used on Drawings.
4. SDI certification.
5. UL certification.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Store doors and frames in accordance with SDI/ANSI A250.11.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metal doors and frames:
    a. Ceco Door by ASSA ABLOY.
    b. Steelcraft by Allegion PLC.
    c. Curries by ASSA ABLOY.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Steel Sheet: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

B. Frames: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

C. Supports and Reinforcing: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

D. Inserts, Bolts and Fasteners: Manufacturer's standard.

E. Primer: Manufacturer's standard coating meeting SDI/ANSI A250.10.

F. Galvannealed Coating Repair: See Specification Section 09 96 00.

G. Thermal Insulation: Polyurethane, CFC free.

H. Sound Insulation: Mineral batt insulation.

### 2.3 ACCESSORIES

A. Glass Panels in Doors:
1. Fixed, integral stops on exterior face.
2. Snap-in stops or stops secured with countersunk Phillips head machine screws on interior face.
3. Reinforce cut-out in door panel with minimum 20 GA galvannealed or galvanized steel channel.
4. Glass: See Specification Section 08 81 00.

B. Frame Anchors:
1. Jamb anchors:
    a. Masonry wire anchors: Minimum 0.1875 IN wire, galvanized.
    b. Existing wall anchor: Minimum 18 GA, galvanized.
    c. Stud partition and base anchors: Minimum 18 GA, galvanized.

C. Louvers:
1. Specification 08 90 00 Louvers and Vents
2. In accordance with SDI 111C.
3. Galvanized steel: ASTM A653, G60.
4. Frame: Minimum 18 GA.
5. Blades: Minimum 22 GA.
6. Blades welded to frame.
7. Blade profile: Inverted "Y" with minimum free area of 50 PCT.
8. Similar to Anemostat "AFDL."

## 2.4 FABRICATION

A. General:
1. SDI/ANSI A250.8.
2. Fabricate rigid, neat in appearance and free from defects.
3. Form to sizes and profiles indicated on Drawings.
   a. Beveled edge.
4. Fit and assemble in shop wherever practical.
5. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
6. Continuously wire weld all joints, dress exposed joints smooth and flush.
7. Provide minimum 18 GA galvanized steel channel reinforcing on all sides of louver cut out.
8. Fabricate doors and frames to tolerance requirements of SDI 117.
9. Fit doors to SDI and NFPA 80 clearances if fire doors are used.
10. Provide fire rated doors which are approved and labeled by UL.
11. All doors shall be handed.
12. Hinge cut-out depth and size on doors and frames shall match hinge specified in Specification Section 08 71 00.
13. Design and fabricate doors to requirements of the building code.

B. Hollow Metal Doors:
1. General:
   a. 1-3/4 IN thick.
   b. Fabricate with flush top caps.
      1) Thickness and material to match door face.
      2) Exterior doors: Seal weld top cap to door face and grind smooth and flush.
      3) Interior doors:
         a) Attach top cap to door with concealed fasteners or by welding.
         b) Factory seal if attached with fasteners.
         c) No exposed fasteners will be accepted.
   c. Continuously wire weld all joints and dress, smooth and flush.
2. Exterior:
   a. Doors 48 IN wide, or less: SDI/ANSI A250.8, Level 3, and physical performance level A, Model 2.
      1) Face sheet minimum thickness: 16 GA.
      2) Insulated: Minimum R10.
   b. Doors over 48 IN wide: SDI/ANSI A250.8, Level 3, and physical performance level A, Model 3.
      1) Face sheet minimum thickness: 14 GA.
      2) Stile and rail minimum thickness: 16 GA.
3. Fire rated:
   a. SDI/ANSI A250.8, Level 3, and physical performance level A, Model 2.
   b. Face sheet minimum thickness: 16 GA.
   c. FM labeled.
   d. UL fire labeled.
   e. Comply with UL 10B and UL 10C.
   f. Maximum transmitted temperature:

1) Fire doors shall have a maximum transmitted temperature end point of not more than 250 DEGF above ambient at the end of 30 minutes of standard fire test exposure.

g. Pairs UL fire labeled without astragal.

h. Comply with NFPA 80.

4. Interior:

a. Doors 48 IN wide, or less: SDI/ANSI A250.8, Level 2, and physical performance level "B", Model 2.

1) Face sheet minimum thickness: 18 GA.

b. Doors over 48 IN wide: SDI/ANSI A250.8, Level 3, and physical performance level A, Model 3.

1) Face sheet minimum thickness: 16 GA.

2) Stile and rail minimum thickness: 16 GA.

c. Sound insulated, minimum STC-35.

C. Hollow Metal Frames:

1. Door frames:

a. Provide 2 IN face at all heads, jambs and mullions for frames in stud walls.

b. Provide 4 IN face at head where noted on Drawings or required by wall construction.

c. 26 GA galvannealed steel boxes welded to frame at back of all hardware cutouts.

d. Steel plate reinforcement welded to frame for hinge, strikes, closers and surface-mounted hardware reinforcing.

1) All plate reinforcement shall meet size and thickness requirements of SDI/ANSI A250.8.

e. Split type frames not acceptable.

1) All horizontal and vertical mullions and transom bars shall be welded to adjacent members.

f. Conceal all fasteners.

g. Frames shall be set up, all face joints continuously wire welded and dressed smooth.

h. Exterior (up to 4 FT wide): 16 GA.

i. Exterior (over 4 FT wide): 14 GA.

j. Fire rated:

1) 16 GA.

2) Comply with UL 10B and UL 10C.

3) Comply with NFPA 80.

k. Interior: 16 GA.

l. Provide removable spreaders at bottom of frame.

2. Borrowed lite frames:

a. 2 IN face at head, jamb, sill and mullions unless noted otherwise on Drawings.

b. 16 GA.

c. Field applied stops: Manufacturer's standard with finish to match frame.

d. Provide welded type frames.

1) Continuously wire weld all joints and dress smooth.

D. Prepare for finish hardware in accordance with hardware schedule, templates provided by hardware supplier, and SDI/ANSI A250.6.

1. Locate finish hardware in accordance with SDI/ANSI A250.8.

2. See Specification Section 08 71 00 for hardware.

3. Prepare doors for swing direction indicated.

a. Preparing doors for non-handed hinges is not acceptable.

E. After fabrication, clean off mill scale and foreign materials and prime with rust inhibiting primer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install doors and frames in accordance with SDI/ANSI A250.11, the building code and manufacturer's instructions.

B. Plumb, align, and brace frames securely until permanently anchored.
   1. After completion of walls, remove temporary braces and spreaders.
   2. Anchor frames with minimum of three anchors per jamb.
      a. Number and location of anchors shall be in accordance with SDI and frame manufacturer's recommendations.

C. At new masonry or metal stud construction, place frames in conjunction with construction of walls or partitions.
   1. Metal stud construction:
      a. Anchor frames using steel stud anchors.
      b. Attach wall anchors with self-tapping screws.

D. Install fire-rated frames in accordance with NFPA 80 and manufacturer's instructions.

E. Use plastic plugs to keep silencer holes clear during construction.

F. Immediately after erection, sand smooth rusted or damaged areas.
   1. Touch-up with rust-inhibiting primer.
   2. Finish paint door and frame in accordance with Specification Section 09 96 00.

G. Install three silencers on strike jamb of single door frame and two on head of double door frame.
   1. See Specification Section 08 71 00.

H. Protect doors and frames during construction.

**END OF SECTION**

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# SECTION 08 11 16
## ALUMINUM DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Aluminum doors and frames.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 07 92 00 - Joint Sealants.
   2. Section 08 71 00 - Door Hardware.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American National Standards Institute/National Fenestration Rating Council (ANSI/NFRC):
      a. 100, Procedure for Determining Fenestration Product U-Factors.
      b. 400, Procedure for Determining Fenestration Product Air Leakage.
   3. American National Standards Institute/Steel Door Institute (ANSI/SDI):
      a. A250.8, Specifications for Standard Steel Doors and Frames.
   4. ASTM International (ASTM):
      a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      b. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      c. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

B. Qualifications:
   1. Door and frame fabricator must have minimum 10 years of experience in fabrication of flush aluminum doors and associated frames.
   2. Installation: Door and frame installation shall be performed by experienced workmen having a minimum five years of experience installing products similar to those specified.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Schedule of doors and frames using same reference numbers as indicated on Drawings.
   3. Certifications:
      a. Certification of manufacturer qualifications.
      b. Certification of installer qualifications.

B. Samples:
   1. 6 x 6 IN sample of door section showing edge construction, core, impact reinforcement and face sheet with finish as specified.

2. 6 x 6 IN sample of door frame specified, in color specified, showing weatherstripping, anchoring device, stops and all parts of the frame necessary for complete installation.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Store doors and frames in a dry, weather protected area.
   1. Place units on wood skids providing a minimum 6 IN air space above the ground.
   2. Do not store units flat, set frames and doors on edge providing minimum 1/2 IN air circulation space between each unit.
   3. Provide covering which will ensure air flow around each unit to prevent trapping of moisture.
   4. If door wrapper becomes wet immediately remove and provide dry protection equivalent to wrapper removed.

B. Storage recommendations by unit manufacturer shall take precedent over the above requirements.

### 1.6 WARRANTY

A. Factory applied high performance organic coatings utilizing PVDF resins shall be provided with manufacturer's standard 20-year warranty against color fade, chalking and film integrity.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Aluminum doors and frames:
      a. Kawneer.
      b. Special-Lite, Inc.

### 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Thermal Performance:
   1. Exterior doors shall meet the requirements of the Oregon Energy Code.
   2. Air Infiltration: NFRC 400.
      a. Maximum 0.18 CFM/SF @ 6.27 PSF.
   3. Thermal Transmittance: NFRC 100.
      a. Opaque Swinging Door and Frame Assembly: U = 0.37 maximum.

B. Acoustical Performance:
   1. Sound Transmission: ASTM E90.
      a. STC: 26 minimum.
      b. OITC: 26 minimum.

### 2.3 MATERIALS

A. Aluminum:
   1. Sheet:
      a. ASTM B209.
      b. Alloy 5005 architectural quality.
   2. Extrusions:
      a. Aluminum ASTM B221.
      b. Alloy 6063T5.

B. Insulation:
   1. Closed cell urethane or polyisocyanurate.
      a. CFC and HCFC free.
      b. Ozone depletion potential: 0.
   2. Density: Minimum 5.0 PCF.
   3. Flame spread index: Less than 75.
   4. Smoke developed index: 450 maximum.

C. Fasteners:
   1. Stainless steel.
      a. Type 304 or 316.

## 2.4 MANUFACTURED UNITS

A. General:
   1. Fabricate rigid, neat in appearance and free from defects.
   2. Form to indicated sizes and profiles.
   3. Fit and assemble in shop wherever practical.
   4. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
   5. Factory prepare for finish hardware, in accordance with hardware schedule and templates provided by hardware supplier.
      a. Locate hardware per ANSI/SDI A250.8.
      b. See Specification Section 08 71 00 for hardware.
   6. Conceal fastenings wherever practical.
      a. Exposed fasteners to be countersunk Phillips or Jackson flat head screws and bolts.

B. Doors:
   1. Nominal 1-3/4 IN thick.
   2. Stiles and Rails:
      a. One piece aluminum extrusion with integral reglets to accept face sheets on both faces of door.
         1) Screw or snap-in applied caps are not acceptable.
      b. Corners: Mitered with full-width tie rod.
   3. Face Sheets:
      a. Exterior doors:
         1) Exterior face:
            a) 0.125 IN aluminum] sheet.
               (1) Rabbet edges of sheet to be fully captured by perimeter extrusions.
            b) Texture: Smooth.
         2) Interior face:
            a) 0.125 IN aluminum sheet.
               (1) Rabbet edges of sheet to be fully captured by perimeter extrusions.
            b) Texture: Smooth.
      b. Interior doors:
         1) 0.125 IN aluminum 0.120 IN FRP sheet.
            a) Rabbet edges of sheet to be fully captured by perimeter extrusions.
         2) Texture: Smooth.
   4. Core:
      a. Insulated.
      b. Minimum R 5.8.
   5. Hardware reinforcement:
      a. Aluminum bars or plate.
      b. Reinforce hinges using continuous bar in hinge stile, tapped for hinges.
      c. Reinforce for hardware using plate screwed to tubular frame.
   6. Special-Lite Model SL-16

C. Frames:

1. General:
    a. Minimum thickness: 0.120 IN.
    b. Site-line:
        1) Minimum: 1-3/4 IN.
        2) Maximum: 2-1/4 IN.
2. Exterior frames:
    a. Thermally broken extruded aluminum with applied stops.
        1) Weatherstripping: Resilient bulb.
    b. Depth: 4-1/2 IN.
    c. Special-Lite model SL-450TB.
3. Interior frames:
    a. Tubular extruded aluminum with applied stops.
        1) Weatherstripping: Manufacturer's standard pile
    b. Depth: 4-1/2 IN.
    c. Special-Lite model SL-245.
4. Frames to be vertically reinforced at jambs.
    a. Reinforce for hinge using bar in hinge side of frame, tapped for hinges.
    b. Reinforce for all other hardware using plate screwed to frame.
    c. Reinforcement sizes shall be determined by the frame manufacturer.
        1) Minimum thickness: 1/4 IN.
    d. Wood blocking is not acceptable.
5. Provide dissimilar metals protection.
    a. See Specification Section 09 96 00.

D. Finish:
1. Door and frame finishes shall match.
2. Exterior doors:
    a. Anodized:
        1) Architectural Class 1 coating per AA DAF 45.
        2) Dark bronze: AA-M12C22A42 or A4.
3. Interior doors:
    a. Anodized:
        1) Architectural Class 1 coating per AA DAF 45.
        2) Dark bronze: AA-M12C22A42 or A44

### 2.5 ACCESSORIES

A. Lites (Glass Panels):
1. Fixed, integral stops on exterior face.
2. Screw-less snap-in stops or stops secured with countersunk Phillips head machine screws on interior face.
3. Glass: See Specification Section 08 81 00.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions.

B. Plumb, align, and brace securely until permanently anchored.
1. Number and location of anchors shall be in accordance with frame manufacturer's recommendation with minimum of three anchors per jamb.

C. Hardware: See Specification Section 08 71 00.

D. Seal perimeter of door frame.
1. See Specification Section 07 92 00.

## 3.2 FIELD QUALITY CONTROL

A. Repair all damaged finishes or replace framing member or door as directed by Engineer.
   1. Use only materials and finishes as recommended or furnished by door and frame manufacturer.
   2. Final repaired finish shall match surrounding original finish or item being repaired shall be replaced with new item.

## 3.3 CLEANING

A. Clean doors and frames as recommended by manufacturer prior to acceptance by Owner.

## 3.4 PROTECTION

A. Protect doors and frames during construction.

**END OF SECTION**

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# SECTION 08 31 00
ACCESS DOORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Ceiling access doors.
   2. Floor access doors.
   3. Wall access doors.
   4. H-20 loading doors.
   5. Odor resistant vault access doors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Specification Section 09 96 00 - High Performance Industrial Coatings.
   4. Specification Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      d. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      e. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      g. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      h. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      i. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   3. Occupational Safety and Health Administration (OSHA).
   4. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

### 1.3 DEFINITIONS

A. Clear Opening Size: Space within the opening having no obstructions. Furnish model that will provide the minimum clear opening indicated.

B. Standard Duty: Will support live load of 150 PSF.

C. Heavy Duty: Will support live load of 300 PSF.

D. H-20 loading: As defined in AASHTO Guidelines.

E. Odor Resistant: Air infiltration rate of less than 1.0 CFM/LF of cover perimeter while under a pressure differential, across the cover, of 1 IN WC.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Lifetime warranty information on secondary fall protection system.Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Floor access doors:
      a. The BILCO Company.
      b. Babcock-Davis.
      c. Dur-Red Products.
      d. Halliday Products.
      e. USF Fabrication by Eagle Manufacturing Company.
   2. Odor resistant vault access doors:
      a. The BILCO Company.
      b. Nystrom.
   3. H-20 loading doors:
      a. The BILCO Company.
      b. Dur-Red Products.
      c. Halliday Products.
      d. USF Fabrication by Eagle Manufacturing Company.
   4. Ceiling access doors:
      a. The BILCO Company.
      b. J.L. Industries.
      c. Milcor by Hart & Cooley, Inc.
      d. Dur-Red Products.
      e. Larsens Manufacturing Company.
   5. Wall access doors:
      a. J.L. Industries.
      b. Milcor by Hart & Cooley, Inc.
      c. Larsens Manufacturing Company.
   6. Fire rated ceiling and wall access doors.
      a. J.L. Industries.
      b. Milcor by Hart & Cooley, Inc.
      c. Larsens Manufacturing Company.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Aluminum:
   1. Sheet and Plate: ASTM B209.
   2. Extruded shapes: ASTM B221.

B. Steel:
   1. Sheet Metal: G90 Galvanized, ASTM A653/A653M.
   2. Fabrications: Hot-Dip Galvanized, ASTM A123/A123M.
   3. Hardware: Hot-Dip Galvanized, ASTM A153/A153M.

C. Stainless Steel: ASTM A240/A240M or A666.

## 2.3 MANUFACTURED UNITS

A. General:
   1. All access doors shall be provided by the same manufacturer when possible.
   2. Coat all aluminum components in contact with concrete or masonry with manufacturer's standard bituminous coating.

B. Odor Resistant Vault Access Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with continuous anchor flange.
   2. Cover: 1/4 IN mill finish diamond plate aluminum.
      a. Reinforce cover as required for loading specified.
         1) Live load: 300 PSF.
         2) Deflection: Maximum 1/150 of span.
   3. EPDM gasket.
   4. Hardware:
      a. All hardware to be type 316 stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
      c. Slam lock and removable key handle.
   5. Bilco Company, Type "J-AL-R" or "JD-AL-R"
      a. Sizes(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.
      b. Provide secondary fall protection system.

C. H-20 Loading Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
      a. 1-1/2 IN DIA drain coupling.
   2. Cover:
      a. 1/4 IN mill finished diamond plate aluminum.
      b. Reinforce cover with aluminum stiffeners.
         1) Reinforced for AASHTO H-20 wheel loading for use in off street applications.
         2) Deflection: Maximum 1/150 of span.
   3. Hardware:
      a. All hardware to be stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
      c. Slam lock and removable key handle.
   4. The BILCO Company, Type "J H-20 IN or "JD H-20."

D. Fire Wall and Ceiling Access Doors:
   1. Prime painted galvanized steel.
   2. Door and Frame: 14 GA.
   3. Hinges: Continuous, concealed.
   4. Provide flush, screwdriver-operated locks with metal cam.
   5. J L. Industries "TM" Series.

E. Fire Rated Wall Access Doors:
   1. Prime painted galvanized steel.
   2. Heavy-duty construction.
   3. Frame: 14 GA.
   4. Door: 14 GA, 2 IN thick, insulated.
      a. Hinge: Continuous 16 GA, Type 304 stainless steel with stainless steel pin.

b. Latch: Mortise slam lock with manufacturer's standard cylinder.
5. Automatic closer.
6. UL Labeled: 1-1/2 HR "B" Label in 2 HR fire barrier.
7. J L. Industries "FD" Series.
8.

F. Fire Rated Ceiling Access Doors:
1. Prime painted galvanized steel
2. Frame: 16 GA.
3. Door: 20 GA, 2 IN thick, insulated.
a. Hinge: Continuous 16 GA, Type 304 stainless steel with stainless steel pin.
b. Latch: Mortise slam lock with manufacturer's standard cylinder.
4. Automatic closer.
5. Warnock Hersey listed for ceiling installations:
a. Non-combustible rating: 3 HR.
b. Combustible rating: 1 HR.
6. J L. Industries "FD" Series.

## 2.4 ACCESSORIES

A. Secondary Fall Protection System:
1. Design and install system such that when in the open position, no part of the system obstructs the clear opening size listed in the SCHEDULES Article in PART 3 of this Specification Section.
2. Platform: Design grating to meet OSHA 29 CFR 1910.23 requirements for protection for floor openings.
3. Finish:
a. Powder coated.
b. Color: Safety Orange or Safety Yellow.
4. Hardware:
a. Stainless steel Type 316.
b. Tamper proof Type 316 stainless steel bolts.
5. Provide positive latch to hold grating in upright position.
6. Size: Allow 6 IN clear space on each unhinged side for visual observation.
7. Provide padlock hasp for Owner provided padlock.
8. Double leaf openings:
a. Provide two individual grating platforms independent from one another.
1) Provide each platform with a padlock hasp and positive latch to hold grating in upright position.
9. Install secondary fall protection system at the factory.

B. Load Rating Plates:
1. Minimum 18 GA Type 316 stainless steel, ASTM A666.
2. Engraved with maximum design live load allowed for unit on which it will be mounted.
3. Display load in English units as well as metric units.
4. Size as required for text as needed.
5. Text:
a. Font: Helvetica Narrow, all caps.
b. Size: 1/4 IN height.
c. Depth of engraving: 3 MILS.
6. Finish:
a. Text:
1) Black epoxy baked on paint.
2) Plate to have finish conductive to paint application.
b. Coat entire plate with baked on clear coat on front and back side.
7. Attach to top of all floor or vault access doors using stainless steel screws in location determined by manufacturer.

a. Provide a neoprene gasket under the plate to separate the stainless steel from the aluminum cover or frame.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide plug for drainage coupling to prevent odors from escaping through drain into drainage channel frame of odor resistant vault door.

C. Provide 1.5 IN schedule 80 PVC drain piping at floor and vault access door(s) with drain outlet.
1. Provide piping in accordance with Specification Section 40 05 00 22 20 00.
2. Connect drain piping to drain outlet and stub out through bottom of slab
   a. Provide adequate length to make connection after formwork is removed.
3. Route piping as indicated in Schedule Article.
4. Provide positive slope.

### 3.2 SCHEDULES

A. Vault Access Door Schedule:

| DOOR NO. | DRAWING NO. | LOCATION | CLEAR OPENING SIZE (a) | TYPE | REMARKS |
|---|---|---|---|---|---|
| YV-1001 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-3001 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-4700 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-5001 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-5002 | 002C504 | YARD VAULT | 6 FT-0 IN x 5 FT-0 IN | H-20 | |
| YV-5003 | 002C504 | YARD VAULT | 6 FT-0 IN x 5 FT-0 IN | H-20 | |
| YV-5004 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-6001 | 002C504 | YARD VAULT | 4 FT-0 IN x 4 FT-0 IN | H-20 | |
| YV-6002 | 002C504 | YARD VAULT | 6 FT-0 IN x 5 FT-0 IN | H-20 | |

1. Notes:
   a. See definition of Clear Opening Size in the DEFINITIONS Article in PART 2 of this Specification Section.
   b. Provide secondary fall protection system.
   c. Route piping to sump.
   d. Route piping to daylight.
   e. Route piping to nearest wall and provide 90-degree elbow down.

## END OF SECTION

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# SECTION 08 33 22
## ALUMINUM ROLLING OVERHEAD DOORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Aluminum rolling overhead doors.
   2. Motor operators.
   3. Control Systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   3. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A269/A269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      f. A276/A276M, Standard Specification for Stainless Steel Bars and Shapes.
      g. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
      h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      i. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      j. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      k. A501/A501M, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
      l. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
      m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      n. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      o. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
      p. E330/E330M, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
      q. F467, Standard Specification for Nonferrous Nuts for General Use.

r. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use.
s. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
t. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 KSI (830 MPa) and 150 KSI (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

4. International Code Council (ICC):
   a. International Energy Conservation Code (IECC). – Use Oregon Energy Code.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. National Fenestration Manufacturer's Council (NFRC):
   a. 102, Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.
7. Underwriter's Laboratories (UL):
   a. 325, Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

B. Qualifications:
   1. Installer to be licensed or approved in writing by door manufacturer.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Schedule of doors using same reference number for openings as indicated on Drawings.
   4. Motor operator and accessories technical data including complete wiring and control diagram for motor operators and control stations.
   5. Certifications:
      a. Certification of Installer's qualifications.

B. Samples:
   1. Actual metal color samples of manufacturer's full line of colors available.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Aluminum rolling overhead doors:
   a. CornellCookson
   b. Wayne Dalton.
   c. Overhead Door Corporation.
   d. Raynor Garage Doors.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Wind Load: ASTM E330/E330M.
   1. Exterior doors: See Structural Drawings.
   2. Interior doors: 20 PSF minimum.

B. Air Infiltration:
   1. Meet ASHRAE 90.1 and IECC C402.4.3.
   2. Air leakage: <1.00 CFM/SQFT.

C. Thermal performance:
   1. NFRC 102: U-factor: 0.91.

D. Sound Rating:
   1. ASTM E90.
   2. Minimum assembly rating: STC-21.

## 2.3 MATERIALS

A. Aluminum:
   1. Shapes, plate: ASTM B221.
   2. Sheet: ASTM B209.
   3. Bolts and nuts: ASTM F467 and F468.

B. Steel:
   1. Hot dipped galvanized:
      a. Fasteners: ASTM A153/A153M.
      b. All other components: ASTM A123/A123M.
   2. Bars, shapes, and plate: ASTM A36/A36M.
   3. Pipe: ASTM A53/A53M or A501/A501M.
   4. Tubing: ASTM A500/A500M.
   5. Bolts and nuts: ASTM A307 or ASTM F3125, Grade A325.

C. Insulation:
   1. Closed cell polyurethane foam.
   2. CFC free.

D. Weatherproofing:
   1. Resilient: Neoprene or vinyl.
   2. Brush type: Nylon or polypropylene.

E. Miscellaneous Fasteners: Aluminum or stainless steel.

## 2.4 MANUFACTURED UNITS

A. Door Curtain:
   1. Insulated flat profile:
      a. Overhead Door Corporation "625 Series".
      b. 2-5/8 IN high.
      c. Interlocking face sheets:
         1) Exterior face: 0.040 IN.
         2) Interior face: 0.024 IN.
      d. Galvanized endlocks.
      e. Core: Insulated.

2. Bottom bar:
    a. Two structural angles bolted back-to-back.
        1) Minimum 1/8 IN thick.
    b. Aluminum or stainless steel.

B. Operation:
1. Motor operated with integral chain hoist backup.

C. Guides:
1. Manufacturer's standard structural angle guide system for size of door specified.
    a. Cold-rolled guides are not acceptable.
    b. Furnish curtain wind locks as necessary for design wind load.
    c. Material:
        1) Interior doors: Aluminum.
        2) Exterior doors:
            a) Doors not requiring wind locks: Aluminum.
            b) Doors requiring wind locks: Galvanized steel.
2. Mounting:
    a. Interior face of wall.

D. Headplates:
1. Galvanized steel plate mounted to guides.
2. Stainless steel plate mounted to guides.
3. Sized to support counterbalance assembly, curtain, motor operator and hood.
    a. Field verify headroom and side clearances and coordinate motor operator mounting accordingly.

E. Counterbalance Assembly:
1. Pipe barrel:
    a. Galvanized Steel.
    b. Stainless steel.
    c. Maximum deflection: 0.03 IN/FT.
2. Torsion springs:
    a. Oil-tempered helical torsion springs on cast anchors.
    b. 100,000 cycle.
3. Adjustable tension wheel.

F. Hood:
1. Minimum 0.040 IN aluminum or minimum 24 GA stainless steel.
2. Air baffle extending full length.

G. Weatherstripping:
1. Guide tracks: Exterior and interior weatherseal.
2. Lintel: Brush-type weatherseal.
3. Bottom seal:
    a. Manually-operated doors: Resilient weather seal.
    b. Motor-operated doors: Electric safety edge.

H. Finish:
1. Curtain:
    a. Powder coat:
        1) Factory prime and finish coats.
        2) Prime coat: Minimum 0.2 MIL baked-on prime paint.
        3) Finish coat: Minimum 0.6 MIL baked-on polyester powder coat.
        4) Color: To be selected by Engineer from manufacturer's complete offering.
2. Hood:
    a. Stainless steel: No. 4 brushed.
3. Guides, head plates, and counterbalance assembly:

a. Manufacturer's standard powder coating.

I. Trim Pieces: Material and finish to match door curtain.

J. Locking:
1. Motor operated doors: Integral motor brake.
2. Manually operated doors: Slide bolts each jamb.

## 2.5 ACCESSORIES

A. Motor Operator:
1. Minimum 1/2 HP with integral brake.
a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
b. See Specification Section 01 61 03 for additional motor requirements.
1) Provide manufacturer's standard reversing controller with motor thermal protection if motor is not internally protected as specified in Specification Section 01 61 03.
c. Motor shall be sized by door manufacturer for door size indicated on Drawings.
1) Opening/Closing rate: Between 2/3 and 1 FPS.
2. Provide enclosures with the required rating per NEMA 250 to meet classifications identified in the Contract Documents.
a. See Specification Section 01 61 03.
3. Provide integral backup chain hoist and release with integrated interlock.
a. Provide chain keeper for each hoist.
4. Control System:
a. General:
1) Control system shall be hard wired to the voltage system in the motor operator.
a) Battery powered control stations or receivers are not acceptable.
2) Provide wiring terminations for all supplied control system components.
a) Wireless control stations or entrapment protection components are not acceptable.
3) Provide enclosures with the required rating per NEMA 250 to meet classifications identified in the Contract Documents.
b. Manual control station:
1) Interior controls: Surface mounted.
a) Pushbutton operation: Open, Close, Stop.
2) Exterior controls: Surface Mounted.
a) Key operation: Open, Close, Stop.
(1) Coordinate keying with master keying specified in Section 08 71 00.
b)
c. Entrapment protection:
1) Comply with UL 325.
a) Instant reversing.
b) When activated shall prevent operator from closing an open door.
2) Electric safety edge:
a) Contact-type sensor installed on leading edge of the door.
b) When activated shall prevent operator from closing an open door.
c) Safety edge on exterior doors shall act as a weatherseal.

## 2.6 MAINTENANCE MATERIALS

A. Provide 2 OZ of touch-up paint properly labeled for each different color of door.
1. Touch-up paint shall be formulated to be compatible with finish specified and shall be capable of being applied without special equipment or tools.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Installation shall be done by manufacturer's authorized representative.

C. Provide all required trim, weatherstripping, closures etc., for complete weather tight installation.

D. Adjust for proper counter balance.

E. Seal along bottom of vertical track (guides), seal the vertical joint between the two separate track angles (if not filled by welding) and seal all holes in vertical track (not being used for fasteners) to provide a completely weather tight track and door system.
   1. At fastener locations provide aluminum washers under bolt head to completely cover the slotted holes in the vertical guide.

F. Electrical disconnect and conduit and wiring from standard three pushbutton control to motor operator is provided as indicated on the Electrical Drawings.

G. Provide aluminum or stainless steel bracing for motor operator to eliminate vibration.

H. Provide dissimilar materials protection on all surfaces coming in contact with dissimilar materials.

### 3.2 ADJUSTMENT

A. Prior to occupancy, adjust door for smooth operation.

**END OF SECTION**

# SECTION 08 39 23
## SMOKE CONTAINMENT SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Smoke Containment Systems, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Minimum seven years' experience in producing Smoke Containment Systems of the type specified.

B. Installer Qualifications:
   1. Factory trained by manufacturer.

C. Certifications:
   1. Certification of compliance with latest edition of UL 864, Standard for Safety for Control Units and Accessories for Fire Alarm Systems.
   2. Certification of compliance with latest edition of UL 1784, Standard for Air Leakage Tests of Door Assemblies.
   3. Testing Laboratory Label.

D. ASTM International:
   1. ASTM A240 Standard Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

E. International Code Council:
   1. ICC-ES AC77 Acceptance Criteria of Smoke Containment Systems

F. National Fire Protection Association:
   1. NFPA 70 National Electrical Code
   2. NFPA 72 National Fire Alarm Code
   3. NFPA 105 Recommended Practice for the Installation of Smoke-Control Door Assemblies

G. UL:
   1. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
   2. UL 508 Industrial Control Equipment.
   3. UL 864 Control Units for Fire Protective Signaling Systems.
   4. UL 1784 Air Leakage Tests for Door Assemblies.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Indicate the following on the shop drawing submittal:
      a. Elevator lobby ceiling height.
      b. Hoistway door opening width, height, jamb, and head projection.
      c. Mounting height.
      d. Curtain width and housing width.
      e. Show and identify related work performed under other sections of the specifications.
   2. Electrical interconnect drawings.

B. Product Data:
   1. Manufacturer's standard catalog data.

C. Project Information:
   1. Certifications: See paragraph 1.2 B.
   2. Manufacturer's testing procedures.

D. Contract Closeout Information:
   1. Operation and Maintenance Data.
   2. Owner Instruction Report.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Smoke Containment Systems for elevator hoistway doors:
   1. Base:
      a. Smoke Guard Systems.
   2. Optional:
      a. Cornell.
      b. Door Systems.
      c. McKeon Door Company.
      d. U.S. Smoke & Fire.

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 MATERIALS

A. Provide Smoke Containment Systems at the following locations:

| Schedule of Smoke Containment Units | | | | | |
|---|---|---|---|---|---|
| Elevator Name | Elevator No. | Floor Location | Finishes | | Base Model # |
| | | | Auxiliary Rails | Rail Extensions | |
| Passenger | 1 | All levels | Field Paint | Field Paint | Model 600 |

### 2.3 SYSTEM DESCRIPTION

A. Connect system to normally open auxiliary contact circuit of smoke detector equipped with an emergency power supply.

B. Performance:
   1. Air leakage not to exceed 3CFM per SF of door opening at 0.01 IN of H2O pressure differential, at 400 deg F.
   2. Tested per current edition IBC.

C. Base Product:
   1. Model 600 by Smoke Guard Corporation.

D. Auxiliary and extensions rails:
   1. Utilize full height auxiliary rails where any of the following conditions occur:
      a. Where elevator door frames are non-magnetic.
      b. Where face width is of elevator door frames is less than 2 IN wide.
      c. Where frames do not adequately project from the wall surface.
   2. Utilize extension rails from top of frame to ceiling where following occur:
      a. Where magnetic elevator frames are used and do not extend to ceiling.
   3. Material and Profile:
      a. Material: 16 GA, Type 430, ferrous stainless steel complying with ASTM A240.
      b. Face Width: 2 IN.
      c. Depth: 1/2 to 1 IN in depth as required for conditions.
      d. Mechanically attach auxiliary items per manufacturer instructions.
   4. Finish:

a. Standard factory finish:
1) No. 4 brushed stainless steel finish unless otherwise scheduled.

E. Curtain:
1. 2 MIL thick transparent polyimide film reinforced at 0.25 IN each way with 200 denier Nomex yarn.
2. Attach flexible multi-pole magnetic strips to each longitudinal edge of curtain.

F. Rewind Motor:
1. General:
a. Comply with NFPA 70.
2. Model 600:
a. Voltage: 12 VDC.
b. Emergency Power Supply: 12 V DC battery with charger.
c. Control Station: Metal box with battery backup, power disconnect with integral circuit breaker, step down power transformer (120 VAC to 12 VDC), and controller circuit board.
d. Wall Switch:
1) Include switch to rewind curtain into housing, system status indicators, keyed curtain deployment switch, and keyed to silence function.
2) Install in back-box provided by Electrical installer, and shown on Electrical Drawings.

G. Housing:
1. 20 GA, powder coated, cold rolled steel container with dust cover.
2. Door with concealed hinges.
3. Paint:
a. Paint in field to match ceiling color of lobby where installed.
b. Utilize high-heat, spray application, as approved by system manufacturer.

H. Release mechanism:
1. Release Mechanism: Comply with UL Standard No. 508, 864, or both.

I. Rewind Switch:
1. To retract deployed curtain back into housing.
2. Manufacturer's standard type for model specified.

J. Label:
1. Include the following on each unit:
a. Manufacturer name.
b. Maximum leakage rate, specified pressure, and temperature conditions.
c. Label of testing agency.

K. Signage:
1. Post each smoke containment system with sign warning occupants not to exit through smoke barrier.

## 2.4 OPERATION

A. Deployment of Curtain:
1. Deploy curtain within 10 second of loss of primary AC power.
a. Units fed by building emergency power or equipped with battery back-up shall remain in retracted position while back-up power is maintained.
2. Deploy curtain upon signal from local smoke detector.
3. Deploy curtain mechanically under its own power.

B. Bypassing deployed curtains with back-up power:
1. Press pressure sensitive switch embodied in curtain fabric.

a. Switch shall be readily identifiable, clearly marked, and function from either side of the curtain.
2. Motor shall momentarily retract the curtain, allowing occupant to pass.
3. Curtain shall then redeploy.

C. Resetting Units:
1. Retract deployed curtain and reset by use of toggle switch located on housing, or wall switch where specified.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions and applicable codes and ordinances.

B. Examine substrates upon which work will be installed.
1. Verify that wall surfaces and elevator door frames and finishes are acceptable for installation of smoke containment system components.

C. Do not start work until unsatisfactory conditions have been corrected.

D. Provide Smoke Containment System with curtain, control station, metal housing, rewind switch, auxiliary rails and extensions, and accessories as required for complete, UL-labeled, installation.

### 3.2 FIELD QUALITY CONTROL

A. Field Test:
1. Cycle test installations per manufacturer's procedures.
2. Notify Owner's representative, local code authorities, elevator installer, of date scheduled for testing.

B. Demonstrate required testing and maintenance procedures to Owner's representative.
1. Submit written instructions with contract closeout information.

**END OF SECTION**

# SECTION 08 41 10
STOREFRONT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Thermally broken storefront.
   2. Entrance doors and hardware.
   3. Electric door assisting device.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 07 92 00 - Joint Sealants.
   2. Section 08 71 00 - Door Hardware.
   3. Section 08 81 00 - Glass and Glazing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American Architectural Manufacturers Association (AAMA):
      a. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
   3. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   4. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
      a. A156.19, Power Assist and Low Energy Power Operated Doors.
   5. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads for Buildings and Other Structures.
   6. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      d. C1363, Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
      e. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
      f. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
      g. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   7. American Welding Society (AWS):
      a. D1.2, Structural Welding Code - Aluminum.

B. Qualifications:
   1. Qualify welders and welding process in accordance with AWS D1.2.

### 1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. All weather: Capable of operation from -50 to +120 DEGF.

### 1.4 SUBMITTALS

A. Shop Drawings:
1. Product technical data for framing system and major accessories specific to this Project:
   a. Entrance door.
   b. Acknowledgement that products submitted meet requirements of standards referenced.
   c. Manufacturer's installation instructions.
2. Computer generated elevation drawings indicating all frame and door dimensions and details specific to this Project.
3. Warranty.
4. Test reports.
5. Complete wiring layout/diagrams for electric door assisting device.

B. Samples:
1. Metal samples showing range of anodizing finish specified for Engineer's approval.
2. After approval of color samples, provide three, 2 x 3 IN samples of color and finish approved.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
   a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Store units in vertical position off ground with wood spacers between each unit.
1. Store in accordance with manufacturer's instructions.

### 1.6 WARRANTY

A. Written warranty signed jointly by fabricator, installer, and Contractor, agreeing to repair or replace any items of work performed under this Specification Section which fail.
1. Failure includes defects in materials, installation, workmanship, water tightness of assembly, sealant, glazing or any other defects in storefront system which affects its ability to perform as weathertight envelope.
2. Warranty period is five years from date of acceptance.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Storefront system:
   a. Kawneer Co., Inc.
   b. United States Aluminum.
   c. Vista Wall.
   d. YKK-AP America.
2. Electric door assisting device:
   a. Horton Automatics.

### 2.2 MATERIALS

A. Storefront: Aluminum, ASTM B221, 6063-T5.

B. Doors: Aluminum, ASTM B221, 6063-T5.

C. Thermal Barrier: Extruded copolymer.

D. Fasteners: Stainless steel.

E. Sealants: See Specification Section 07 92 00.

F. Brackets, Anchors, Reinforcements: Aluminum or stainless steel.

## 2.3 ACCESSORIES

A. Doors:
1. Types as indicated on Drawings.
2. Factory glazed.
3. Finish to match storefront.

B. Hardware:
1. Hardware specified is based on Kawneer unless noted otherwise.
2. All hardware to be 630 or 626 finish.
3. Equip doors with following hardware:
   a. Interior single door (Double door similar):
      1) Butts:
         a) Manufacturer's heavy duty stainless steel, full mortise, ball bearing type with non-removable pin.
         b) Size: Minimum 4-1/2 x 4 IN.
      2) Closer: See Specification Section 08 71 00.
      3) Threshold: Manufacturer's standard 1/2 x 4 IN aluminum.
      4) Weatherstripping:
         a) See Specification Section 08 71 00.
         b) Storefront manufacturer's standard brush type or pile type weatherstripping is not acceptable.
      5) Cylinder: See Specification Section 08 71 00.
      6) Flush bolts: Manufacturer's standard stainless steel automatic bolts top and bottom.
      7) Exit device: Paneline II with Panic Guard.
      8) Pull: "Style G3 IN (doors with exit device).
   b. Exterior single door (Double door similar):
      1) Butts:
         a) Manufacturer's heavy duty stainless steel, full mortise, ball bearing type with non-removable pin.
         b) Size: Minimum 4-1/2 x 4 IN.
      2) Closer: See Specification Section 08 71 00.
      3) ePush: Not required for doors with exit device.
      4) Pull: "Style G3 IN (doors with exit device).
      5) Exit device: Paneline II with Panic Guard.
      6) Threshold: Manufacturer's standard 1/2 x 4 IN aluminum.
      7) Weatherstripping:
         a) See Specification Section 08 71 00.
         b) Storefront manufacturer's standard brush type or pile type weatherstripping is not acceptable.
      8) Flush bolts: Manufacturer's standard stainless steel automatic bolts top and bottom.
      9) Cylinder: See Specification Section 08 71 00.

C. Electric Door Assisting Device:
1. This device to be installed at exterior doors.
2. Low energy, self contained, electromechanical type.
   a. 120 VAC, 60 cycle, 1 PH.

3. Direct current operation.
4. Door capable of manual operation with power on or off without damage to operating unit.
5. Manual/automatic operation.
6. Comply with ADA and ANSI/BHMA A156.19.
7. Adjustable opening and closing speed with range of 4 to 6 seconds.
8. Adjustable time delay prior to closing with range of 2 to 30 seconds.
9. Activating switch: Extruded aluminum or stainless steel, momentary contact wall mounted push button activating switch.
    a. Engraved with international handicap insignia.
    b. Provide two switches for each door.
10. Provide unit complete with all required wiring for interconnecting activating switch(es) with controller and any other miscellaneous items required for complete installation.
    a. Operator shall be mounted above door with extruded aluminum cover finished to match the door.
    b. Electrical service to control unit provided in the Electrical Design.
11. Horton Automatics Model 7000.

D. Glass:
1. ASCE 7.
2. See Specification Section 08 81 00.

E. Flashing:
1. Minimum 0.040 IN aluminum.
2. Finish to match storefront if exposed.
3. Mill finish if concealed.

F. Sealant: See Specification Section 07 92 00 and manufacturer's recommendations.

G. Fasteners:
1. Structural fasteners anchoring framing to building structure: Stainless steel.
2. Exposed fasteners attaching system framing or components to other system framing or components.
    a. Aluminum: Finish to match finish of system.
3. Provide Phillips head screws where exposed.

## 2.4 FABRICATION

A. General:
1. Fully degrease and clean members prior to assembly or application of protective coatings.
2. Weld using methods recommended by manufacturer and AWS to avoid discoloration.
3. Grind exposed welds smooth and restore finish.
4. Ease corners of cut edges to a radius of approximately 1/64 IN.
5. Conceal fasteners wherever possible.
6. Fit and assemble work at shop to maximum extent possible.
7. Maintain true continuity of line and accurate relation of planes and angles.
8. Provide secure attachment and support at mechanical joint, with hairline fit of contacting members.
9. Reinforce work as necessary to withstand wind loadings and to support system.
10. Separate dissimilar metal with bituminous paint or preformed separators to prevent corrosion.
11. Separate metal surfaces at moving joints with plastic inserts or other nonabrasive concealed inserts to permanently prevent freeze-up of joint.
12. Prepare and reinforce frames for hardware.
    a. Refer to Specification Section 08 71 00 for hardware not specified in this Specification Section.
13. Frames to be structurally reinforced as required by frame manufacturer.
    a. Reinforcement:

1) Structural steel, ASTM A36, hot-dip galvanized after fabrication, ASTM A653, G90.
2) Provide dissimilar metals protection; see Specification Section 09 96 00.
3) All structural reinforcement sizes shall be determined by the frame manufacturer.

14. Minimum wall thickness of 0.07 IN for all frame components.

B. Storefront:
1. Nominal 1-3/4 x 4-1/2 IN minimum section with sightline maximum of 2 IN.
   a. Depth of system as required for loading criteria indicated.
   b. Depth of system may be different between thermally broken and non-thermally broken frames but is to be consistent on entire Project for each of the individual systems.
2. Complete extruded aluminum framing system:
   a. Thermally broken system:
      1) Kawneer VG451T.
      2) Provide thermally broken system on all openings in the building exterior wall and where specified on the interior for borrowed lite systems.
3. Include all sills, mullions, anchors, division bars, and flashing.
4. Use no through metal connectors in thermally broken systems.
5. Fabricate thermally broken system to accept 1 IN insulating glass.
6. Provide complete system under single responsibility.

C. Doors:
1. ASTM B221, aluminum.
2. Top rail: 3-1/2 IN.
3. Side rails: 3-1/2 IN.
4. Bottom rail: 10 IN.
5. Minimum thickness of door components shall be 0.125 IN.
6. Single acting, full mortise butt hinge operation.
7. Prepare and reinforce door for hardware specified.
8. Kawneer Series 350.

D. Sealants:
1. Refer to Specification Section 07 92 00.
2. Provide sealant color to match finish of system at exposed locations.
3. Provide sealants compatible with aluminum system and recommended for use with this type of installation.

E. Finishes:
1. Architectural Class 1 coating per AA DAF 45.
   a. Anodized: AA-M12C22A42/44, dark bronze.

## 2.5 SOURCE QUALITY CONTROL

A. General Test Requirements:
1. Utilize independent testing laboratories specifically qualified to conduct all performance tests required.
2. Performance tests may be conducted in manufacturer's laboratories provided they are witnessed and certified by qualified independent testing laboratory personnel.
3. Provide certification that proposed system has been tested in accordance with and meets the requirements of the standards identified in this Specification Section.
4. Test air infiltration first, water resistance second.
   a. Other tests may be in any order.

B. Air Infiltration Tests (Doors):
1. Test in accord with ASTM E283.
2. Air infiltration: 0.50 CFM/LF of perimeter crack of fixed wall area when tested at 1.567 PSF pressure differential.

C. Air Infiltration Tests (Storefront Framing):

1. Test in accordance with ASTM E283.
2. Air infiltration: 0.06 CUFTM/SF of wall area when tested at a static air pressure differential of 6.24 PSF.

D. Water Resistance Test:
1. Test in accordance with ASTM E331.
2. No leakage allowed at a minimum static air pressure differential of 8 PSF.

E. Uniform Load Test:
1. Uniform load:
a. A static air design load of 20 PSF shall be applied in the positive and negative direction in accordance with ASTM E330.
b. There shall be no deflection in excess of L/240 of the span of any framing member.
c. At a structural test load equal to 1.5 times the specified design load, no glass breakage shall occur and no permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

F. Thermal Tests:
1. Perform all thermal tests on unit sized as required to produce representative areas of framing, vision glass, and spandrel glass.
2. Provide test unit which reflects most restrictive situation on project (e.g., worst framing, glass, spandrel proportions for producing desired thermal results).
3. Test in accordance with AAMA 1503.
4. Thermal transmittance of insulated glass and framing areas: Average U-value of 0.65 BTUH/SF/DegF, maximum.
5. Condensation resistance test:
a. Determine in accordance with ASTM C1363 and AAMA 1503.
b. Provide condensation resistance factor (CRF) not less than 50.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Verify suitability of substrate to accept installation.
1. Correct defects.

B. Install products in accordance with manufacturer's instructions.

C. Set units plumb, level and true to line.

D. Anchor securely in place.

E. Separate metal surfaces from sources of corrosion or electrolytic action.

F. Set sill and base members in a bed of sealant.

G. Provide joint fillers or gaskets for weathertight construction.

H. Seal all joints within and at perimeter of system.
1. Do not seal joints intended to allow the framing system to drain.

I. Install flashing where shown on Drawings and/or where required.

### 3.2 CLEANING

A. Clean all excess sealant, compounds, metal shavings, dirt, fingerprints, and any other foreign material from frame surface promptly after installation.

B. Clean glass inside and out and apply cross streamers attached to frame.

C. Install electric door assisting device in accordance with manufacturer's instructions.
1. Conceal conduits feeding unit.

2. Mount activating switches where shown on Drawings.
   a. Mount at height recommended by manufacturer and to meet requirements of ADA and ANSI/BHMA A156.19.
3. Adjust rate of opening and closing speed and adjust time delay prior to closing to meet requirements of ADA.

**END OF SECTION**

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# SECTION 08 45 00
## TRANSLUCENT PANEL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Translucent panel system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 62 00 - Flashing and Sheet Metal.
   4. Section 07 92 00 - Joint Sealants.
   5. Section 08 81 00 - Glass and Glazing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. ASTM International (ASTM):
      a. C1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
      b. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
      c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. Society of the Plastics Industry (SPI):
      a. Shatter Resistance Test.

B. Qualifications:
   1. Installer factory trained and approved in writing by system manufacturer.
   2. Installer shall have a minimum of five years' experience installing system similar to system specified.
   3. Panel system shall be designed by Professional Structural Engineer licensed in the State of Oregon.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Provide computer generated scaled elevation Drawings, Specification Sections and details stamped and signed by a Professional Structural Engineer licensed in the State of Oregon incorporating the wall construction used for this Project to demonstrate anchorage, flashing and sealing conditions.
   4. Provide structural calculations specific to this Project stamped and signed by same Engineer stamping and signing the Shop Drawings.

5. Warranty: Provide draft of warranty for Engineers review.
6. Certifications:
    a. Certified test reports indicating conformance to material properties and design criteria specified.
    b. Certification of installer qualifications.
    c. Certification of Engineers credentials.

B. Samples:
1. Submit three (3) each of the following to the Architect for review at the same time the Shop Drawings are submitted:
    a. Each aluminum frame section – 6" long.
    b. Samples of aluminum illustrating the specified finish.
    c. Glazing gaskets – 6" long – each type.
    d. Samples of glazing, each minimum 6" x 6", in specified color.
    e. Test reports evidencing minimum performance as described below.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in protective cartons and store to protect from damage.

### 1.6 WARRANTY

A. The Manufacturer shall provide a written warranty certifying that if, within one (1) year from the shipment date of the system, the system experiences water leakage owing to defects in fabrication or materials, the Manufacturer will, in a timely manner, furnish (only) new components to replace all of those found to be defective.
1. The above warranty does not apply in the cases of structural movement of the building(s), negative air pressure inside the building(s), acts of God, alteration or abuse of the products, or unreasonable use.
2. The liability of the Warrantor shall be limited to the above and shall not include incidental or consequential damages of any kind.
3. The polycarbonate or glass glazing materials or any other materials or system finishes on metals) furnished and warranted by others, shall be covered by only those warranties.

B. These additional written warranties will also be provided:
1. The polycarbonate manufacturer's ten (10) year prorated warranty against defective materials, color change and damage.
2. The framing finish applicator's warranty as specified below :
    a. Anodized Finish: Five (5) year from date of application against chalking, fading, cracking, crazing, and blistering.
    b. Fluoropolymer Finish: Five (5) years from date of application against peeling, checking, cracking, chalking, and fading.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Translucent panel system:
    a. An aluminum-framed wall system that is to be glazed with translucent cellular polycarbonate panels that interconnect via extruded tongue and groove edges.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Translucent Panels:
   1. Glazing shall be polycarbonate, extruded and supplied in one single length whenever possible. In addition, they shall be extruded with integral tongue and groove vertical edges that facilitate connecting the panels together.
      a. Systems assembled from two (2) or more individual layers of polycarbonate shall not be permitted.
      b. System shall be dry glazed.
      c. Bottom edges of glazing panels shall rest on non-continuous supports, which allow atmospheric air to reach their bottom edges, which shall be covered by a continuous air permeable tape. EPDM, silicone rubber, or neoprene setting blocks, or any other support method that would tend to restrict the flow of air through the panels is not acceptable.
      d. Air permeable tape shall also be applied to the top edges of the glazing panels.
      e. Unrestricted thermal movement of the glazing panels shall be allowed to occur within the framing system without compromising its weathertightness.
      f. Length and width as indicated on Drawings
   2. Appearance:
      a. The extruded panels shall be uniform in color with an integral extruded multi-cell core. The panel's exterior skins shall be interconnected and spaced apart by continuous ribs, perpendicular and/or be diagonal "X" pattern to the skins. The space between the two exterior skins, in a cross section, shall be divided by multiple parallel intermediate walls. Dual wall systems with an interstitial space shall not be permitted.
      b. Panels shall consist of a polycarbonate resin with permanent, co-extruded, ultraviolet (UV) protective layers on exterior face of the panels. This protective layer shall be co-extruded by the manufacturer during the original extrusion of the panel and shall be a permanent part of both the interior and exterior of the panels. Post-applied coating or films of dissimilar materials are unacceptable.
      c. Panel thickness shall be a minimum of 40mm (1-9/16").
      d. Panel width shall be nominally 19-11/16"
      e. Panel weight shall be nominally 0.82 lbs. per sq. ft.
      f. Color (Panel): Opal
      g. The panels shall be designed and formed with interlocking sides so that multiple panel installations can be achieved without the need to introduce independent mullion framing members.
      h. The panels shall be designed and formed in a manner that allows the insertion of optional internal reinforcement bars, each in close proximity to the interlocking joints of a multiple panel application.
      i. Panel shall be extruded in one single length. Transverse connections are not acceptable.
      j. Panels shall be supplied with closed cell, factory applied, and continuous gasket material on the panel tongue.
      k. The interior cells of the cellular polycarbonate sheets shall be blown clean prior to being sealed. The top and bottom of each sheet shall be sealed with an air permeable filter tape.
      l. The open end of each panel shall rest on a continuous metal setting fin or setting block which is designed to allow atmospheric air to reach the air permeable tape at the bottoms of the panels.
      m. Glazing shall be installed in accordance with panel and system manufacturer's guidelines.
   3. Thermal and Solar Performance:
      a. Insulation Value ("U-Value"): TBD BTU/hr. $ft^2$ $^0F$.
      b. Light Transmission (LT %): TBD

c. Shading Coefficient (SC): TBD
d. Solar Heat Gain Coefficient (SHGC): TBD

4. Attachment:
   a. Attachment of glazing sheets to the intermediate structural elements (i.e. purlins, or girts) or to structural members parallel to the translucent panels shall be achieved by means of one of the following:
      1) One-piece stainless steel clips, which are designed with protruding "T" portions which engage the corresponding grooves extruded in the polycarbonate panels and thereby constrain the sheets. This clip is mounted on a perpendicular (to the glazing panels) face of the transverse structural element.
5. Flammability:
   a. The panel shall have a CC1 fire rating classification when tested in accordance with ASTM D-635 or equivalent.
   b. The panel shall have a Class A flame spread and smoke development rating when tested in accordance with ASTM E-84. Or equal systems must submit ASTM E-84 tests results documenting that the glazed panel has been tested and passed as a complete and full assembly in a manner intended for use on this project. Test results of individual components of a glazed assembly shall not be accepted or permitted as evidence of compliance.

B. Glazing Gaskets:
   1. Shall be elastomeric, having low friction surfaces where they contact the glazing.
   2. Shall be tested for chemical compatibility with the glazing, and test reports evidencing same shall be presented to the Architect.

C. Fasteners:
   1. Concealed fasteners are to be used for all aluminum framing.
   2. The use of adhesives, plastic welding, or sealants in system construction is prohibited.
   3. Where exposed, shall be stainless steel, 300 Series, with stainless steel backed neoprene washers.
   4. Concealed fasteners may be stainless or zinc-plated steel in accordance with ASTM Specifications A165-55 or A164-55.
   5. Bolts, anchors and other fastening devices shall be as required for the strength of the connections and shall be suitable for conditions encountered. Washers shall be of the same metals as fasteners.

D. Panel Framing System:
   1. Extruded aluminum.
   2. Shall be extruded aluminum of 6063-T5, 6005-T5 or 6105-T5 alloy and temper. All sections shall be formed true to detail and free from defects impairing appearance, strength or durability.
   3. Sill frame shall include continuously extruded aluminum weep hoods integral to the pressure cap. Post applied metal or plastic weep hoods are not approved.
   4. Pressure caps retaining the polycarbonate panels shall be designed to prevent over compression of the polycarbonate panels during installation to ensure free thermal movement of the polycarbonate. Screw on pressure caps or other designs that to not prevent over compression of the polycarbonate shall not be permitted.
   5. Thermally broken perimeter aluminum framing members, exclusive of cover caps, shall incorporate an integral structural polyurethane thermal break.
   6. Manufacturer's standard section capable of performing for intended use on this Project.
   7. Support structure, constructed of materials of adequate load bearing capacity and to maintain visual design concepts, and for attachment to and support of the specified system, supplied by other trades.
   8. Whenever possible, fasteners shall be concealed.
   9. The rabbet depth of all framing members shall, at a minimum, be based on a ¾" (.75") engagement of the glazing panel, plus 1/8" (.125") cutting tolerance, plus .005 x the glazing

dimension (in inches) that affects that rabbet. For example, a glazing panel that is 100" long will require a minimum rabbet depth of .75" + .125" + (.005 x 100") = 1.375".

10. System shall not require vertical aluminum framing in the field of the glazing with exception of the jamb locations at the outermost perimeters of the openings.
11. Finish:
    a. Anodized Coatings:
        1) Architectural Class I (215-R1) Clear Anodized type AA-M10C22A41 complying with AAMA 611, 0.7 mil thick minimum.
    b. High-Performance Organic Coatings:
        1) Pigmented organic coatings: Fluoropolymer, 2-coat 50% KYNAR 500 complying with AAMA 2604. Colors - custom.

E. Flashing:
1. Minimum 0.040 thick Aluminum
    a. Painted finish: 3105-H14.
    b. Anodized finish: 5005-H34.
2. Factory formed to required profile(s) in 10-ft lengths, whenever practical, to allow for field trimming to suit as-built conditions.
3. The finish on this metal shall match as closely as possible that which is on the extruded aluminum framing members.

### 2.3 DESIGN CRITERIA

A. Air Infiltration: Not to exceed 0.022 cfm/sq. ft. of glazing area when tested at a pressure of 6.24 psf (0.03 kPa) in accordance with ASTM E-283.

B. Water Penetration: None when tested vertically at a pressure equal to 9psf per ASTM E-331.

C. Structural Performance: The system shall be capable of meeting codes for supporting the design loading for this project as listed below:
1. Positive Wind Load: _TBD_ psf
2. Negative Wind Load: TBD_ psf
3. Snow Load: TBD psf

D. Testing by a certified independent testing laboratory, in accordance with ASTM E-330, shall evidence this. In addition, the deflection of all framing members oriented normal to the glazing plane shall not exceed L/175.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify suitability of substrate to accept work.

B. Installation constitutes acceptance of substrate.

### 3.2 INSTALLATION

A. Install units in accordance with manufacturer's written installation instructions.

B. Anchor units to resist loading indicated.

C. Use methods of attachment to structure which include provisions for thermal movement.

D. Glazing shall be installed in accordance with panel and system manufacturer's guidelines.

E. Remove all protective coverings on polycarbonate panels during or immediately after installation.

F. Installation shall be performed by a company with ten (10) years continuous experience in commercial construction.

G. Protect contact points between unprotected dissimilar metals (except stainless steel) using continuous separators of FRP, PVC tape (or approved equal)

## 3.3 CLEANING

A. During installation, protect exposed surfaces against accumulation of paint, caulking, disfiguration and damage.

B. Interior glazing surfaces shall be cleaned as the panels are being installed. The exterior shall be cleaned as each phase of the work is completed.

C. Follow panel manufacturer instructions when cleaning exposed panel surfaces. Clean polycarbonate and frame at time of installation.

D. Follow panel manufacturer's guidelines when removing foreign substances from panel surfaces. Use only solvents that are deemed acceptable for use.

E. Before final acceptance, repair and/or replace any defective materials or work.

**END OF SECTION**

# SECTION 08 51 13
ALUMINUM WINDOWS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Aluminum windows.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 92 00 - Joint Sealants.
   4. Section 08 81 00 - Glass and Glazing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 904, Voluntary Specification for Multi-Bar Hinges in Window Applications
      b. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
      c. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   2. ASTM International (ASTM):
      a. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
      b. C1363, Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
      c. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
      d. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
      e. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   3. American Welding Society (AWS):
      a. D1.2, Structural Welding Code - Aluminum.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data for framing system and major accessories including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Hardware being provided by window manufacturer.
      c. Glass being provided by window manufacturer in factory glazed units.
      d. Manufacturer's installation instructions.

3. Elevation drawings indicating window dimensions and details.
4. Color charts showing range of colors of anodized units for Engineer's color selection.

B. Samples:
1. After initial color selection, provide 2 x 3 IN minimum sample of each color and finish selected.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Qualifications of testing laboratory.
3. Test results.
4. Warranty.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Store units in vertical position off ground with wood spacers between each unit.

### 1.6 WARRANTY

A. Five year warranty of weathertightness of installation.
1. Air and water integrity and structural adequacy of units and hardware, including sealants and sealing within and around perimeter of installation.
2. Signed jointly by fabricator, installer, and contractor.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Thermally broken windows:
a. Wausau Metals Corp., 2250-T Series.
b. Kawneer Company Inc., 8225-T Series.
c. EFCO Windows, Series450X/G

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Extruded Aluminum: 6063T5 alloy.

B. Sealants: As specified in Section 07 92 00.

C. Thermal Insulator: Poured in place polyurethane, self-adhering to adjacent aluminum surfaces.

D. Weatherstripping: Sponge neoprene.

### 2.3 ACCESSORIES

A. Screens:
1. 18 x 16 mesh aluminum wire screens.
2. Secure to aluminum shapes with vinyl spline.
3. Hold in place with spring loaded plungers.
4. Removable to inside of building.
5. Finish same as window frames.

B. Flashing:
   1. Minimum 0.040 IN aluminum.
   2. Finish to match window frames.
   3. Mill finish if concealed.

## 2.4 FABRICATION

A. General:
   1. Fully degrease and clean members prior to assembly or application of protective coatings.
   2. Weld by methods recommended by manufacturer and AWS D1.2 to avoid discoloration at welds.
   3. Grind exposed welds smooth and restore finish.
   4. Ease corners of cut edges to a radius of approximately 1/64 IN.
   5. Conceal fasteners wherever possible.
   6. Fit and assemble work at shop to maximum extent possible.
   7. Maintain true continuity of line and accurate relation of planes and angles.
   8. Provide secure attachment and support at mechanical joint, with hairline fit of contacting members.
   9. Reinforce work as necessary to withstand wind loadings and to support system.
   10. Separate dissimilar metal with paint or preformed separators to prevent corrosion.
      a. See Section 09 96 00.
   11. Separate metal surfaces at moving joints with plastic inserts or other nonabrasive concealed inserts to permanently prevent freeze-up of joint.
   12. Reinforce frames for hardware.
   13. Structural steel reinforcement hot-dip galvanized after fabrication meeting G-90, ASTM A924, requirements.

B. Operating Sash (Casement and Projected):
   1. Mitre members at corners.
   2. Fasten together by use of a corner block and permanently join by mechanical means, chemical or heliarc welding on nonexposed surfaces, leaving only hairline joinery.
   3. Seal weathertight.
   4. Do not use joinery methods which discolor finish.

C. Construct Window Frames (Fixed and Projected):
   1. Cope and mechanically fasten together at corners or mitre at corners and heliarc weld on nonexposed surfaces, leaving only hairline joinery.
   2. Seal weathertight.
   3. Do not use joinery methods which discolor finish.

D. Thermal Insulator: Provide minimum 1/4 IN separation between exterior and interior metal surfaces after bridge is removed.

E. Weatherstripping:
   1. Thermally broken type windows:
      a. Casement and projected:
         1) Provide two rows of fin type extruded neoprene weatherstrips extending around perimeter of sash at both inner and outer overlap contacts.
         2) Provide corners which are securely staked and joined.
         3) Provide units which are easily replaceable.

F. Window Hardware:
   1. General:
      a. Locking device and strikes: White bronze and/or non-magnetic stainless steel.
      b. All hardware elements that bridge sash or frame thermal barrier: Reinforced nylon, deirin or suitable non-metallic, low conductivity material.

c. Custodial key operation: Secure sash in closed position and automatically lock in washing position.
d. Safety keys removable only in closed position.

2. Projected:
a. Two balance arms with adjustable non-abrasive friction pivots or adjustable non-abrasive friction shoes to support sash in any open position.
b. Concealed, four-bar friction hinges meeting AAMA 904.
c. Two locks when sash are more than 4 FT wide.
d. Use incorporated stop within hinge in lieu of Life Safety hold open device when four-bar friction hinges are used.

3. Glass: See Section 08 81 00 for types of glass to be installed under this Section.

G. Fasteners:
1. Finish exposed fasteners to match finish of system.
2. Provide Phillips flat head screws where exposed.

H. Finish: AA-MA10C22A42, anodized.
1. Color: Dark bronze.

## 2.5 SOURCE QUALITY CONTROL

A. General Test Requirements:
1. Utilize independent testing laboratories specifically qualified to conduct all performance tests required.
2. Performance tests may be conducted in manufacturer's laboratories provided they are witnessed and certified by qualified independent testing laboratory personnel.
3. Test air infiltration first, water resistance second.
a. Other tests may be in any order.
4. Test data on vertical pivot windows will be accepted for fixed windows for condensation resistance, thermal, temperature exposure and acoustical tests provided the fixed windows are the same as the vertical windows tested in the following respects:
a. Same frame section (or same family of extrusions).
b. Same basic metal mass inside and outside.
c. Identical thermal break.
d. Same type of glazing.
5. CRF, thermal and exposure tests may be made on alternate test unit.
6. Alternate test unit: Same as test unit except as follows:
a. Window unit as required by AAMA 1503, 3 x 4 FT.
b. Unit need not be identical to project unit but must comply as follows:
c. Same thickness of frame section (front to back).
d. Identical thermal break.
e. Same basic metal mass on outside.
f. Same type of glazing.
g. Submit all information necessary to prove that Alternate Test Unit complies in above respects.

B. Test Requirements:
1. Air infiltration test:
a. With sash and ventilators closed and locked, test in accordance with ASTM E283.
b. Air infiltration, in CFM/FT of crack length, at pressure differential of 6.24 PSF as follows:
1) Fixed windows: 0.06 maximum, all others 0.10 maximum.
2. Water resistance test:
a. Mount glazed unit in its vertical position, continuously supported around outside perimeter with sash and ventilators closed and locked.
b. Test in accordance with ASTM E331.
c. No uncontrolled leakage allowed, with pressure differential of 6.24 PSF.

3. Uniform load deflection test:
   a. Test in accordance with ASTM E330.
   b. Subject unit to load of 25 PSF applied to outside of window and 25 PSF applied to inside of window.
   c. Maximum allowable deflection of any unsupported span: L/175.
   d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms, or any other damage which would cause window to be inoperable will be allowed.
4. Uniform load structural test:
   a. Test in accord with ASTM E330.
   b. Subject unit to loads indicated below.
   c. Stabilize pressure and maintain it for minimum period of 10 seconds.
   d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms or any other damage which would cause window to be inoperable will be allowed.
   e. Maximum permanent deformation of any main frame, sash or ventilator member: 0.4 PCT of its span.
   f. After performing Uniform Load Structural Test, increase loads 1-1/2 times and perform safety test.
   g. Design unit to withstand following design pressures acting normal to plane of wall, at applicable heights and locations.
      1) At height of 30 FT or less: TBDPSF acting inward TBDPSF acting outward; per structural wind loading general notes..
5. Projected ventilator torsion:
   a. Remove ventilator, deglaze and support horizontally on fulcrums at diagonally opposite corners with other top corner secured in same plane between fulcrums clamped above and below.
   b. Apply 15 LB load acting vertically downward at free corner of ventilator.
   c. Deflection at free corner: 0.121A (A is area in square foot of ventilator being tested).
   d. Measure deflection from original position of free corner.
6. Projected, latch rail horizontal load:
   a. Support unglazed ventilator by clamping stiles, 6 IN from latch rail to horizontal supports under jambs.
   b. Apply 30 LB concentrated load to center of span of latch rail, perpendicular to plane of ventilator.
   c. Deflection at point of load application: 0.062 IN, maximum.
7. Projected, latch rail vertical load:
   a. Clamp stiles of each unglazed ventilator to vertical supports 6 IN from latch rail.
   b. Apply 30 LB concentrated load at center of span of latch rail, parallel to plane of ventilator.
   c. Deflection at point of load application: 0.062 IN, maximum.
8. Projected, intermediate frame rail torsion:
   a. Place unglazed window frame in horizontal position.
   b. Apply 40 LBF-IN (10 LB load on 4 IN lever arm measured from extremity of rail) to center of span of each intermediate horizontal rail.
   c. Deflection at point of load application: 0.070 IN, maximum.
9. Projected, intermediate frame rail vertical load:
   a. Clamp jambs of unglazed unit to vertical support 6 IN from test rail.
   b. Apply 30 LB concentrated load at center span of each intermediate rail parallel to plane of window.
   c. Deflection at point of load application: 0.062 IN, maximum.
10. Projected balance arm test:
    a. Test all arms if two or more ventilators are in unit.
    b. Support unglazed unit at 45-DEG angle to vertical and clamp frame its full height.

c. Open ventilator 45 DEG with balance arms in compression, and block in level position at both friction shoes.
d. Apply 60 LB vertical concentrated load at each free corner of ventilator for 1 minute.
e. After removal of loads, balance arms shall function normally with no apparent damage.

11. Condensation resistance test:
    a. Perform on "test unit," except size may be 3 x 4 FT, minimum.
    b. Test in accordance with AAMA 1503.
    c. CRF (Condensation Resistance Factor): 50, minimum.
12. Thermal test:
    a. Perform on "test unit" except size may be 4 x 6 FT, minimum.
    b. Test in guarded hot box ASTM C1363, with an exterior temperature of 18 DEGF, an interior of 68 DEGF and 15 MPH fan-generated wind velocity on exterior.
    c. "U" value: not to exceed 0.65 BTU/HR/SQFT/DEGF.
    d. Calculated "U" values from smaller units or data or theoretical assumptions will not be acceptable.
13. Temperature exposure test:
    a. Perform on "test unit" except size may be 4 x 6 FT, minimum.
    b. Maintain interior chamber temperature at 70 DEGF.
    c. Reduce exterior ambient temperature to minus 15 DEGF.
    d. Interior rail of frame and ventilator must maintain a temperature of not less than +_65 DEGF as indicated by thermocouple temperature sensing.
14. Structural thermal barrier tension test:
    a. Test urethane filled sections of aluminum.
    b. Mechanically secure interior and exterior faces of 12 IN section in horizontal position.
    c. Apply heat tape to exterior face to control surface temperature at 180 DEGF 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
    d. Apply direct tension (pull) using a Universal testing machine set in 12,000 LB load range.
    e. Test results: No loss of bond at 4000 LB IN/IN/MIN.
15. Structural thermal barrier shear test:
    a. Test urethane filled sections of aluminum.
    b. Mechanically secure interior face of 12 IN section in vertical position.
    c. Apply heat tape to exterior face to control surface temperature at 180 DEGF 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
    d. Apply load to exterior face by a bearing plate resting on top of exterior face, using Universal Testing machine set in 12,000 LB load range at a strain rate of 0.050 IN/IN/MIN.
    e. Test results: No loss of bond at 5500 LB loading.
16. Structural thermal barrier combined torsion and shear test:
    a. Test urethane filled sections of aluminum.
    b. Secure interior face of 12 IN section in horizontal position.
    c. Apply heat tape to exterior face to control surface temperature at 180 DEGF 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
    d. Apply load to bearing plate centered on portion of glazing pocket to exterior side of thermal barrier, using a Universal Testing machine set in the 12,000 LB load range.
    e. Test results: No loss of bond at 3900 LB load applied at strain rate of 0.05 IN/IN/MIN.
17. Acoustical test:
    a. Test in accordance with ASTM E90 and ASTM E413.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Set units plumb, level, and true to line.

C. Anchor securely in place.

D. Separate metal surfaces from sources of corrosion or electrolytic action.
   1. See Section 09 96 00.

E. Set sill and base members in a bed of sealant.

F. Provide joint fillers or gaskets for weathertight construction.

G. Seal all joints within and at perimeter of system.

H. Provide sealant color to match finish of system at exposed locations.

I. Provide sealants compatible with aluminum system and recommended for use with this type of installation.

J. See Section 07 92 00 for sealants.

### 3.2 FIELD QUALITY CONTROL

A. Installation supervised or inspected by manufacturer's authorized representative.

**END OF SECTION**

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# SECTION 08 62 50
## TUBULAR DAYLIGHTING DEVICES

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. Tubular daylighting devices and accessories.

### 1.2 RELATED SECTIONS

A. Section 06100 - Wood Framing; Site built wood curbs and nailers.

B. Section 07540 - Thermoplastic Membrane Roofing: Flashing of skylight base.

C. Section 07600 - Flashing and Sheet Metal: Metal curb flashings.

D. Division 23 HVAC Air Distribution

Division 25 - Integrated Automation Controls: Lighting controllers.

E. Division 26 Electrical: Power cable, power supply and electrical connections.

F. Lighting Equipment and Controls: Control cable, dimming controls, light bulbs and lamps.

### 1.3 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
   1. AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights; 2011.

B. American National Standards Institute (ANSI):
   1. ANSI C63.4-2014 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

C. ASTM International (ASTM):
   1. ASTM A463/A463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.
   3. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   4. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   5. ASTM D635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   6. ASTM D1929 - Test Method for Ignition Properties of Plastics.
   7. ASTM D2843 - Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.
   8. ASTM F1642 - Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading.
   9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   10. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings.
   11. ASTM E283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   12. ASTM E308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.
   13. ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls and Doors.

14. ASTM E547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference.
15. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missiles and Exposed to Cyclic Pressure Differentials.
16. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.
17. ASTM F2912 - Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading.

D. Factory Mutual (FM):
   1. FM Standard 4431 - The Approval Standard for Skylights.

E. Federal Emergency Management Agency (FEMA):
   1. FEMA P-361 - Safe Rooms for Tornadoes and Hurricanes.

F. International Building Code (IBC): 2019 OREGON STRUCTURAL SPECIALTY CODE. (OSSC)
   1. IBC Section 1710 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by ATI PE); 2012.
   2. IBC Section 2606.7.2 - Installation - Diffuser Fall Out Test (Devised by PE); 2012.

G. OSHA 29 CFR - 1910.23 (e)(8) (Guarding Requirements for Skylights); 1926 Subpart M (Fall Protection); 1926.501(b)(4)(i); 1926.501(i)(2); 1926.501(b)(4)(ii).

H. Underwriters' Laboratories (UL):
   1. UL 2108 - Low Voltage Lighting Systems.

## 1.4 PERFORMANCE REQUIREMENTS

A. Daylight Reflective Tubes: Spectralight Infinity with INFRAREDuction Technology combines ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance. Patented spectrally-selective optical surface yields an average total- and specular-reflectance for the Visible Light spectrum (400 nm to 700 nm) providing maximized visible light transmission and less than 25 percent reflectance for Infrared (IR) heat wavelengths (750 nm to 2500 nm) for minimized heat transmission, resulting in a spectrally-selective Total Solar Spectrum (250 nm to 2500 nm) reflectance less than 37 percent, as measured using a Perkin Elmer Lambda 1050 spectrophotometer with a Universal Reflectance Accessory. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance with ASTM E308.

B. SKYVAULT M74 DS / OPEN CEILING
   1. AAMA/WDMA/CSA 101/IS2/A440, Class CW-PG80, size tested 36 inches by 36 inches (914 mm by 914 mm), Type TDD and Type TDDOC.
      a. Air Infiltration Test: Single and Dual Glazed Dome (M74 DS Type DP and DPP):
         1) Passes Air infiltration; maximum of 0.05 cfm/ft2 (0.3 L/s/m2) when tested according to ICC-ES AC-16, and ASTM E283.
         2) Meets or exceeds the air leakage performance levels with a maximum 0.4 cfm/ft2 when tested in accordance with ASTM E283.
         3) Air exfiltration will not exceed 0.4 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E283.
      b. Water Resistance Test
         1) Single and Dual Glazed Dome (M74 DS Type DP and DPP): Passes water resistance; no uncontrolled water leakage with a pressure differential of 12.11 psf (580 Pa) or 15 percent of design pressure and a water spray rate of 5 gallons/hour/sf for 24 minutes when tested in accordance with ICC-ES AC-16, ASTM E547, ASTM E331, and TAS 202.

c. Uniform Load Test: All units tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E330.
    1) Single and Dual Glazed Dome (Type DP and DPP): Design Pressure plus or minus 80.20 psf (plus or minus 3.84 kPa).
        a) Passes uniform load test: No breakage, permanent damage to fasteners, hardware parts, or damage to make daylighting system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 240.6 psf (11.52 kPa) or Negative Load of 160 psf (7.66 kPa) when tested according to ICC-ES AC-16, and ASTM E330

2. Hurricane Resistance:
    a. Large Missile Impact test:
        1) Dual Glazed Dome (Type DPP) Passes:
            a) No signs of penetration, rupture, or opening when tested in accordance with TAS 201
    b. Uniform Static Air Pressure Test: Passes Design pressure rating a minimum of plus or minus 80.2 psf (3.84 kPa) when tested in accordance with ASTM E1886, ASTM E1996, and TAS 202
    c. Air Infiltration Test:
        1) Dual Glazed Dome (Type DPP) Passes:
            a) Air Infiltration a maximum 0.04 cfm/ft2 at 1.57 psf (25 mph) test pressure when tested in accordance with TAS 202
            b) Air Infiltration, a maximum 0.05 cfm/ft2 at 6.24 psf (50 mph) test pressure when tested in accordance with TAS 202.
    d. Water Penetration Test:
        1) Dual Glazed Dome (Type DPP) Passes: No sign of water penetration at 12.11 psf (0.580 kPa) or 15 percent of Design Load when tested in accordance with TAS 202.
    e. Cyclic Wind Pressure Loading:
        1) Dual Glazed Dome (Type DPP): Passes. No signs of failure during the cyclic load test when tested in accordance with ASTM E1886, ASTM E1996, and TAS 203.
3. Wind Load Test:
    a. Daylight Collector System (Type C): Passes: No sign of failure or destruction when a maximum 2.5 times design load is applied laterally to the exposed cylindrical section when tested in accordance with IBC Section 1710 and Florida Building Code Section 1715.3 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by Architectural Testing Inc. PE.
    b. Design Load: 69.7 psf.
    c. Force Coefficients of Chimneys, Tanks, Rooftop Equipment, and Similar Structures according to ASCE/SEI 7-10 Figure 29.5-1
        1) Cross Section: Round
        2) Type of surface: Moderately smooth
        3) Ratio (h/D): 1.4
        4) Force coefficient: 0.6
4. Fire Testing:
    a. Fire Rated Roof Assemblies: When used with the Dome Edge Protection Band and mounted on curbs 4 inches high or greater, all domes shall meet the prescriptive fire rating requirements for Class A, B, and C roof assemblies as described in the International Building Code / 2019 OREGON STRUCTURAL SPECIALTY CODE. (OSSC).
    b. Self-Ignition Temperature Testing:
        1) Outer Dome Glazing (Type DP and DPP): Self-Ignition Temperature greater than 650 degrees F when tested in accordance with ASTM D1929.
        2) Inner Dome Glazing (Type DPP): Self-Ignition Temperature greater than 650 degrees F when tested in accordance with ASTM D1929.

3) Cylinder Collector (Type C): Self-Ignition Temperature greater than 650 degrees F when tested in accordance with ASTM D1929.
4) Diffuser (Type - All M74 DS): Self-Ignition Temperature greater than 650 degrees F when tested in accordance with ASTM D1929.

c. Smoke Density Rating:
1) Outer Dome Glazing (Type DP and DPP):
a) Smoke Density Rating no greater than 450 per ASTM E84.
b) Smoke Density Rating no greater than 75 per ASTM D2843
2) Inner Dome Glazing (Type DPP): Smoke Density Rating no greater than 75 per ASTM D2843
3) Cylinder Collector (Type C):
a) Smoke Density Rating no greater than 450 per ASTM E84
b) Smoke Density Rating no greater than 75 per ASTM D2843
4) Light Transmitting Diffuser (Type - All M74 DS): Smoke Density Rating no greater than 75 per ASTM D2843

d. Rate of Burn and/or Extent of Burn:
1) Outer Dome Glazing (Type DP and DPP): Minimum CC-1 Classification less than 1 inch (25 mm) extent of burn per ASTM D635
2) Inner Dome Glazing (Type DPP): Minimum CC-2 Classification less than 2.5 inches/min (62 mm/min) rate of burn per ASTM D635.
3) Cylinder Collector (Type C): S Minimum CC-1 Classification less than 1 inch (25 mm) extent of burn per ASTM D635
a) Raybender Daylight Lens (Type C): Minimum CC-2 Classification less than 2.5 inches/min (62 mm/min) rate of burn per ASTM D635.
4) Diffuser (Type - All M74 DS): Minimum CC-2 Classification less than 2.5 inches/min (62 mm/min) rate of burn per ASTM D635.

5. FM Certification:
a. Spread of Flame: Passes: Class A at 5 in 12. No flame spread when tested in accordance with FM modified version of ASTM E108 Fire Test of Roof Coverings.
b. Simulated Hail Resistance (Pre UV Exposure): Passes: No cracking or breaks when tested with nominal 2.0 in. (51 mm) diameter ice ball having a kinetic energy of 26.8 ft-lbs (36.4J)
c. Simulated Hail Resistance (Post UV Exposure): Passes: No cracking or breaks when tested with nominal 2.0 in. (51 mm) diameter ice ball having a kinetic energy of 26.8 ft-lbs (36.4J) after no less than 1000 hours of ultraviolet (UV) light exposure.
d. Simulated Impact: Passes: No breakage or through openings when a 100 lb (45.5 kg) weight dropped from 4 ft (1.2 m) above highest point of test sample.
e. Simulated Wind Uplift: Passes: 195 psf Wind Rating. No separation, breaking or cracking occurred when tested in accordance with FM 4431.

6. Interior Finish Classification (IBC Section 803):
a. Outer Dome Glazing (Type DP and DPP): Class B per ASTM E84
b. Cylinder Collector (Type C): Class B per ASTM E84
c. Diffuser (Type - All M74 DS): Comply with IBC Section 2606.7.2 (Diffuser Fall Out Test).

7. Fall Protection Performance
a. Passes fall protection test: No penetration of dome or curb cap shall occur when subject to 700 lb (318.2 Kg)/60 second static load test and 700 lb (318.2 Kg)/2-foot (610 mm) impact drop test when tested in accordance with OSHA 29 CFR 1926 Subpart M (Fall Protection) 1926.501(b)(4)(i); 1926.501(i)(2); and 1926.501(b)(4)(ii).
b. Passes fall protection test: Oregon State OSHA Fall Protection Code of Regulations, Title 8, Section 3212 (e)(1)

8. Blast Resistance: ASTM F1642, ASTM F2912, GSA-TS01-2003, and UFC 4-010-01:
a. Airblast Loading ASTM Hazard Rating: Passes: No Break Rating
b. Airblast Loading UFC Level of Protection: Passes High Level of Protection
c. Dynamic Overpressure Loading ASTM Hazard Rating: Passes: No Break Rating

d. Dynamic Overpressure Loading UFC Level of Protection: Passes High Level of Protection

## 1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Data sheets showing roof dome assembly, flashing base, reflective tubes, diffuser assembly, and accessories.
   4. Installation requirements.

C. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including rough opening and framing dimensions, anchorage, roof flashings and accessories.

D. Electrical wiring diagrams and recommendations for power and control wiring.

E. Verification Samples: As requested by Architect.

F. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

G. Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features:
   1. LED Luminaires: Include estimated useful life, calculated based on IES LM-80 test data.
   2. To meet LM-80 lifetime projections, LM-80 Max Drive Current must not be exceeded. Lumen maintenance and lifetime predictions are valid for drive current and case temperature conditions used for LM-80 testing as included in the applicable LM-80 test report for these products.

## 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: All primary products specified in this section will be supplied by a single manufacturer with a minimum of twenty years experience in the top lighting industry. Secondary products shall be acceptable to the primary manufacturer.

B. Installer Qualifications: All products shall be installed by a single installer with a minimum of five years demonstrated experience, with adequate equipment, skilled workers, and practical experience to meet the project schedule.

C. Skylights shall conform with authorities having jurisdiction and be designed to meet design criteria of the project location and the following:
   1. Skylights must be certified by NFRC.
   2. Skylights must be Tested and labeled in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
   3. Skylights must have Factory Mutual (FM) Approval Class Number 4431.
   4.
   5. Meet or exceed OSHA 200 pound (90 kg) Drop Tests expressed in 29 CFR 1910.23(e)(8)
   6. Skylights shall provide minimum 69 psf (3.30 kPa) design load.

D. Pre-Installation Meeting: Contractor shall convene a pre-installation meeting on the project site minimum one week before beginning work of this Section. The meeting shall include the Architect or Owner's Representative and representatives of all related trades to:
   1. Coordinate between the at least the following trades.
      a. Roofing to install the flashing, skylight, and LED Light Kit (when specified)
      b. Electrical to wire components and program lighting controls.
   2. Verify project requirements and site logistics.

3. Assess integrity of the roofing system and building structure.
4. Review manufacturer's installation instructions and warranty requirements.

### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in a cool dry location protected from the weather and in the manufacturer's original unopened containers until ready for installation.

B. Store products in manufacturer's unopened packaging until ready for installation.

### 1.8 PROJECT CONDITIONS

A. Coordinate delivery schedule with the Contractor and project schedule to minimize on site storage.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

C. Store materials in a dry area, protected from freezing, staining, contamination or damage.

### 1.9 WARRANTY

A. Daylighting Device: Manufacturer's standard warranty for 10 years.

B. Electrical Parts: Manufacturer's standard warranty for 5 years, unless otherwise indicated.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Acceptable Manufacturer: Solatube International, Inc., which is located at: Solatube International 2210 Oak Ridge Way; Vista, CA 92081-8341; Toll Free Tel: 888-765-2882; Tel: (760) 477-1120; Fax: (760) 597-4488; Email:request info (sales@solatube.com); Web:http://www.solatube.com

B. Requests for substitutions will be considered in accordance with provisions of Section 01 25 13.

### 2.2 TUBULAR DAYLIGHTING DEVICES

A. Tubular Daylighting Devices General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.

B. SkyVault Series: Solatube Model M74 DS
   1. Capture Zone:
      a. Daylight Collector (Type C) with key components consisting of:
         1) Collector Dome: Polycarbonate 0.125 inch (3.2 mm) minimum thickness classified as CC1 material; UV inhibiting; (100 percent UVC, 100 percent UVB and 98.8 percent of the range of UVA transmission). Dimensions: 31.5 inches (800 mm) diameter by 6 inches (152 mm) high.
         2) Collector Cylinder: Polycarbonate 0.093 inch (2.4 mm) minimum thickness, classified as CC1 material; UV inhibiting, blocks all radiation < 380nm: 100 percent UVC, 100 percent UVB and 76 percent of the range of UVA transmission). Dimensions: Dimensions 35.88 inches (911 mm) high by 51.5 inches (1308 mm) arc length.
         3) Collector Cylinder Back Panel: Support for collector assembly. Fabricated of corrosion resistant zincalum steel sheet CS-B AZ50, conforming to ASTM A792/A792M, with a thickness of 0.0276 inch (0.7 mm). Dimensions: 36 inches (914 mm) high by 48 inches (1219 mm) arc length.
         4) Collector Cylinder LightTracker Reflector: Daylight reflector. Aluminum sheet, thickness 0.018 inch (0.5 mm). Interior Finish: Spectralight Infinity with

INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance. Dimensions: 36 inches (914 mm) high by 48 inches (1219 mm) arc length.

5) Micro-replicated Raybender HD Fresnel Lens: Daylight collecting lens. Impact resistant acrylic, 0.020 inch (0.51 mm) thick film with linear prism lens structure, classified as CC2 material. Dimension: 16 inch (406 mm) high by 51.75 inch (1314 mm) arc length.
6) Cylinder Collector Stanchion: "U" shaped support connecting the dome ring to the base cone assembly; (2) each. Fabricated of corrosion resistant galvanized steel sheet (G90), conforming to ASTM A653/A653M, with a thickness of 0.052 inch (1.3 mm). Dimensions: 36 inches (914 mm) high by 0.50 inches (12.7 mm) wide by 0.375 inches (9.5 mm) deep.
7) Base Cone Assembly: Conical shaped support connecting the daylight collection system to the curb-cap of associated TDD unit. Fabricated of corrosion resistant stainless steel (302/304), conforming to ASTM A463/A463M, with a thickness of 0.034 inch (0.86 mm). Dimensions: 35.9 inches (912 mm) major diameter by 30.385 inches (772 mm) minor diameter by 2.28 inches (58 mm) high.
8) Upper seal (M74 DS Type C): Outer Dome, Cylinder Dome, and Back Panel interface. Adhesive backed PU foam "D" profile with water resistant polymeric skin. Dimension: 0.375 inch (9.5 mm) wide by 0.25 inch (6.35 mm) high.
9) Lower seal (M74 DS Type C): Outer Dome and Support Cone interface. Adhesive backed 45 degree angle pile weather-strip. Dimension: 0.670 inch (17 mm) high by 0.27 inch (6.85mm) wide.

b. Domes:
   1) Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
      a) Fasteners: Non-corrosive metal fasteners including: non-magnetic stainless steel, zinc plated steel, aluminum, or injection molded nylon.
      b) Dome Edge Protection Band: For Classified Roof Assemblies. For approved assemblies, curb height (by others or built on site) must be more than 8 inches (203 mm). Galvanized steel. Nominal thickness of 0.039 inch (1 mm).
   2) Dual Dome Glazing: Type DPP.
      a) Outer Dome Glazing: 0.125 inch (3.2 mm) minimum thickness, vacuum formed polycarbonate classified as CC1 material; UV inhibiting; (100 percent UVC, 100 percent UVB and 98.8 percent of the range of UVA transmission).
      b) Inner Dome Glazing: 0.040 inch (1 mm) minimum thickness, copolyester (PETG) polyethylene terephthalate with glycol classified as CC2 material.
      c) Seals:
         (1) Inner Dome Seal: Adhesive back closed cell foam seal 0.125 inch (3.2 mm) or 0.188 inch (4.8 mm) tall by 0.375 inch (9.5 mm) wide.
         (2) Dome Assembly Seal: Adhesive backed pile weather-strip, 0.350 inch (8.9 mm) tall by 0.187 inch (4.8 mm) wide.

c. Dome Options:
   1) Security Guard: Type SG, welded stainless steel rods 1/8 inch diameter mounted with an 8 inch maximum cross section. Assembly fastened with 1/8 inch diameter blind rivets in 6 locations to Curb-Cap assembly.

d. Flashings:
   1) Curb Cap Flashing Base: Type FC one piece, seamless, leak-proof flashing and base support for dome and top of tube and cap flashing. Fabricated of corrosion resistant sheet steel, conforming to ASTM A653/A653M or ASTM A463/A463M or ASTM A792/A792M, with a thickness of 0.0276 inch (0.7 mm) plus or minus .004 inch (.01 mm).
      a) Base Style: Curb-cap, with inside dimensions of 35.5 inches by 35.5 inches (905 mm by 905 mm) to cover curb specified in Section 07600.

b) Insulation: Nominal 1 inch thick thermal isolation pad to reduce thermal conduction between curb-cap and tubing and thermal convection between room air and curb-cap. Rated R-6 (OFxft2xhr/Btu) Insulation is Polyisocyanurate foam utilizing CFC, HCFC, and HFC free blowing agent. Type-1 Class-1 per ASTM C 1289; Passes UL 1715 (15-minute thermal barrier per IBC 2603.4); Attic ventilation may be required per IBC 1203.2.
c) Curb Seal: Includes a double bead of adhesive backed closed cell foam seal 0.188 inch (4.8mm) tall by 0.375 inch (9.5mm) wide to reduce air infiltration.
d) Tube Collar: Attached to top of curb-cap section; 0.018 inch (0.45 mm) nominal thickness aluminum conforming to ASTM B 209.
(1) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

e. Curbs: Metal Insulated Roof Curb: Corrosion resistant 18 Gauge hot-dipped galvanized steel conforming to ASTM A653 G90 with continuous welded seams, integrated base plate for water tightness and extra strength, lined with 1-1/2 inch fiberglass fireproof sound attenuating thermal insulation, factory installed 2 by 2 treated wood nailer secured to top ledge of curb. Curb designed for single-ply roofing, lightweight fill or tapered insulation low slope roof types.
1) C20 20 inch (508 mm) high Metal insulated curb

2. Transfer Zone:
a. Extension Tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm) conforming to ASTM B 209 with Tab-Lock tube joint structural connection system.
1) Reflective Tubes:
a) Reflective 24 inch (610 mm) extension tube, Type EXX or Type EL with total length of run as indicated on the Drawings.
b) Belt Alignment Tab aligns Tube Belt on to tube in the correct location.
c) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
2) Tab-Lock
a) Tab-Lock captures adjoining tube or tube connector using periodic opposing hooks integrated in the tube perimeter with mating retention detents.
b) Hook system allows ease of tube engagement or disengagement for single operator from man-lift or rooftop.
c) System intertwines the ends of the adjoining tubes and tube connectors between each Tab-Lock station.
d) Intertwining function accepts tubes and connectors of common diameters that reduces light loss up to 2 percent per tube joint relative to tubes with 0.3 inch (7.6 mm) diameter difference.
3) Tube Belt:
a) Sheet-metal belt 2 inch (50.8 mm) wide by 28.5 inch (724 mm) nominal diameter by 0.022 inch (0.5 mm) thick CS-B AZ-50 ASTM A792 with 0.10 inch (2.5mm) diameter stainless steel type 302 ASTM A313 torsion spring actuated toggle clamp.
b) Retains Tab-Lock tube joint structural connection system; stiffens linear tube assembly; and prevents tube rotation or disengagement under normal use.
c) Includes locking tab to prevent unintentional Tube Belt Latch opening due to handling, service, vibration, or normal operation or use.
4) Extension Tube Options
a) Reflective 48 inch extension tube, Type EL 48 inches (1220 mm) long. Use to replace two standard 24-inch (610 mm) extension tubes when long tube runs are required.

b) Trim Ring: Type R. Provides a finished appearance to the installation, covering the cut edge of the roof deck penetration in an open ceiling application.
c) Thermal Insulation Panel with Integral 24 inches (610 mm) Extension Tube: Type TIP, high-performance dual-glazed, thermally-broken tube insulation system consisting of two acrylic panels, spaced 1.0 inch (25.4 mm) apart, classified CC2 Class C material, 0.110 inch (2.8 mm) thick, housed in a polyethylene terephthalate glycol-modified (PETG) or acrylonitrile butadiene styrene (ABS) band classified as CC2 material 0.060 inch (1.5 mm) thick by 1.75 inch (44.5 mm) high with Spectralight Infinity high reflectance specular finish interior surface, and assembled with stainless steel disk spacers 0.0197 inch (0.5 mm) thick and aluminum rivets 0.13 inch (3.2 mm) fastened periodically around the perimeter. Dual-glazed Panel assembly integrated with a 12 inch (305 mm) Upper and a 12 inch (305 mm) Lower Transition Tube made of Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance to form a nominal 24.9 inch (633 mm) tube assembly with integrated Tab-Lock connections.

3. Delivery Zone:
   a. Bottom Assembly:
      1) Amplifier Assembly for Tubes Not Penetrating Ceilings (Open Ceiling): Type A, 36 inch (914 mm) diameter amplifier diffuser assembly attached directly to bottom of tube.
         a) Amplifier: Conical shaped assembly 23.7 inches (602 mm) tall, 28.5 inches (724 mm) upper diameter, and 36 inches (914 mm) lower diameter.
            (1) Amplifier collimates incident light. Light reflects off 2 successively angled facets designed to mix the light to reduce glare and to correct the incident angle by 15 degrees and 25 degrees successively thereby improving the transmission efficiency through the diffuser lens by reducing retro-reflection due to first surface refraction and concentrating the distribution of light by reducing the cone of illumination relative to the incident angle correction.
            (2) Assembly comprised of 3 multifaceted segments to be joined together with 15 - 0.125 Inch (3 mm) rivets.
            (3) Tube Connect Slots at upper perimeter receive 6 Tab-Lock Hook features from adjoining tube for mechanical tube engagement.
            (4) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
            (5) Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance with ASTM E308.
         b) Amplifier Diffuser Belt:
            (1) Sheet-metal belt 2 inch (50.8 mm) wide by 36 inch (914mm) nominal diameter by 0.022 inch (0.5 mm) thick CS-B AZ-50 ASTM A792 with 0.10 inch (2.5 mm) diameter stainless steel Type 302 ASTM A313 torsion spring actuated toggle clamp.
            (2) Retains Tab-Lock tube joint structural connection system; stiffens linear tube assembly; and prevents tube rotation or disengagement under normal use.
            (3) Includes locking tab to prevent unintentional Latch opening due to handling, service, vibration, or normal operation or use.
      2) Diffuser Lens:

a) Lens: Type L2, Prismatic lens designed to maximize light output and diffusion. Visible Light Transmission shall be greater than 90 percent at 0.100 inch (2.5 mm) thick. Classified as CC2.
b) Diffuser Collar: Attached to diffuser lens; 0.018 inch (0.45 mm) nominal thickness aluminum.
   (1) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.
c) Diffuser Seal: "L" shaped EPDM closed cell foam 0.86 inch (21.8 mm) wide by 1.37 inch (34.8mm) tall by 0.16 inch (4.1 mm) thick to minimize condensation and bug, dirt and air infiltration per ASTM E283.
d) Diffuser Band: Stainless steel diffuser band, 0.25 inch (6.4 mm) wide by 0.020 inch (0.5 mm) thick stainless steel Type 201 ASTM A666, for enhanced seal performance and protection.

### 2.3 ACCESSORIES

A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.

C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Examine openings, substrates, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and other conditions.

C. If substrate and rough opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Coordinate requirements for power supply, conduit and wiring.

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Coordinate installation with substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing to ensure that each element of the Work performs properly and that finished installation is weather tight.
   1. Install flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.
   2. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.
   3. Coordinate attachment and seal of perimeter air and vapor barrier material.

C. Where metal surfaces of tubular unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, provide permanent separation as recommended by manufacturer

D. Align device free of warp or twist, maintain dimensional tolerances.

E. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

## 3.4 FIELD QUALITY CONTROL

A. Provide independent testing and inspection as specified in Section 01 45 33. Inspect installation to verify secure and proper mounting.
   1. Test for water leaks in accordance with AAMA 502 after installation and curing of sealants but prior to installation if interior finishes.
   2. Perform test for total area of each unit skylight.
   3. Notify the Architect and the Contractor of any failed tests.

## 3.5 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

## 3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION**

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# SECTION 08 71 00
DOOR HARDWARE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Door Hardware, as indicated, in accordance with provisions of Contract Documents.

B. Notify Architect of items which will not operate properly, attain the required fire label, or where components are physically or functionally incompatible.

C. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Hardware Supplier Qualifications:
   1. Architectural door hardware supplier with warehousing facilities.
   2. Operating in the project's vicinity for a period of not less than 2 years.
   3. Certified Architectural Hardware Consultant (AHC) available throughout construction.

B. Electrified Hardware Supplier Qualifications:
   1. Experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project and acceptable to manufacturer of materials.
   2. Prepare data for electrified door hardware based on testing and engineering analysis of manufacturer's assemblies similar to those in this project.

C. Fire Rated Door Assemblies:
   1. Provide door hardware rated for use in assemblies complying with NFPA 80.
   2. Include listed and labeled hardware from a qualified testing agency, for fire protection ratings indicated,
   3. Comply with Positive Pressure Requirements UL-10C, Category A or NFPA 252.

D. Smoke and Draft Control Assemblies:
   1. Provide S-Labels where required.
   2. Applicability:
      a. Fire-rated doors (20 minute or higher) in Smoke Barriers and Corridor walls.
      b. Doors forming part of an Elevator Lobby enclosure, including doors in non-rated Smoke Partitions.
   3. Maximum Leakage: 3 cfm/SF of door face area when tested at pressure of 0.10 inches water per UL 1784.

E. Radiation Resistant Doors:
   1. On doors indicated with (LL) hardware, provide either lead lining or lead wrapping of case and thru-bolts as applicable to type of hardware to assure shielding integrity.

F. Finish designations and standards: Builders Hardware Manufacturers Association (ANSI/BHMA) Standard 1301.

G. Regulatory Requirements:
   1. Barrier free design requirements of the local jurisdiction and Americans with Disabilities Act (ADA).
   2. Listing requirements of the local jurisdiction and UL listing where applicable by type.

H. Preinstallation Conference:
   1. Prior to installation of hardware, Contractor conduct an on-site meeting to instruct hardware installer personnel in the proper installation of hardware and related electronics.
      a. Manufacturer's Reps for Locksets, Closers, Exit Devices, and other major hardware devices shall be present and direct instruction of installers.
      b. Require attendance of affected parties, not limited to: Contractor, Hardware Installer, Electrical Installer, Door and Frame Installers and Security Installer, where applicable, and installer working with low voltage wiring of electromechanical hardware.
      c. Discuss installation sequence of components, point-to-point wiring diagrams, and address questions raised by installers.

## 1.3 SUBMITTALS

A. Product Data:
   1. For each type of material and accessory.

B. Shop Drawings:
   1. Complete Hardware Schedule by door.
      a. Complete list of products including model numbers and cut sheets.
      b. Use Heading Numbers logically derived from Architect's Hardware Set numbers.
      c. Hardware Sets shall follow the guidelines established in Door and Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule.
      d. Notify Architect of items which will not operate properly, attain the required fire label, and where components are physically or functionally incompatible.
   2. Diagrammatic Elevations and Point-to-Point Wiring Diagrams of openings scheduled to receive electrified hardware and electronic access control devices.
      a. Provide detailed wiring diagrams showing connections for signaling, control and locking functions and notes pertinent to programming, operation, etc.
      b. When door hardware sets include automatic operators and locking or latching hardware on the same doors, provide detailed wiring diagrams.
      c. Submit with Hardware Schedule.

C. Project Information:
   1. Certification that items bear UL label where required.
   2. Meeting minutes from Pre-Installation Meeting.
   3. Names of supplier's certified AHCs active on project.

D. Contract Closeout Information:
   1. Schedule of components installed as hardware sets for each opening.
   2. Operating and maintenance data.
      a. Parts catalog for each product furnished.
      b. Keying records.
   3. Owner instruction report.
   4. Letter stating extra material has been delivered.

## 1.4 SPECIAL WARRANTY

A. Written warranty in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within three years from date of Substantial Completion, or 25 years from date of Substantial Completion in the case of manual surface closers.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking or breakage.
      b. Faulty operation of door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

### 1.5 MAINTENANCE

A. Extra Materials:
   1. Provide special tools as supplied by hardware manufacturer, for each different or special hardware component.

## PART 2 -PRODUCTS

### 2.1 MANUFACTURERS

A. Hinges:
   1. Base:
      a. Hager Hinge
   2. Optional:
      a. Stanley Hardware
      b. McKinney
      c. Ives

B. Pivots:
   1. Base:
      a. Rixson Specialty Door Controls
   2. Optional:
      a. Ives
      b. ABH Manufacturing

C. Power Transfer Devices:
   1. Base:
      a. Von Duprin
   2. Optional:
      a. Securitron.
      b. Security Door Controls.
      c. ABH Manufacturing

D. Flushbolts and Coordinators:
   1. Base:
      a. Ives
   2. Optional:
      a. Door Controls
      b. Rockwood
      c. Hager Hinge
      d. ABH Manufacturing

E. Cylinders:
   1. Base:
      a. Same manufacturer as listed for Locks, Latches and Deadbolts.

F. Locks, Latches, and Deadbolts:
   1. Base:
      a. Schlage Lock
   2. Optional:
      a. Sargent Manufacturing
      b. Stanley Security Solutions/Best Access Systems

G. Patient Latches:
   1. Base:
      a. Schlage Lock
   2. Optional:
      a. Trimco

b. Sargent Manufacturing
c. ABH Manufacturing

H. Exit Devices:
1. Base:
a. Von Duprin
2. Optional:
a. Sargent Manufacturing
b. Precision Hardware

I. Electric Strikes:
1. Base:
a. Von Duprin
2. Optional:
a. HES
b. Securitron

J. Magnetic Locks:
1. Base:
a. Schlage
2. Optional:
a. Securitron

K. Door Pulls, Pushplates, and Pushbars:
1. Base:
a. Trimco
2. Optional:
a. Hager Hinge
b. Burns Manufacturing
c. Ives
d. Rockwood Manufacturing

L. Overhead Stops and Door Holders:
1. Base:
a. Glynn-Johnson
2. Optional:
a. Sargent Manufacturing
b. Rixson
c. Rockwood
d. Dorma
e. ABH Manufacturing

M. Door Closers:
1. Base:
a. LCN
2. Optional:
a. Sargent Manufacturing
b. Stanley

N. Kickplates, Armorplates, and Door Edging:
1. Base:
a. Trimco
2. Optional:
a. Hager Hinge
b. Burns Manufacturing
c. Ives
d. Rockwood Manufacturing
e. ABH Manufacturing

O. Door Stops:
   1. Base:
      a. Ives
   2. Optional:
      a. Sargent Manufacturing
      b. Corbin Russwin Architectural Hardware
      c. Hager Hinge
      d. Trimco

P. Thresholds, Head Drips, Weatherstripping, and Smoke Gaskets:
   1. Base:
      a. Reese Enterprises
   2. Optional:
      a. National Guard Products
      b. Pemko Manufacturing
      c. Zero International

Q. Access Control Devices:
   1. Provided by Security System Installer.

R. Door Position Switches (DPS):
   1. Provided by Security System Installer.

S. Key Cabinet:
   1. Base:
      a. Lund Equipment
   2. Optional:
      a. Telkee

T. Weldable Gate Boxes:

U. Other materials:
   1. Base: As indicated.

V. Other manufacturers desiring approval comply with Section 01 25 13 and submit samples of both specified item and proposed item for comparison.

## 2.2 MATERIALS

A. Finishes and Fasteners:
   1. Finishes:

| Hardware Component | Satin Chrome Series | | | |
|---|---|---|---|---|
| | Base Metal | ANSI / BHMA | Finish Description | US Equiv. |
| Locksets and Latchsets | Brass/Bronze | 626 | Satin Chromium plated over nickel | US26D |
| Door Pulls, Pushbars, and Pushplates | Stainless Steel | 630 | Satin Stainless Steel | US32D |
| Kickplates and Armorplates | Stainless Steel | 630 | Satin Stainless Steel | US32D |
| Exit Devices | Brass/Bronze | 626 | Satin Chromium plated over nickel | US26D |
| Hinges | Stainless Steel | 630 | Satin Stainless Steel | US32D |
| | Steel | 652 | Satin Chromium plated over nickel | US26D |
| Thresholds, Weatherstripping, Head Drips | Aluminum | 719 | Mill finish aluminum | US27 |
| | | | | |
| Door stops, holders, pivots, door edging and other unlisted items | Brass/Bronze | 626 | Satin Chromium plated over nickel | US26D |
| Patient Latches | Stainless Steel | 630 | Satin Stainless Steel | US32D |
| Exposed arms and covers of closers: | Any | 689 | Powder Coated, Aluminum Color | US20A |

a. Tactile Warning:
   1) Etched, milled or knurled surface treatment.
   2) Provide on corridor-side levers of doors to loading platforms, boiler and mechanical rooms, stages, utility stairs, roof access, communications and electrical closets.

2. Fasteners:
   a. Manufacture hardware to conform to templates.
   b. Prepare for Phillips oval head machine screw installation unless directed otherwise.
   c. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
   d. Fasteners in mineral core doors:
      1) Attachment of hinges:
         a) Use screws, which are fully threaded (from tip to head).
         b) For mineral core doors, use thru-bolted half surface hinges.
      2) Attachment of Closers:
         a) Use through-bolts at mineral core doors.
         b) Use fully threaded screws at doors with solid wood blocking.
   e. Provide concealed fasteners (unless thru bolted).
   f. Provide non-corrosive fasteners.

3. Templates:
   a. Provide templates to door and frame suppliers.
   b. List template numbers on Hardware Schedule submittal for use by fabricators.
   c. Provide copies of approved Hardware Schedule to related suppliers, fabricators, and installers.

B. Hinges:
   1. Butt Hinges:
      a. Butts and Hinges: ANSI/BHMA A156.1
      b. Template Hinge Dimensions: ANSI/BHMA A156.7
      c. Self-Closing Hinges: ANSI/BHMA A156.17.
      d. Full mortise, unless noted otherwise.
         1) Non-rising, flat button tips.
         2) Hospital tips: Psychiatric patient areas.
         3) Hospital tips: Inmate areas.
         4) Non-removable pins (NRP): Provide at out-swinging exterior doors and where specifically indicated.
      e. Following table refers to manufacturer's numbers that are considered equal:

| Type | Manufacturer | | | | Description | |
|---|---|---|---|---|---|---|
| | Hager | Stanley | Ives | McKinney | ANSI | Remarks |
| 1 | BB1199 | FBB199 | 5BB1HW | T4B3386 or T4A3386 | A5111 | Stainless Steel, Heavy Weight, 5-knuckle, 4 Ball Bearing, Non-ferrous for wet/exterior usage. |
| 2 | BB1168 | FBB168 | 5BB1HW | T4B3786 or T4A3786 | A8111 | Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel with Steel Pin. |
| 3 | BB1279 | FBB179 | 5BB1 | TB2714 or TA2714 | A8112 | Standard Weight, 5-knuckle, 2 Ball Bearing, Steel with Steel Pin |
| 4 | BB1263 | FBB268/78 | 5BB1SCHW | T4B3795 or T4A3795 | A8121 | Swing Clear Hinge, Heavy Weight, 5-knuckle, 4 Ball Bearing, Steel with Steel Pin |
| 5 | 1250 | 2060R | 3SP1 | 1552 | K81071F | Spring Hinge, (single-acting), Steel, Use two Type 5 (Spring Hinges) in combination with Type 2 (Heavy Weight Ball Bearing) hinges |

   f. Hinges Types according to door location and width:

1) Type 1 - Stainless Steel, Heavy Weight, Ball Bearing Hinge:
   a) Exterior out-swinging doors with non-removable pins (NRP) option.
   b) Exterior in-swinging doors.
   c) Interior in-swinging doors to wet areas (showers, kitchens, etc.).
2) Type-2 - Steel, Heavy Weight, Ball Bearing Hinge:
   a) Interior greater than 36 inches wide.
3) Type-3 - Steel, Normal Weight, Ball Bearing Hinge:
   a) Interior less than or equal to 36 inches.
4) Type-4 - Swing Clear, Steel, Heavy Weight, Ball Bearing:
   a) Use on openings where specifically indicated or scheduled.
   b) Upgrade to Stainless Steel for exterior and interior wet areas.
5) Type 5 - Spring Hinges, Steel, Heavy Weight.
   a) Where specifically indicated or scheduled.
   b) Use on steel gates in stairs.
   c) Upgrade to Stainless Steel for exterior and interior wet areas.
6) Type 6 - Double-acting spring Hinges, Steel, Heavy Weight.
   a) Where specifically indicated or scheduled.
   b) Upgrade to Stainless Steel for exterior and interior wet areas.

g. Hinge quantities per door leaf:
   1) Leaves up to 60 inches: 2 hinges
   2) Leaves between 61 inches and 90 inches: 3 hinges
   3) Leaves between 91 inches and 120 inches: 4 hinges
   4) Leaves between 121 inches and 150 inches: 5 hinges
   5) Leaves taller than 151 inches: add 1 hinge for each 30 inches increase in leaf height thereafter.

h. Hinge sizes:

| Door Thickness | Door Width | Minimum Hinge Height | Minimum Hinge Width |
|---|---|---|---|
| 1-3/8 inches | Up to 32 inches | 3-1/2 inches | 3-1/2 inches |
| | From 32 inches to 36 inches | 4 inches | |
| | Greater than 37 inches | 4-1/2 inches | |
| 1-3/4 inches | Up to 36 inches | 4-1/2 inches | 4-1/2 inches |
| | From 37 inches to 48 inches | 5 inches | |
| | Over 48 inches | 6 inches | |
| 2 to 2-1/2 inches | Up to 42 inches | 5 inches Heavy Weight | 5 inches |
| | Over 43 inches | 6 inches Heavy Weight | |

i. Openings with electrified hardware:
   1) Utilize transfer methods specified in individual Hardware Sets.
   2) Where Power Transfer devices are scheduled:
      a) Factory machine cut-outs in hinge leaves to accommodate electric Power Transfer (EPT) devices.
   3) Where Continuous Geared Electric Hinges are scheduled:
      a) Supply continuous hinges as described above and additionally having integral, through-wire conductors.
      b) Minimum current-carrying capacity: 3.5 amp (continuous), 16 amp (impulse).
      c) Number of Conductors: As required for devices served.

C. Pivots:
   1. ANSI/BHMA-A156.4, Type CO7111.

2. Offset distance: 3/4 inches.
3. Configuration:
    a. Use a minimum of one bottom pivot and one top pivot per leaf for doors up to 60 inches tall.
    b. Use one additional intermediate pivot for each additional 30 inches in height.
    c. Upgrade as recommended by manufacturer where door weight or width exceeds capacity of models listed.
    d. Upgrade from models listed as necessary for fire rated openings.
4. Applications:
    a. Offset Pivots for Interior Doors:
        1) Base Products:
            a) Bottom pivot: 117 by Rixson
            b) Intermediate Pivot: 119 by Rixson
            c) Top Pivot: 180 by Rixson
    b. Offset Pivots for lead lined doors:
        1) Base Products:
            a) Bottom pivot: L117 by Rixson.
            b) Intermediate Pivot: ML19 by Rixson.
            c) Top Pivot: L180 by Rixson.
    c. Offset Pivots for aluminum and hollow metal entrance doors:
        1) Base Products:
            a) Bottom pivot: 195 by Rixson
            b) Intermediate Pivot: M19 by Rixson
            c) Top Pivot: 180 by Rixson
    d. Double-acting pivots:
        1) Type and Model indicated in HW sets.

D. Automatic Flushbolts (AFB):
1. Include Rub/Strike Plate on active door leaf.
2. Include Dustproof Strikes with bottom rod.
3. Base Products:
    a. FB31P at metal doors.
    b. FB41P at wood doors.

E. Constant Latching Flushbolts (CLFB):
1. Include Rub/Strike Plate on active door leaf.
2. Include Dustproof Strike.

F. Manual Flushbolts (MFB):
1. Include Dustproof Strikes.

G. Dustproof Strikes:
1. Base: Ives DP2.
2. Include with Flushbolts.

H. Door Coordinators:
1. Base: Ives, COR Series.
2. Optional: Door Controls, 600 Series.
3. Provide where indicated.
4. Provide where Astragals are used.
    a. Exceptions:
        1) Coordinators are not required at double egress pairs.
        2) Coordinators are not required where manual Flushbolts are used.
    b. Provide where Automatic and Constant latching Flushbolts are used.
5. If coordinator is provided for door which has stop which lacks enough surface area to allow proper mounting. Provide shims, bars, etc., as required.

6. Provide solid shim or other fascia piece that will result in surface being flush with edge of coordinator.
7. Provide filler sections as required to finish opening.

I. Cylinders:
1. ANSI/BHMA A156.5 Grade 1.
2. Material: Brass or bronze, stainless steel, or nickel silver.
3. Finish: Match lock mechanism to which cylinders are installed.
4. Cylinder Type: Interchangeable cores at Exit Devices; Conventional cores (non-interchangeable) at other locksets.
5. Cylinder Type: Conventional cores (non-interchangeable).
6. Cylinder Type: Interchangeable cores.
7. IC Format: Full-sized Interchangeable Cores (IC).
8. IC Format: Small Format Interchangeable Cores (SFIC) matching Best, Falcon, etc.
9. Cylinder Mechanism:
   a. Conventional, 6-pin tumbler.
   b. Top row consisting of 6-pin tumblers plus additional side bitting.
10. Key Control:
    a. Open.
    b. Restrictive.
11. Determine key type required to suit locking mechanism. Include appropriate trim rings, cams, tail pieces, and adaptors.
12. Patented cylinders and keys to protect against unauthorized manufacture.
13. Provide cylinders for all locking mechanisms scheduled.
14. Base Product:
    a. Everest Primus by Schlage.
    b. Everest Restricted Conventional by Schlage.
    c. Everest Open Conventional by Schlage.
    d. Classic Primus by Schlage.
    e. Classic Conventional by Schlage.
    f. Signature Series by Sargent Manufacturing.
    g. XC Series by Sargent Manufacturing.
    h. Optional Products: Comparable products by approved manufacturers.

J. Keys:
1. Material: Nickel silver
2. Stamping: Permanently inscribe each key with a control number and the following: DO NOT DUPLICATE.
3. Quantity: In addition to one extra blank key for each lock, provide the following:
   a. Cylinder Change Keys: 3
   b. Master Keys: 6
   c. Grand Master Keys: 6
   d. Great-Grand Master Keys: 6

K. Mortise Locks and Latches:
1. ANSI/BHMA-A156.13, Series 1000, Operational and Security Grade-1.
2. Mortise with antifriction latch bolt with 3/4 inch throw and deadbolt with 1 inch throw.
3. Sectional trim.
4. Sectional trim unless otherwise specified.
5. Full escutcheon trim unless otherwise specified.
6. Backset: 2-3/4 inches
7. Base Product: L Series by Schlage.
8. Optional Products:
   a. 8200 Lever Lock by Sargent Manufacturing
   b. 40H by Best
9. Lever Style: 17 Design.

10. Functions as indicated in Hardware Sets and in accordance with ANSI/BHMA-A156.13.

L. Cylindrical Locks and Latches:
   1. ANSI/BHMA-A156.2, Series 4000, Grade 1.
   2. Heavy duty cylindrical with latch bolt throw as follows:
      a. Single doors: 1/2 inches minimum, or as otherwise required by fire label.
      b. Pair doors: 3/4 inches minimum, or as otherwise required by fire label.
      c. Backset: 2-3/4 inches.
   3. Base Product: ND Series by Schlage.
   4. Optional Products:
      a. 10-Line by Sargent Manufacturing
      b. 9K by Best
   5. Lever Design: Sparta lever.
   6. Functions as indicated in Hardware Sets and accordance with ANSI/BHMA-A156.2.

M. Electrified Locksets:
   1. Furnish from the same manufacturer as mechanical locks and latch sets.
   2. Match trim style and finish of mechanical locks and latch sets.
   3. Furnish electrical lock function and associated electrical components to perform as indicated in the operational description for each electrified hardware set.
      a. Electrified Mortise Locksets:
         1) Base Product: L9080 by Schlage.
         2) Optional Products: 8200 Series by Sargent Manufacturing; 47HW Series by Best.
      b. Electrified Cylindrical Locksets:
         1) Base Product: ND96 by Schlage.
   4. Privacy Gaskets:
      a. Brush type gaskets installed in vertical gaps between door and frame.
      b. Kerf into door stiles to depth required for zero sight line.
      c. Base Product: 369 AP by Pemko with 3/16 inches pile height.

N. Auxiliary Deadbolts:
   1. ANSI/BHMA A156.5, Grade 1.
   2. Lock Throw: 1 inch minimum, or as otherwise required by fire label.
   3. Backset: 2-3/4 inches (unless otherwise indicated).
   4. Classroom Function: Keyed on one side, thumbturn on the other can only retract bolt.
   5. Function ANSI F16: Keyed on both sides.
   6. Function ANSI F17: Keyed on one side, thumbturn on the other.
   7. Function ANSI F18: Keyed on one side, no trim on the other.
   8. Door Bolt Function: Thumbturn on one side, no trim on the other.
   9. Privacy Function: ANSI F17 with OCCUPIED indicator.
   10. Base Product: B600/700/800 Series Commercial Grade Auxiliary Locks by Schlage.

O. Exit Devices:
   1. ANSI/BHMA-A156.3, Grade 1
   2. Include cylinders at lockable exit devices.
   3. Lever Trim: Match lever style specified for Locks and Latches.
   4. Offset Pull Style: 1 inch diameter; 8190-0 by Ives/Von Duprin.
   5. Fire Rated Openings:
      a. Use fire rated exit devices.
   6. Non-rated Openings:
      a. Use doggable devices UL-listed for accident hazard.
         1) Exception 1: Omit dogging or use fire rated devices at Smoke Partitions.
         2) Exception 2: Omit dogging or use fire rated devices where openings include Card Readers and dogging could compromise ability to secure the opening.
   7. Vertical-rod Exit Devices:
      a. Exterior Openings:
         1) Include bottom rods and floor strikes.

b. Interior Openings greater than 90 minutes:
   1) Include bottom rods and floor strikes.
c. Interior Openings 90 minutes or less:
   1) Provide LBR (Less Bottom Rod) devices where allowed by fire label.
   2) Include thermal pins, as required by fire label for LBR devices.
d. Where exposed bottom rods are required: Protect rods with rod and latch guards.
   1) Base product: RG-27 by Von Duprin.

8. Electrified devices:
   a. Include concealed Power Transfer devices where electrified Exit devices are scheduled.
      1) Select Power Transfer models having required number of conductors and conductors of the wire gauge recommended for the device served.
   b. Include Power Supply as required.
9. Base Products - Push Pad type (smooth-case): 98 Series by Von Duprin; Except 35 Series for narrow stile doors.
   a. Optional Products: 88-Series by Sargent Manufacturing; Apex 2000 Series by Precision.

P. Strikes:
1. Provide manufacturer's standard strike for each latching/locking mechanism.
   a. Finish: Match latch/lock device.
2. Standards:
   a. Strikes for Bored Locks and Latches: ANSI/BHMA A156.2.
   b. Strikes for Mortise Locks and Latches: ANSI/BHMA A156.13.
   c. Strikes for Auxiliary Deadlocks: ANSI/BHMA A156.5.
3. Strike Lip:
   a. Curved lip extended to protect frame.
   b. Locks with 3-piece antifriction latch bolts: Flat-Lip Strikes.
   c. Locks used on frames with applied wood casing trim: Extra-Long-Lip Strikes.
4. Provide manufacturer's standard Wrought Strike Box for each latching/locking mechanism.
5. Provide specially fabricated Strike Boxes where set in aluminum framing.

Q. Electric Strikes:
1. ANSI/BHMA A156.31 Grade 1.
2. UL listed for continuous duty.
3. Field selectable voltage: 12/24 VDC.
4. Field selectable operation: Fail Safe (FS)/Fail Secure (FSE).
5. Latch bolt Monitor Switch where indicated.
6. Coordinate model number with door and frame configuration and lock type.
7. Base Product:
   a. 6200 Series by Von Duprin.
8. Optional Product:
   a. 1006 Series by HES.
   b. ES-4 & ES-5 by Stanley

R. Door Closers (surface applied):
1. General:
   a. ANSI/BHMA A156.4, Grade 1.
   b. UL listed for use on fire doors.
   c. Body Material: Cast iron.
   d. Size door closers to comply with manufacturer's recommendations for door sizes, locations, and accessibility requirements for opening force.
   e. Adjust closer to meet accessibility requirements for opening force and closing speed.
   f. Supply arms, brackets, and plates, as required.
   g. Mount closers on room side of corridor doors unless conditions prohibit such mounting.
   h. Integral back checks.
   i. Include limiting cushion stop at exterior, out-swinging doors.

2. Base Products:
    a. Models 4011 and 4111 by LCN.
    b. Models 4041 and 4041XP by LCN.
3. Optional Products:
    a. 281 Series by Sargent Manufacturing.
    b. QDC100 Series by Stanley.
    c. 9500 Series by Norton.

S. Door closers for Section 08 11 16 integrated doors.
1. Base Product: LCN 3030 or 4040.
2. Other closer manufacturers submit templates to manufacturer for machining.

T. Automatic Doors:
1. Swinging Doors:
    a. Automatic Operators, Motion Sensors, Wall Switches, Presence Sensors for Automatic Swinging Doors: Provide Low Power Assist Operator with a bollard mounted push button activated via card reader and call in button at Bldg 300 main entry only,
    b. Balance of Hardware specified in this Section and scheduled in Section 08 06 71.
    c. Balance of Hardware specified in this Section and scheduled in Section 08 06 71.

U. Door Trim and Protectives:
1. Kickplates and Armorplates:
    a. ANSI/BHMA A156.6, Type J100.
    b. Material: Stainless Steel; 0.050 inches thick.
    c. Material: Plastic Laminate, 1/8 inches thick, color as selected.
    d. Height:
        1) Kickplates: 8 inches high.
        2) Armorplates: 34 inches high.
    e. Width:
        1) Single Doors: 2 inches less door width (LDW).
        2) Pair Doors: 1 inch less door width (LDW).
    f. Bevel edge on top and sides of plates.
    g. Coordinate installation of plates with locks and other hardware items
        1) Cutouts where required.
2. Door Edging:
    a. Material: Stainless Steel.
    b. Minimum Thickness: 0.050 inches thick.
    c. Provide where indicated in HW sets.
        1) Provide 1 at hinge edge and 1 at latch edge of door.
        2) Exception: Omit from hinge edge where continuous geared hinges are scheduled.
    d. Height: 34 inches
    e. Provide cut-outs for hinges and similar items.
    f. Install with supplied screws.
    g. Base Product: KE31-1 by Trimco.

V. Door Holders and Stops:
1. General:
    a. Provide Door Stop at each door leaf.
    b. Use type as indicated in Hardware Set.
    c. If no type is indicated, use criteria listed below.
2. Wall-mounted Door Stops:
    a. Provide where door encounters a wall when opened 110 degrees or less.
        1) Wall stop is not required for times when door is used in rescue mode.
    b. Except provide overhead type:
        1) Where door encounters a tile or glass wall.
        2) Where door encounters casework, railings or obstructions other than a wall.

3) Where door has pushbutton lockset or other hardware incompatible with wall stops.

c. See Sections 06 or 09 22 16 for blocking.

d. Base Products:

1) Wood Screw, plastic anchor: WS406CCV by Ives

2) Screw, drywall anchor: WS407CCV by Ives

3. Overhead Door Stops:

a. Provide where door could swing more than 110 degrees without encountering a wall or where door meets an exception preventing use of a wall stop.

b. Base Products:

1) Doors up to 45 inches wide: 450 series by Glynn Johnson

2) Doors over 45 inches wide: 90 series by Glynn Johnson

3) Exterior doors without a closer: 90 series by Glynn Johnson

4) Exterior doors with a closer: 100 series by Glynn Johnson

5) Lead lined doors: 90 series by Glynn Johnson

6) Double-acting door has no wall adjacent: 100 series by Glynn Johnson

c. Johnson

W. Perimeter Seals:

1. Where door or frame is extruded aluminum, refer to Aluminum Door/Frame specifications for Perimeter Gasket products.

2. Thresholds:

a. ANSI/BHMA A156.6.

b. Material: Aluminum.

c. UL and ADA compliant.

d. Size for frame depth.

e. Provide required bolt cutouts.

f. Base Products are meant to describe design intent. Contractor to verify that models indicated are appropriate for sill conditions and finishes.

1) Choose from Base Product models wherever possible.

2) Include elevators and other adaptors where required.

g. Base Products:

1) Saddle Thresholds: S404 or S405 by Reese.

2) Saddle Thresholds with Thermal-break: S282, S471or S473 by Reese.

3) Half Saddle Thresholds for offset conditions: S814, S439 or S514 by Reese.

4) Panic Threshold: S248 with pile insert by Reese.

5) Bumper Seal Thresholds with Thermal break: 273x292 FGPK by Pemko.

6) Carpet-to-carpet conditions: S565 by Reese.

3. Weatherstripping:

a. ANSI/BHMA A156.22; air leakage not to exceed 0.50 cubic feet per minute per linear foot of crack when tested to ASTM E 283.

b. Head and Jamb Stops:

1) Surface mounted, adjustable, screwed to frame stops.

2) Base Product: 775 by Reese.

c. Sweeps:

1) Base Product: 810 by Reese.

d. Meeting stiles of door pairs:

1) Base Product: M35 by Reese.

4. Head Drip:

a. Provide on exterior doors other than main entrance doors.

b. Bed flange in sealant and screw to head of frame using non-corrosive fasteners.

c. Base Product: R201 by Reese.

5. Fire and Smoke Seals:

a. Provide approved seals to achieve the fire/smoke labels indicated for the opening.

b. Provide at other locations indicated to control sound, air and light infiltration.

c. Performance:
    1) Fire Door Assemblies (other than openings also requiring smoke control):
        a) ANSI/BHMA A156.22; air leakage not to exceed 0.50 cubic feet per minute per linear foot of crack when tested to ASTM E 283.
    2) Smoke- and Draft-Control Door Assemblies:
        a) Where smoke- and draft-control door assemblies are required, provide seals that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
        b) Air Leakage Rate: Maximum air leakage of 3 cubic feet per minute per square foot at the tested pressure differential of 0.1 inches of water.
d. Intumescent seal (surface-applied):
    1) At head and jambs of openings: Pemko HSS2000.
e. Perimeter Gaskets:
    1) Base Product – Frame perimeter seals at jambs and heads:
        a) 797 by Reese; S88 by Pemko.
    2) Base Product - Meeting Stiles:
        a) 93 by Reese; 355_S by Pemko.
f. Astragal:
    1) Provide where indicated.
    2) Where not indicated:
        a) Provide as required to obtain fire label.
        b) Provide on pair doors located on exterior wall.
        c) Provide on pairs of radiation resistant doors.
    3) Fire Rated Openings:
        a) Flat steel:
        b) UL listed for labeled doors.
    4) Exterior Openings:
        a) Aluminum with weatherstripping gaskets.

6. Isolation Seals:
    a. Normal Duty:
        1) Jambs and Heads: Reese 99
        2) Door Bottom: Reese 330, automatic door bottom.
        3) Meeting Stiles: Reese 87.

X. Silencers:
1. Silencers are listed in Section 08 11 00 and 08 11 16 but are required as described in this Article.
2. Provide Silencers at openings except those receiving perimeter gaskets such as weather, fire, fire/smoke, and sound gaskets.

Y. Controlled Access Accessory Items
1. Card Readers (OF/CI):
    a. Furnished by Owner and installed by Contractor.

Z. Electric Door Assisting Device (Door Operator)
1. This device to be installed on door 300-100A only.
2. Low energy, self-contained, electromechanical type.
    a. 120 VAC, 60 cycle, 1 PH, 15 amp.
3. Direct current operation.
4. Door capable of manual operation with power on or off without damage to operating unit.
5. Manual/automatic operation.
6. Comply with ADA and ANSI/BHMA A156.19.
7. Adjustable opening and closing speed with range of 3 to 10 seconds.
8. Adjustable time delay prior to closing with range of 5 to 28 seconds.
9. Activating switch:
    a. Extruded aluminum or stainless steel, momentary contact.

b. Wall mounted push button activating switch.
c. Pedestal mounted push button activating switch.
d. Engraved with international handicap insignia.

10. Provide unit complete with all required wiring for interconnecting activating switch with controller and any other miscellaneous items required for complete installation.
11. Provide key operated "ON/OFF" activation of the opening device on the exterior side of the door opening in close proximity to the wall mounted push button activating switch.
    a. Include extruded aluminum or stainless steel face plate having the words "DOOR ASSISTING DEVICE" with the lock cylinder below having the words "ON/OFF" in their respective positions.
    b. Text to be engraved into face plate.
    c. Text to be painted flat black.
12. Finish to match door and frame on which device is used.
    a. Conceal all conduit running to and from the device.
    b. Key switch:
        1) Single pole, double throw maintained contact switch.
        2) Sargent #4370.
13. Door Position Switches (DPS):
    a. Provided by Security System.
14. Fire Alarm Relays:
    a. Specified with Fire Alarm System in Section 28 31 00.
15. Low Voltage Power (centrally supplied by Security System):
    a. Unless otherwise noted, Owner's Security System will provide low voltage power required to power items with current draw less than 2 amp (24 VDC) including the following:
        1) Magnetic Locks.
        2) Electric Strikes.
        3) Electro-Mechanical Mortise Locksets.
        4) Electro-Mechanical Cylindrical Locksets.

AA. Key cabinet:
1. Size to permit minimum 100% expansion of system.

BB. Weldable Gate Boxes:
1. Steel box used to enclose specified lock mechanism indicated.
2. For use at ornamental iron gates or other locations indicated.
3. Base Product: applicable models made by Keedex, Inc.

CC. Extra Material:
1. Deliver to Owner extra materials from same production run as products installed.
    a. Package products with protective covering and identify with descriptive labels.
2. Interchangeable cores:
    a. Provide 10 extra for each Master keyed group.
3. Extra Keys:
    a. As specified in Article entitled: Operation – Keying
4. Hardware Items:
    a. For the following items, provide a quantity of units equal to 1% of amount installed for each function and type; with a minimum of 1 unit each required:
        1) Latchsets and Locksets.
        2) Closers.
        3) Patient latches.

DD. Operation – Keying:
1. Establish keying system with Owner:
2. Provide and set up complete visible card indexed system with key tags and control slips.
3. Tag and identify keys and install in key cabinet.
4. Provide 3 keys for each lock mechanism.

5. Master key and key in groups as directed.
   a. Provide 6 master keys for each group.
6. Grand Master key and key in as directed.
   a. Provide 6 copies of grand master keys.
7. Great Grand Master key and key in as directed.
   a. Provide 6 copies of grand master keys.
8. Key to existing master key system.
9. Construction Keying:
   a. Provide cylinders with feature that permits voiding of construction keys without cylinder removal.
      1) Provide 10 construction master keys.
   b. Provide construction keying for exterior doors and primary entrances to construction areas.
      1) Openings requiring construction keying determined by General Contractor based on sequence of construction activities.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine scheduled openings for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Coordinate reinforcement or other preparation of doors and frames.

C. Installation constitutes responsibility for performance.

D. Coordinate installation power supply and communication wiring to electrically operated devices.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's installation instructions, supervised or inspected by an AHC.

B. Furnish items of hardware for proper door swing.

C. Permanently install hardware after finishing operations are complete.

D. Protect finishes by temporary coverings as required.

E. Mounting Heights:

| Item | Height [1,2] (to Item Centerline) |
|---|---|
| Mortise Locksets | 40-5/16 inches AFF to Centerline of Strike [3] |
| Cylindrical Locksets | |
| Patient Latches | |
| Exit Devices | |
| Door Pulls | 42 inches AFF to Centerline of Pull |
| Pushplates | 45 inches AFF to Centerline of Plate |
| Auxiliary Deadbolts | 48 inches AFF to Centerline of Strike |
| Butt Hinges (and Pivots) | Top Hinge: Not more than 11-3/4 inches down from frame |
| | Bottom Hinge: Not more than 13 inches above floor |

| Item | Height [1,2] (to Item Centerline) |
|---|---|
| | Equally spaced between Top and Bottom Hinges. Refer to Part 2 for quantity required. |
| Other Items | Comply with SDI and DHI Recommendations |

**Footnotes/Additional Requirements:**

1. Mounting Heights shall also comply with ADA and ICC/ANSI 117.1
2. Mounting Heights shall also comply with Building Code and Fire Codes.
3. Deviation from listed height will be allowed up to + 1-1/2 inches provided this does not cause a conflict between the lock and lite cutouts.

F. Install hardware with fasteners concealed where not required by code to be exposed.

G. Coordinate installation of electric access control hardware.
   1. Hardware installer to be responsible for coordination with electrical installer for low voltage installations.

H. Door Position Switches (DPS):
   1. Coordinate door and frame preparations with door and frame suppliers, and Security System installer as appropriate.
   2. Locate in frame head approximately 4 inches from latching door edge, unless otherwise instructed.

## 3.3 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware to ensure proper operation or function.
   1. Lubricate moving parts with lubricant recommended by manufacturer.
   2. Replace units which cannot be adjusted and lubricated to operate smoothly.

B. Conversion of Construction Keying to Permanent (by Contractor):
   1. Convert cylinders from Construction to Permanent configuration at time of Substantial Completion.
   2. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology.

C. Conversion of Construction Keying to Permanent (by Owner):
   1. Demonstrate conversion method to Owner's facility personnel, making certain Owner's team understands methodology required to convert cylinders from Construction to Permanent configuration.
   2. Ensure that Owner has proper instruction and tools needed to convert keying to final configuration.

D. Approximately six months after substantial completion, check and readjust to assure proper function of doors and hardware.
   1. Clean and lubricate operational items.
   2. Replace items which have deteriorated or failed.
   3. Prepare a written report of current and predictable problems in operation of hardware.
   4. Report visit and furnish copy of report to Owner with copy to Architect.

E. When hardware is installed more than one month prior to final acceptance or occupancy, during week prior to acceptance or occupancy, make a final check and adjustment of hardware items.
   1. Remove temporary coverings.
   2. Clean and lubricate for proper function and finish.

3. Adjust door control devices to compensate for operation of heating and ventilating equipment.

F. Instruct Owner's personnel:
   1. Operating and maintenance procedures.
   2. Key control system.
   3. Converting cylinders from Construction to Permanent key configuration.

G. Prior to substantial completion instruct Owner's personnel in systems operation.
   1. Standard system operation and maintenance.
   2. Modification of codes.
   3. Acquisition, monitoring and scheduling of ID cards.
   4. Instruction in software applications.

**END OF SECTION**

# SECTION 08 81 00
GLASS AND GLAZING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Glass and glazing.
   2. Fire resistance rated glass.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 92 00 - Joint Sealants.
   4. Section 08 11 00 - Hollow Metal Doors and Frames.
   5. Section 08 11 16 - Aluminum Doors and Frames.
   6. Section 08 41 10 - Storefront.
   7. Section 08 51 13 – Aluminum Windows

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. Z97.1, Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
   2. ASTM International (ASTM):
      a. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
      b. C1036, Standard Specification for Flat Glass.
      c. C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
      d. C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
      e. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
      f. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
   3. Code of Federal Regulations (CFR):
      a. Title 16 - Commercial Practices, Chapter ii - Consumer Product Safety Commission (CPSC), Subchapter B - Consumer Product Safety Act Regulations:
         1) 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
   4. Glass Association of North America (GANA):
      a. Glazing Manual.
   5. Insulating Glass Certification Council (IGCC).
   6. Insulating Glass Manufacturers Alliance (IGMA):
      a. TM-3000, North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use.
   7. National Fire Protection Association (NFPA).
      a. 80, Standard for Fire Doors and Other Opening Protectives.
      b. 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
      c. 252, Standard Methods of Fire Tests of Door Assemblies.
      d. 257, Standard on Fire Test for Window and Glass Block Assemblies.
   8. Underwriters Laboratories, Inc. (UL):
      a. 9, Standard for Fire Tests of Window Assemblies.
      b. 10B, Standard for Fire Tests of Door Assemblies.
      c. 263, Standard for Fire Tests of Building Construction and Materials.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Safety Glazing: Glazing meeting the requirements of the building code and CPSC 16 CFR 1201.

C. Other terms as identified in CSPC 16 CFR 1201.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Certification that glass has been tested and approved for use in fire resistance rated doors or walls.
         1) Copies of all test criteria.
   3. Certification that insulating glass units meet requirements of IGCC and are certified by IGCC to ASTM E2190.

B. Samples:
   1. Two, 12 x 12 IN sample of each type, color, and thickness specified.
      a. Samples are not required for clear monolithic glass.

C. Informational Submittals:
   1. Warranty.

### 1.5 WARRANTY

A. Provide manufacturer's written 10 year warranty to cover deterioration of glass, glass units, coatings and ceramic frit.
   1. Insulating glass units shall be warranted against failure of hermetic seal resulting in fogging or film formation on the interior glass surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Glass:
      a. Guardian Glass by Guardian Industries.
      b. Insulite Glass Co., Inc.
      c. NSG/Pilkington.
      d. Oldcastle Building Envelope.
      e. Vitro Architectural Glass.
      f. Viracon.
   2. Fire Resistance Rated Glass:
      a. SAFTI*FIRST* by O'Keefe's, Inc.
      b. Technical Glass Products by Allegion PLC.
      c. Vetrotech Saint-Gobain.
   3. Gaskets, glazing compounds, setting blocks, spacers, sealant, sealant tape, etc., as recommended by glass manufacturer, glass unit fabricator.
      a. Provide materials as required by NFPA for use in fire-rated units.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. General:
   1. ASTM C1036.
      a. Clear glass: Type I, Class 1, Quality Q3.
      b. Tinted glass: Type I, Class 2, Quality Q3.
   2. Thickness: 1/4 IN, unless noted otherwise.

B. Heat Strengthened and Fully Tempered Glass: ASTM C1048.
   1. General use: Kind HS.
   2. Safety glazing: Kind FT.
      a. Meet requirements of ANSI Z97.1 and CSPC 16 CFR 1201.
   3. Condition:
      a. Clear or tinted vision glass: Condition A.
      b. Spandrel Glass (ceramic coated): Condition B.
      c. Coated vision glass: Condition C.
         1) ASTM C1376, Kind CV or CO.

C. Fire Resistance Rated Glass:
   1. ASTM E119 or UL 263 listed.
   2. Fire rating required: As scheduled on Drawings.
      a. Fire-rated glazing assemblies shall be marked in accordance with the building code.
   3. Thickness required by fire rating.
      a. Minimum 3/16 IN thick.
   4. Optically clear, colorless and free from distortion.
   5. Impact safety rated in addition to fire rating; meet ANSI Z97.1, Category 11.

## 2.3 MANUFACTURED UNITS

A. Insulating Glass Units:
   1. ASTM E2190, Class A.
   2. Two lites of glass separated by a hermetically sealed air space.
      a. Spacer: Stainless steel "warm edge" spacer.
         1) Thickness: 1/2 IN.
         2) Color: Black.
      b. Perimeter Sealant: Silicone.
         1) Color: Black.

B. Insulating Fire Resistance Rated Glass Units:
   1. ASTM E119 or UL 263 listed.
   2. Fire rating required: as scheduled on Drawings.
      a. Hose stream.
   3. Thickness required by fire rating specified.
   4. Maximum temperature on non-fire side of glass to be 450 DEGF.
   5. Impact safety rated: ANSI Z97.1 or CPSC 16 CFR 1201 Cat. I and II.
   6. Rated for two-way (non-directional) protection.

## 2.4 ACCESSORIES

A. Glazing Compounds:
   1. Non-sag, non-stain type.
   2. Pigmented to match frame units not requiring painting.
   3. Compatible with adjacent surfaces.
   4. One- or two-part polyurethane or silicone sealant for use in setting glass.
      a. Provide glazing compounds which will not be affected by chemicals stored in rooms where glazing compounds are used.

B. Sealant Tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim.

C. Gaskets:
   1. Flexible polyvinyl chloride or neoprene.
      a. ASTM C864.
      b. Provide gaskets which will not be affected by chemicals stored in rooms where gaskets are used.
   2. Extruded of profile and hardness required to receive glass and provide a watertight installation.
   3. Provide gaskets in accordance with NFPA in fire resistance rated glazing.

D. Setting Blocks and Spacers:
   1. Neoprene or EPDM, compatible with sealants used.
      a. ASTM C864.

E. Compressible Filler Stock: Closed cell polyethylene or polyethylene jacketed polyurethane foam.

F. Shims, Clips, Screws and Other Miscellaneous Items: As required by condition.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with recommendations of manufacturer, GANA Glazing Manual and IGMA TM-3000.

B. Install setting blocks in adhesive or sealant.

C. Install spacers inside and out, of proper size and spacing, for all glass sizes larger than 50 united inches, except where gaskets are used for glazing.

D. Provide 1/8 IN minimum bite of spacers on glass.

E. Spacer thickness to equal sealant width.

F. Prevent sealant exudation from glazing channels of insulating glass which is more than 1/2 IN thick; colored, heat absorbing, coated or laminated glass sizes larger than 75 united inches; and other glass more than 9/32 IN thick or larger than 125 united inches.
   1. Leave void at heel (or install filler) at jambs and head.
   2. Do not leave void (or install filler) at sill.

G. Miter cut and bond gasket ends together at corners.

H. Immediately after installation, attach crossed streamers to framing held away from glass.

I. Use polysulfide-based glazing sealants in window assembly and as perimeter sealant around frames in areas which may be exposed to chlorine gas or chlorine liquid splash or spillage.
   1. See Specification Section 07 92 00 for sealants.

J. Install fire resistance rated glass in accordance with manufacturer's recommendations and in accordance with applicable fire testing criteria.

### 3.2 FIELD QUALITY CONTROL

A. Do not install glass with edge damage.

B. Do not apply anything to surfaces of glass.

C. Remove and replace damaged glass.

### 3.3 CLEANING

A. Maintain glass reasonably clean during construction, so that it will not be damaged by corrosive action and will not contribute to deterioration of other materials.

B. Wash and polish glass on both faces not more than seven days prior to acceptance of work in each area.
   1. Comply with glass manufacturer's recommendations.

## 3.4 SCHEDULES

A. General:
   1. Provide safety glazing for all applications where required by the building code and CPSC 16 CFR 1201.
   2. Provide heat strengthened glazing for all general use applications where safety glazing is not required.

B. Glass Type 4: Insulating Units.
   1. Exterior lite: 1/4 IN clear.
   2. 1/2 IN dehydrated air space.
   3. Interior lite: 1/4 IN clear.
   4. Performance Requirements:
      a. Transmittance:
         1) Visible light: 76 PCT.
      b. U-Value
         1) Winter: 0.47.
         2) Summer: 0.49.
      c. Solar Heat Gain Coefficient (SHGC): 0.70.

C. Glass Type 5: Insulating Low-E Units.
   1. Exterior lite: 1/4 IN with SNX-L 62/34 HT on #2 surface.
      a. Color: [_Pacifica_].
   2. 1/2 IN argon filled air space.
   3. Interior lite: 1/4 IN clear.
   4. Performance Requirements:
      a. Transmittance:
         1) Visible light: 42 PCT.
         2) Solar energy: __18_PCT.
         3) UV: _____8PCT.
      b. Reflectance:
         1) Exterior: _8_ PCT.
         2) Interior: __10___PCT.
         3) Solar: ___25__PCT.
      c. U-Value
         1) Winter: _0.29__.
         2) Summer: _0.27_.
      d. Shading Coefficient: __30___.
      e. Relative Heat Gain: __73___.
      f. Solar Heat Gain Coefficient (SHGC):_0__.

D. Glass Type 15: Fire Resistance Rated Glass.
   1. Thickness and hourly rating as necessary for location shown on Drawings.

E. Glass Type 16: Fire Resistance Rated Insulating Glass Units.
   1. Exterior lite: 1/4 IN clear.
   2. 1/2 IN dehydrated air space.
   3. Interior lite: Fire Resistance Rated Glass.
      a. Thickness and hourly rating as necessary for location shown on Drawings.
   4. Performance Requirements:
      a. Transmittance:
         1) Visible light: _42__PCT.
         2) Solar energy: __18___PCT.
         3) UV: ____8_ PCT.

b. Reflectance:
   1) Exterior: _8_PCT.
   2) Interior: __10_PCT.
   3) Solar: __25___PCT.
c. U-Value
   1) Winter: __0.29__.
   2) Summer: _0.27_.
d. Shading Coefficient: _____.0.3
e. Relative Heat Gain: ___73__.
f. Solar Heat Gain Coefficient (SHGC): _0.30__.

**END OF SECTION**

# SECTION 08 90 00
LOUVERS AND VENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Louvers and vents.
   2. Louvers for hollow metal and aluminum doors.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 62 00 - Flashing and Sheet Metal.
   4. Section 07 92 00 - Joint Sealants.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. Air Movement and Control Association (AMCA).
   3. ASTM International (ASTM):
      a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color chart showing manufacturer's full line of colors including exotic and special colors for color selection by Engineer.

B. Samples:
   1. Samples of factory applied high performance organic coatings of colors proposed for matching color of roofing panels.
      a. Provide actual metal samples (aluminum).
         1) Color cards and computer generated color reproductions are not acceptable.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Louvers:
   a. Airolite Company LLC.
   b. Construction Specialties, Inc.
   c. Ruskin Company.
   d. Industrial Louvers, Inc.
   e. American Warming and Ventilating.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. Louvers:
   1. 4 IN deep for stationary louvers
   2. 6 IN deep for gravity exhaust combination louver damper.
   3. Drainable with blades at 37-1/2 DEG.
   4. Continuous blade appearance.
   5. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 IN thick.
   6. Minimum free area: 8.58 SQFT for 4 x 4 FT louver.
   7. Maximum pressure drop: 0.10 IN of water at 700 FPM.
   8. Water penetration: 0.01 OZ/SQFT at 873 FPM.
   9. AMCA certified..
   10. Ruskin "ELBD375E" – Gravity Exhaust Combination Louver Damper
   11. Ruskin "ELF 375DX" – Stationary Louver
   12. Insect screen:
      a. 18-16 mesh aluminum.
      b. Install in standard aluminum frame.
   13. Gravity exhaust combination louver damper shall begin to open at approximately 0.03" w.g. pressure and are fully open at approximately 0.1" w.g. pressure.

B. Anchors, Fasteners, Reinforcing: Aluminum or stainless steel.

C. Finish:
   1. Architectural Class 1 coating per AA DAF 45.
      a. Color T.B.D from standard color range.

D. Size: Refer to Mechanical Drawings for louver size, and refer to Architectural Drawings for louver shapes.

E. Blank-Off Plates:
   1. Aluminum sheet, 0.050 IN minimum thickness.
   2. Factory applied flat black painted finish.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchoring and bracing accessories as required.

C. Seal around perimeter on exterior and interior.
   1. See Section 07 92 00.

D. Install 0.040 IN aluminum flashing at sill to match louver and brick vent.
   1. See Section 07 62 00.

**END OF SECTION**

# DIVISION 09

**FINISHES**

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# SECTION 09 22 16
## NON-STRUCTURAL METAL FRAMING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Member of Certified Steel Stud Association (CSSA), Steel Stud Manufacturers Association (SSMA) or Steel Framing Industry Association (SFIA).

B. Referenced Standards:
   1. Refer to Section 01 42 00References.
   2. The American Iron and Steel Institute (AISI):
      a. AISI S220 North American Standard for Cold-Formed Steel Framing – Nonstructural Members.
   3. ASTM International (ASTM):
      a. ASTM C635 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
      b. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
      c. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
      d. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
      e. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold-Formed Framing Members.

C. Gypsum Association (GA):
   1. GA-216 Application and Finishing of Gypsum Panel Products.
   2. GA-234 Control Joints for Fire-Resistance Rated Systems.

### 1.3 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Product Data:
   1. Manufacturer's specifications for each type of material and accessory.
      a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
   2. Where EQ coatings are used, submit copies of nationally recognized testing laboratory results showing conformance with ASTM A653 and AISI S220.
      a. Include data required to show specification compliance.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Non-Structural Metal Framing:
   1. Base:
      a. ClarkDietrich Building Systems

2. Optional:
   a. CEMCO Steel Framing and Metal Lath
   b. Custom Stud Inc.
   c. Marino/WARE
   d. MBA Metal Framing
   e. MRI Steel Framing LLC.
   f. Telling Industries
   g. The Steel Network

B. Isolation Strip Material:
   1. Base:
      a. Reflectix, Inc.
   2. Optional:
      a. Saint-Gobain

C. Knee Wall Brace:
   1. Base:
      a. Pittcon Industries

D. Interlocking Grid Support Systems for Gypsum Board Ceilings:
   1. Base:
      a. USG Corporation
   2. Optional:
      a. Armstrong
      b. Chicago Metallic

E. Other manufacturers desiring approval comply with Section 01 61 00.

F. Products proposed for use in fire-rated assemblies:
   1. Approved by nationally recognized testing laboratory.

## 2.2 DESIGN CRITERIA

A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

| Performance Criteria | | |
|---|---|---|
| **Use Condition [2]** | **Design Pressure** | **Maximum Deflection** |
| Wall enclosing stairs, elevator hoistways, and other vertical shafts | 10 LBS/SF<br>480 Pa | L/240 |
| Wall enclosing vestibules, ground floor lobbies, and similar spaces subject to intermittent exposure to exterior wind conditions | 15 LBS/SF<br>720 Pa | L/240 |
| Walls scheduled with Tile Backer Board, Moisture-Resistant, Impact-Resistant, or Abuse-Resistant Gypsum Wallboard | 5 LBS/SF<br>240 Pa | L/360 |
| Walls scheduled to receive Tile, lath and plaster, or veneer plaster. [1] | | |
| Typical Interior Walls/Partitions (those not listed above) | 5 LBS/SF<br>240 Pa | L/240 |
| Interior Ceilings, Soffits and Bulkheads | 5 LBS/SF<br>240 Pa | L/360 |

**Footnotes**
1. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile, Thin Brick, Lath & Plaster, Simulated Masonry, Adhered Stone, Veneer Plaster and similar brittle finishes which are prone to movement induced cracking.

2. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

## 2.3 MATERIALS

A. Metal Studs and Floor Tracks:
   1. C-shaped, roll formed studs and tracks conforming to ASTM C645.
   2. Steel design standard: 33KSI 227 MPa.
      a. Galvanized: G60 Z180 galvanized conforming to ASTM A653 and AISI S220.
   3. Coatings: As indicated on architectural drawings.
   4. Provide metal framing members that have a minimum recycled content of 35 PCT.
   5. Stud and track depths: As indicated by wall type.
   6. Minimum flange width: 1-1/4 IN 6 MM.
   7. Minimum thickness: 30 MIL (20 GA) 0.752, except as follows:
      a. Increase member thickness to comply with performance criteria.
      b. Decrease member thickness to minimum 18 MIL (25 GA), 0.46 MM studs at following condition:
         1) Where walls do not extend to overhead structural deck and supporting diagonal bracing or horizontal stiffeners are used.
   8. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
      a. Coordinate locations with building services items.
      b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
   9. High strength 50 KSI 345 MPa or 70 KSI 483 MPa studs shall comply with design criteria of equivalent thickness standard 33KSI 227 MPa studs listed.
   10. At walls designated STC 40 and above, use only studs with physical characteristics of studs used in documented STC testing.
   11. Base product: ProSTUD Drywall Framing by ClarkDietrich.

B. Head of Wall Accessories:
   1. Configure to accommodate deflection of superstructure without inducing axial loading on partition wall.
   2. Maintain structural integrity, fire and smoke-resistance, and sound control as required by each wall.
   3. Slotted top deflection track:
      a. Deep leg, vertically slotted track.
      b. Cold-formed sheet steel; galvanized; G60.
      c. Thickness: 30 MIL (20 GA) 0.752 MM minimum.
      d. Width: As required for studs sizes indicated.
      e. Depth: Minimum 2-1/2 IN 63 MM down-standing legs with 1/4 IN 6 MM wide by 1-1/2 IN 38 MM high slots spaced 1 IN 25 MM on center.
      f. Base product: MaxTrak by ClarkDietrich.
   4. Z-bars, cold formed channels and clips:
      a. Accommodate thickness of spray-applied fire-resistive materials.
   5. UL-listed fire resistant components tested for compliance with requirements indicated.
   6. Firestopping Materials:
      a. Sealants, sprays, intumescent strips and forming materials.
      b. Coordinate with sealants specified in Section 07 84 00 and Section 07 92 00.
      c. Intumescent applications:
         1) Factory or field applied.
      d. Base product: Blazeframe by ClarkDietrich.

C. Shaftwall Framing:
   1. C-T or C-H shaped studs with U or J shaped tracks.
   2. Material: Galvanized steel; G40 or certified equivalent..
   3. Thickness: 33 MIL (20 GA) 0.838 MM minimum.
   4. Size: 2-1/2, 4, and 6 IN 63, 100, and 150 MM minimum as indicated.

5. Structural design criteria:
   a. Select stud with properties necessary to limit deflection to L/240 deflection at load of 10 PSF 480 Pa.
   b. Use larger size and thickness to satisfy span and deflection criteria.
6. Shaftwall assembly with gypsum wallboard specified in Section 09 29 00:
   a. Fire resistance tested in accordance with ASTM E119.
   b. Sound transmission loss: Tested in accordance with ASTM E90.
7. Base product: Shaftwall System by ClarkDietrich.

D. Z-Bar Standoff Clips:
1. 30 MIL (20 GA) 0.752 MM galvanized steel.
2. Provide Z-bars for attachment of top track to superstructure elements which are to be protected with sprayed fireproofing.
   a. Size: 2 IN x 2 IN x 2 IN 50 MM x 50 MM x 50 MM.
3. Length:
   a. As required to accommodate beam and deck fireproofing.
      1) At structural steel member: Length equal to flange width of structural steel member.
      2) At steel deck: Minimum length equal to partition width, or as required to span steel deck flutes.
   b. Extend length of Z-bar to accommodate partition offset that will not clear fireproofed steel beam.
4. Base product: ZFC by Telling Industries.

E. Furring Channels:
1. Hat shaped sections.
2. Galvanized: G40 or certified equivalent.
3. Sizes: 7/8 IN 22 MM and 1-1/2 IN 38 MM, as indicated.
4. Minimum Thickness: 30 MIL (20 GA) 0.752 MM; Use heavier gauge as dictated by conditions.
5. Base product: Furring Channel/ Hat Channel by ClarkDietrich.

F. Resilient Channels (RC):
1. Specially designed asymmetrical-shaped channels for improved sound attenuation.
   a. Items which are approved for use in sound-rated assemblies indicated.
   b. Where sound walls are also fire-rated: Items must also be approved for use in fire-rated assemblies indicated.
2. Single-leg channel sections, attached perpendicularly to structural parent studs/joists.
   a. Use double leg variation where used at ceilings with multiple layers of wallboard.
3. Galvanized: G40 or certified equivalent.
4. Sizes: 1/2 IN 13 MM deep or as otherwise indicated.
5. Sizes: 1-1/4 IN 32 MM and 1-1/2 IN 38 MM, as indicated.
6. Thickness: 18 MIL (25 GA) 0.457 MM minimum. Use heavier gauge as dictated by conditions.
7. Base product: RC Series by ClarkDietrich.

G. Sound Isolation Clips:
1. For use with 7/8 IN 22 MM Furring Channels.
2. Rubber isolation bushing enclosed by galvanized steel brackets.
   a. Brackets to be secured to primary framing members (studs or joists) by screws.
   b. Rubber bushing to accept 7/8 IN 22 MM Furring Channels running perpendicular to primary framing members.
3. Vertical Load capacity.
   a. Clips shall have capacity to support wall or ceiling weights as constructed.
   b. Select clips and fasteners to support imposed loads.
4. Base Product: Model Iso-Max Sound Isolation Clips by Kinetics Noise Control.

H. Z-Furring:
   1. Z-shaped sections, attached to structural parent wall.
   2. Galvanized: G40 or certified equivalent.
   3. Sizes: 1, 1-1/2, and 2 IN 25, and 38, 50mm.
   4. Thickness: 18 MIL (25 GA) 0.457 MM minimum; Use heavier gauge as dictated by conditions.
   5. XPS foam insulation: Specified in Section 07 21 00.
   6. Base product: Z-Furring Channel by ClarkDietrich.

I. Accessory Items:
   1. Wire Ties:
      a. Minimum thickness: 43 MIL (18 GA) 1.09 MM soft annealed, galvanized.
   2. Track Fasteners:
      a. Power driven type, to withstand minimum 190 LBS 86 kg shear when driven.
   3. Closure:
      a. Continuous 30 MIL (20 GA) 0.752 MM galvanized closure angle to receive vapor retarder and vapor retarder tape.
   4. Metal Blocking:
      a. C-shaped modified track runners.
      b. G40 galvanized or certified equivalent.
      c. Backing height: 6 IN 150 MM minimum.
      d. Flange width: 1-1/4 IN 32 MM minimum.
      e. Thickness: 30 MIL (20 GA) 0.95 MM minimum.
   5. Backing - Flat Plate:
      a. Flat, sheet metal stock per ASTM A1008.
      b. G40 galvanized or certified equivalent.
      c. Thickness: 50 MIL (18 GA) 1.27 MM minimum.
      d. General installations:
         1) Dimensions: 2 to 12 IN 50 to 300 MM wide, as necessary for items to be supported.
         2) Thickness: 30 MIL (20 GA) 0.752 MM minimum.
         3) Use heavier gauge as necessary for items to be supported.
      e. Laboratory casework and other wall mounted items:
         1) Dimension: Minimum 10 IN 250 MM wide for items to be supported.
         2) Thickness: 54 MIL (16 GA) 1.5 MM minimum.
            a) Use heavier gauge as necessary for items to be supported.
         3) Thickness: 33 MIL (20 GA) 0.9 MM minimum.
            a) Use heavier gauge as necessary for items to be supported.
   6. Knee Wall Brace:
      a. Steel tube and baseplate bolted to concrete floor slab with tube projecting vertically; concealed within framed walls to provide structural stability for knee walls.
      b. Design components compatible with wall type.
      c. Material: Cold-rolled steel tube and base plate, fully welded.
      d. Overall height: Wall height less 2 IN 50 MM.
      e. Spacing as recommended by manufacturer.
      f. Base product: SKB by Pittcon Industries.
   7. Shower Seat Support: See Section 05 50 00.

J. Support Systems for Gypsum Ceilings:
   1. Stud-Framed Ceiling/Soffit Systems:
      a. C-shaped studs or joists; roll-formed.
      b. Galvanized: G40.
      c. Frame member depth: 3-5/8 IN 92 MM minimum, unless otherwise indicated.
         1) Use wider stud sections if ceiling span and support requires.
      d. Flange width: 1-1/4 IN 32 MM minimum.
      e. Stud thickness: 33 MIL 0.838 MM minimum.

2. Tie Wire:
   a. ASTM A641, Class 1 zinc coating, soft temper.
   b. Diameter, single-strand: 62 mils (14 GA) 1.575 MM minimum.
   c. Diameter, double-strand: 42 mils (18 GA) 1.067 MM minimum.
3. Wire Hangers:
   a. ASTM A641, Class 1 zinc coating, soft temper.
   b. Diameter: 97 mils (12 GA) 2.46 MM minimum.
4. Anchors in Concrete:
   a. Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488 or ASTM E1512 as applicable.
   b. Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
   c. Material: Carbon-steel components zinc plated to comply with ASTM-B633, Class Fe/Zn 5 for Class SC 1 service condition.
   d. Material: Stainless-steel components complying with ASTM F593 and ASTM F594, Group 1 Alloy 304 or 316.
5. Powder-Actuated Fasteners in Concrete:
   a. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
   b. Comply with seismic design requirements where applicable.
6. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.
7. Seismic bracing: As indicated and as required by referenced installation standards.

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Examine supporting structure and conditions under which system will be installed.

B. Correct conditions detrimental to proper installation.

C. Installation constitutes acceptance of responsibility for performance.

### 3.2 INSTALLATION - GENERAL

A. Layout and install metal framing accurate to dimensions indicated in drawings.

B. Installation Standard: ASTM C754, except comply with framing sizes and spacing indicated.
   1. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 relative to framing installation.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, wall stops, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

G. Extend framing full height to structural supports.
   1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.

2. Continue framing around ducts and similar items which penetrate partitions.

H. Position studs vertically engaging floor track and head of wall deflection track.
   1. Align stud knockouts to facilitate running of wires and conduit.

I. Space studs maximum 16 IN 400 MM on center.
   1. Stud spacing at Shaftwall: 24 IN 610 MM on center.

J. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.

K. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool per ASTM C754.

L. Anchor studs to deflection track with wafer head screws on both flanges of each stud.
   1. Maintain deflection gap between top of stud and top of slotted track.
   2. Install screws at centerline of slot and secure allowing vertical movement.

M. Anchor fire rated partitions as required by fire resistance design, and firestopping design.

N. Where partitions abut vertical structural elements, provide perimeter relief per Gypsum Association GA-600 Strain Relief System details.

O. Head-of-Wall:
   1. Provide slotted top track for walls extended to structure.
   2. Configure to resist lateral loads while accommodating deflection of overhead building superstructure without inducing axial loading on partition framing.
   3. Secure deflection track to structure in accordance with industry standards and regulatory requirements.
   4. Secure at corners and at ends.
   5. Cut vertical studs 5/8 IN 16 MM short to create a deflection gap when installed into top track.
      a. Secure vertical studs to top track with framing screw at each stud, screwing through track slots for positive stud connection.
   6. Secure Gypsum Wallboard to vertical studs; do not secure Gypsum Wallboard to top track directly.
   7. Where partitions attach to structural elements that are scheduled to receive Spray-applied Fire Resistive Materials (SFRM):
      a. Install Z-bar to underside of steel beams and steel deck before application of sprayed fireproofing.
      b. Locate Z-bars perpendicular to line of partition, spaced maximum 16 IN on center.
      c. Attach each Z-bar with two 0.145 IN x 1 IN 3.7 MM x 25 MM powder-actuated fasteners located minimum 1 IN from ends of Z-bar.
      d. After fireproofing, secure top track to Z-bars with No. 8 x 5/8 IN wafer head framing screws spaced maximum 16 IN 400 MM on center.
   8. Where fire-rated partitions are offset and will not clear fireproofed steel beam, extend Z-bar outrigger horizontally from bottom of beam out to minimum 2 IN 50 MM beyond width of head-of-wall.
      a. Attach 3/4 IN 19 MM expanded metal lath continuous, width of top of Z-bar outriggers prior to fireproofing steel beam to accommodate sprayed fireproofing.
   9. Prepare wall for installation of seals, firestopping, or both:
      a. Fire-rated Walls: Prepare for fire-resistive joint assemblies specified in Section 07 84 00.
      b. Non-fire rated partitions including Smoke Partitions: Prepare for Acoustical Sealant specified in Section 07 92 16.

P. Furring Channels:
   1. Attach furring channel systems directly to parent walls.
   2. Install channels at maximum 16 IN 400 MM OC.

3. Provide additional framing at openings, cutouts, corners, and control joints.
4. Space fasteners not more than 24 IN 610 MM OC, staggered on opposite flanges of furring channels.

Q. Horizontally stiffen partitions over 12 FT 3.66 M high:
1. Use continuous 3/4 IN 19 MM furring channels spaced not over 54 IN 1370 MM OC vertically.
2. Run channels through stud knockouts and wire tie to each stud or secure as recommended by manufacturer.

## 3.3 FRAMING AT OPENINGS

A. Control Joints (CJ):
1. Install additional stud, maximum 1/2 IN 13 MM from jamb studs.
2. Do not fasten extra stud to track or jamb stud.
3. Refer to specification Section 09 29 00 for control joint locations.

B. Prefabricated headers, jambs, and sill framing systems option:
1. Proprietary opening framing systems may be used as an alternative to conventionally fabricated framing.
2. Pre-approved Products:
   a. HDS Framing System by ClarkDietrich.
   b. Quick Frame Rough Opening System by Marino/ Ware.

C. Door Openings:
1. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section for cripple studs at head and secure to jamb studs. Screw into web of jamb stud.
2. Unless indicated otherwise, extend jamb studs through suspended ceilings and secure laterally to overhead structure.
3. Jamb Studs:
   a. Minimum thickness of jamb studs: 30 MIL (20 GA) 0.752 MM at openings.
   b. Install two studs at each jamb, toe-to-toe unless otherwise indicated.
   c. Securely attach first stud to frame.
   d. Fill cavity between studs with acoustic batt insulation where specified in Section 07 21 00 or shown in Drawings.
   e. Join second stud to first stud on each face with 30 MIL (20 GA) 0.752 MM screw attached steel straps at 42 IN 1070 MM on center maximum.
4. Headers:
   a. Openings less than 4 FT 1.2 M wide:
      1) Cut-to-length section of floor runner above and below wall openings.
      2) Split flanges and bend webs at ends.
      3) Overlap and screw attach jamb studs to frames.
   b. Openings over 4 FT 1.2 M wide:
      1) Cut-to-length, horizontal box beam studs above and below wall openings.
      2) Design for actual span and loading.
   c. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.
5. Control Joints at head of jambs:
   a. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2 IN 13 MM clearance from jamb stud to allow for installation of control joint in finished assembly.
   b. Gypsum Wallboard control joints as specified in Section 09 29 00.

D. Other Framed Openings:
1. Frame openings other than door openings the same as required for door openings, unless otherwise indicated.
2. Install framing below sills of openings to match framing required above door heads.
3. Cripple Studs:
   a. Install cut-to-length intermediate vertical studs above and below openings.

b. Spacing: As indicated for typical full-length studs.

4. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.

## 3.4 WALL BACKING AND BLOCKING

A. Metal Wall Backing: Provide in-wall metal wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:
   1. Crash rails, chair rails, wall bumpers, and similar wall protection devices.
   2. Contractor or Owner furnished equipment indicated to be wall mounted.
   3. Toilet accessories that do not include proprietary backing devices.
   4. Toilet partitions and lockers.
   5. Markerboards, tackboards, and chalkboards.
   6. Other wall-mounted items where backing is indicated by details or specification.

B. Verify metal stud framing has been installed to support wall-mounted items specified in Section 05 50 00.

C. Wood Wall Blocking: Specified in Section 06 10 00.

D. Coordinate mounting height, location, and coverage with item to be supported.

E. Determine material width according to item to be supported.

F. Provide in-wall metal wall backing material to interior metal stud walls specified herein and Exterior stud walls specified in Section 05 50 00.

G. Attachment: Minimum 2 - #10 sheet metal screws at each stud.

## 3.5 CEILING FRAMING

A. Install in compliance with manufacturer's recommendations.

B. Provide required items to support and trim out neatly, flush or recessed mechanical and electrical items.

C. Frame openings in ceiling support system to accommodate access panels and similar openings and penetrations.
   1. Completely frame openings with closed channel side of stud facing opening for support of recessed mechanical and electrical items.

## 3.6 CEILING SUPPORT SYSTEMS

A. Install suspension system components in sizes and spacing indicated on Drawings, but not less than required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where abutting or penetrated by building structure.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and secure fasteners appropriate for substrate.

4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and secure fasteners appropriate for structure and hanger.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing:
1. Saddle-tie hangars around main runners.
2. Saddle-tie cross-furring to main runners with one strand 97 mils (12 GA) 2.46 MM or two strands of 42 mils (18 GA) tie wire.
3. Splice main runners by lapping and interlocking flanges 12 IN 300 MM minimum and tying near each end with double loops of 53 mils (16 GA) 1.346 MM wire.
4. Splice cross-furring by lapping and interlocking pieces 8 IN minimum and tying near each end with double loops of 16 GA 1.346 MM wire.
5. Support recessed or drop-in light fixtures by main runners or supplemental framing supported by main runners.
6. Attach surface mounted fixtures to main runners with positive clamping device made of minimum 14 GA 1.9 MM material.
7. Seismic brace ceilings with #12 diagonal wires spaced in a 8 FT x 12 FT 2.44 M x 3.66 M grid within 6 FT 1.83 M of walls.
   a. Locate seismic bracing at intersection of main runners and cross-furring members.
   b. Provide connection between diagonal wires and main runner to prevent slippage for a 200 LB 90 kg seismic load.

F. Grid Suspension Systems:
1. Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces.
2. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
3. Install suspension systems that are level to within 1/8 IN 3 MM in 12 FT 3.66 M measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
4. Coordinate support requirements for in-ceiling devices with capacity of ceiling grid system.

**END OF SECTION**

# SECTION 09 29 00
GYPSUM BOARD

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Gypsum board.
   2. Tile backer board.
   3. Abuse resistant panels.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 06 10 00 - Rough Carpentry.
   4. Section 07 92 00 - Joint Sealants.
   5. Section 09 22 16 - Non-Structural Metal Framing.
   6. Section 09 30 13 - Ceramic Tile (CT).
   7. Section 09 91 10 - Architectural Painting.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C442/C442M, Standard Specification for Gypsum Backing Board, Gypsum Coreboard, and Gypsum Shaftliner Board.
      c. C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
      d. C840, Standard Specification for Application and Finishing of Gypsum Board.
      e. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
      f. C1278/C1278M, Standard Specification for Fiber-Reinforced Gypsum Panel.
      g. C1396/C1396M, Standard Specification for Gypsum Board.
      h. D3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
      i. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      j. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   2. Gypsum Association (GA):
      a. GA-214, Recommended Levels of Gypsum Board Finish.
   3. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.

### 1.3 DEFINITIONS

A. Wet Area:
   1. Toilet rooms, showers, laboratories, janitor closets, or similar areas.
   2. Areas within 5 FT of emergency showers, eye wash stations, service sinks, or mop sinks.
   3. Bottom 4 FT of all Process Areas - see drawings.

### 1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Drawings of unusual conditions.
   a. Control joint layout.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
4. Manufacturer's adhesive, joint treatment compound and tape recommendations.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Gypsum board and accessories:
      a. American Gypsum.
      b. Georgia-Pacific Gypsum LLC.
      c. National Gypsum.
      d. USG Corporation.
   2. Cement board and accessories:
      a. James Hardie Building Products, Inc.
      b. National Gypsum.
      c. USG Corporation.
   3. Abuse resistant panels:
      a. American Gypsum.
      b. Georgia-Pacific Gypsum LLC.
      c. National Gypsum.
      d. USG Corporation.
   4. Gypsum board suspension system:
      a. Armstrong Ceiling and Wall Solutions.
      b. Rockfon.
      c. USG Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. Provide UL Listed materials in fire-resistant rated construction.
   2. Furnish in lengths as long as practicable.

B. Gypsum Board (GB):
   1. ASTM C1396/C1396M.
   2. Thickness: 5/8 IN unless noted otherwise.
   3. Edges: Tapered.
   4. Fire-rated board: Type X.
   5. Water-Resistant Gypsum Board (WRGB):
      a. Water-resistant core and facers.
         1) Smooth face for finishing similar to standard gypsum board.
      b. Mold-resistant: ASTM D3273.
      c. USG "Sheetrock Mold Tough".

C. Gypsum Shaftliner Board:
   1. ASTM C442/C442M and C1396/C1396M.
   2. ASTM E84:
      a. Flame Spread: 20.
      b. Smoke Developed: 0.

3. 1 IN thick solid board.
4. Edges: Double beveled.
5. USG "Sheetrock Gypsum Liner Panels".

D. Cement Backer Board:
1. ASTM C1325.
2. Thickness:
   a. Wall board: 5/8 IN.
   b. Flooring underlayment: 1/4 IN.
3. Water durable, mold resistant, non-combustible cement backer board for tile.
   a. Rot, warp and delaminate resistant.
   b. For use on walls or floors.
   c. See Specification Section 09 30 13 for ceramic tile.

E. Abuse Resistant Panels (ARP):
1. ASTM C1278/C1278M.
2. ASTM E119, Flame Spread: 5.
3. ASTM E84, Smoke Developed: 0.
4. Mold-resistant: ASTM D3273.
5. Thickness: 5/8 IN.
6. Edges: Tapered.
7. USG "Fiberock Aqua-Tough AR."

F. Adhesive: As recommended by board manufacturer.

G. Joint Treatment Compound:
1. ASTM C475/C475M.
2. Recommended by manufacturer for specified board type and location.
3. Do not use self-adhesive fiber mesh tape.

H. Joint Tape:
1. ASTM C475/C475M.
2. Recommended by manufacturer for specified board type and location.

## 2.3 ACCESSORIES

A. Trim:
1. ASTM C1047.
2. Galvanized: ASTM A653/A653M G-60, unless noted otherwise.
3. Corner bead:
   a. Standard type with perforated flanges.
   b. ClarkDietrich "#103 Deluxe Corner Bead".
4. Casing and trim bead:
   a. ClarkDietrich "#200-A Metal U-Trim.
5. Control and expansion joints:
   a. ClarkDietrich "#093 Zinc Control Joint."

B. Fasteners:
1. Gypsum board:
   a. Self-drilling Type S, corrosion-resistant bugle head screws.
2. Abuse-resistant panels:
   a. Self-drilling Type S, HD corrosion-resistant bugle head screws.
   b. Provide stainless steel fasteners in wet areas.
3. Cement backer board:
   a. Self-drilling, corrosion resistant wafer head screws with strip-out prevention ribs.
   b. Do not use drywall screws.

C. Tie Wire and Suspension Wire:
1. Galvanized, soft annealed 12 GA minimum.

2. Use soft stainless steel wire of same gage in all wet areas and/or exterior areas.

D. Gypsum Board Suspension System:
   1. Direct hung factory fabricated heavy duty rated, single web system.
   2. Electro-galvanized.
   3. Fire rated system, UL listed.
   4. Chicago Metallic "Fire Front 650 Drywall Furring System."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
   1. Verify that metal stud framing has been installed plumb, true, and in accordance with the Contract Documents.
   2. Install ceiling suspension system in accordance with manufacturer's recommendations.
   3. Install gypsum board in accordance with ASTM C840.
   4. Install board in fire-rated construction in accordance with UL requirements.
      a. Self-adhesive applied fire rated tape is not acceptable for use on board joints in fire rated walls.
      b. Tape all joints using conventional fire rated joint tape and joint treatment compound.
   5. Erect all board vertically with edges over supporting members.
      a. See Specification Section 09 22 16 non-structural metal framing.
   6. Secure to each support or framing member with screws.
      a. Provide fasteners of sufficient length to penetrate framing member or stud not less than 3/8 IN.
   7. In curved wall or ceiling applications use 1/4 IN thick board specifically designed for use in radius construction.
      a. Apply in multiple layers as required to meet minimum drywall thickness specified.
   8. In areas having gypsum board ceilings and walls, install ceiling first.
   9. Bring boards into contact, but do not force into place.
   10. Fit neatly and carefully.
   11. Stagger edge joints on opposite side of a partition so they occur on different framing members.
   12. Hold board in firm contact with support while fasteners are being driven.
   13. Proceed with attachment from center of board toward ends and edges.
   14. Scribe board prior to cutting.
   15. Where sound-rated walls are indicated on Drawings, verify that sound insulation has been installed in walls.
   16. In fire-rated ceiling assemblies, fasten minimum 4 IN wide drywall strip continuous over all joints on backside of board.
   17. Where gypsum board abuts concrete, masonry, metal deck, exterior doors and windows, or other dissimilar material; provide 3/8 IN joint between edge of gypsum board and abutting material.
      a. Provide continuous casing bead trim on edge of board.
      b. Seal joint with sealant and backer rod.
      c. See Specification Section 07 92 00 for sealant.
   18. Use water-resistant gypsum board (WRGB) in wet locations not scheduled to receive tile finish or abuse resistant panels (ARP).
   19. Use Cement Backer Board in wet locations scheduled to receive tile finish.
      a. Install in accordance with ANSI A108.11 and manufacturer's recommendations.
      b. Use in areas where ceramic, porcelain, or quarry tile is scheduled.
   20. Provide abuse resistant panels (ARP) where scheduled or otherwise indicated on Drawings:
      a. Verify studs, over which abuse resistant panels are being applied, are a minimum of 20 GA in thickness.

B. Installation:
   1. Set fasteners between 3/8 and 1/2 IN from edges and 2 IN in from board corner.
      a. Space maximum of 12 IN on center at edges and in field of board.
      b. Where board butts at wall/ceiling juncture, hold fasteners back 6 IN from edges.
      c. Space fasteners closer if required by UL.
   2. Where two layers of gypsum board are required:
      a. Base layer: Install per single layer system procedures.
      b. Finish layer: Install per single layer system but stagger joints not less than one support from the base layer.
   3. Install fasteners, in gypsum board, so that head rests in a slight dimple without cutting face paper or fracturing core or as recommended by board/panel manufacturer.
   4. Install screws, in cement backer board, flush with board surface.
      a. Do not countersink screws.

C. Control Joints:
   1. Install prefabricated control joints to provide following maximum unjointed lengths or areas:
      a. Partitions: 30 FT, maximum straight run, and at lock side of jamb from head of each door opening to top of partition.
      b. Ceilings:
         1) 50 FT maximum in one direction,
         2) At change of direction or irregular shapes.
         3) Ceiling area: 2500 SQFT, maximum.
   2. Seal control joints.
      a. Use color to match wall or ceiling color as closely as possible.
   3. Where control or expansion joints occur in fire or sound rated assemblies, install suitable backing material to maintain required rating.
   4. Where a partition or ceiling abuts a structural element or dissimilar wall or ceiling, install corner bead, casing bead or other trim as required.

D. Board Finishing:
   1. Securely attach continuous corner beads to all external corners in accordance with manufacturer's recommendations.
   2. Provide the following minimum levels of gypsum board finish in accordance with GA-214.
      a. Areas exposed to view:
         1) Surfaces to receive vinyl wall covering: Level #4.
         2) Surfaces to receive painted finish: Level #5.
      b. Areas not exposed to view:
         1) Fire rated partitions: Level #2 unless a higher grade of finish is required by UL.
         2) Non-fire rated partitions: Level #2.
      c. Provide additional coats of joint compound as required to completely conceal joints, fasteners and accessories.
         1) Joint photographing will not be acceptable.
   3. Sand each coat to remove excess joint compound.
      a. Avoid roughing paper facing on board.
   4. Finish surface shall be smooth and free of tool marks and ridges.
   5. Prime gypsum board surfaces in accordance with Specification Section 09 91 10.
      a. After primer has been applied, inspect surfaces and repair and refinish all areas which show defects.
   6. Refer to ASTM C840 for additional finishing requirements.

## 3.2 FIELD QUALITY CONTROL

A. Manufacturer's Services:
   1. Provide services of manufacturer's factory trained representative to be present during erection of factory prefinished vinyl covered panels.

2. Manufacturer's representative to instruct Owner's personnel on replacing and repairing damaged prefinished vinyl covered panels.

**END OF SECTION**

# SECTION 09 30 13
CERAMIC TILE (CT)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. See the DEFINITIONS Article, Ceramic Tile paragraph for types of tile included in this Specification Section.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 92 00 - Joint Sealants.
   4. Section 09 29 00 - Gypsum Board.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. A108.1, Specification for the Installation of Ceramic Tile.
      b. A137.1, Specifications for Ceramic Tile.
   2. Tile Council of North America (TCNA):
      a. TCA Handbook for Ceramic, Glass, and Stone Tile Installation.

B. Qualifications:
   1. Installer must have minimum five years experience installing similar products with similar substrates.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Ceramic Tile: For purposes of this Specification Section, the term "ceramic tile" is intended to include ceramic, porcelain, granite, and terrazzo tiles.

### 1.4 SYSTEM DESCRIPTION

A. Unless noted otherwise on the Drawings, floor tile selection shall be made from complete range of available sizes within Class 3 durability rating.
   1. Tile colors, styles and profiles and associated trim pieces to be selected from manufacturer's complete line including premium and custom offerings.

### 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Certification of installer qualifications.
   4. Letter from grout and adhesive manufacturer stating that grout and tile adhesive being used is compatible with cement backer board specified in Specification Section 09 29 00.

B. Samples:

1. Complete range of tile samples per the SYSTEM DESCRIPTION Article in this Specification Section for selection by Engineer.
    a. Tile trim may be contrasting color.
    b. Complete range of grout color samples.
2. After selection of colors, types, patterns and sizes, and prior to ordering tile, provide minimum 16 x 16 IN sample palette or two full tiles if 12 x 12 IN (or larger) tile are specified, in color, pattern, blend and type for Engineer's final approval.
    a. Include selected grout color as part of sample.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Ceramic tile:
    a. American Olean (AOT).
    b. Daltile (DTC).
    c. Esquire Interiors LLC (ESQ).
    d. Florida Tile, Inc. (FT).
    e. Metropolitan Ceramics (MC).
    f. Richetti (RICH).
    g. Summitville Tiles, Inc. (SUM).
    h. United States Ceramic Tile Co. (USCT).
2. Adhesives, mortars, grouts and leveling compounds:
    a. Bonsal Co.
    b. Bostik by Arkema.
    c. H.B. Fuller Company (TEC).
    d. LATICRETE International, Inc.
    e. MAPEI, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Adhesives for Setting Tile:
1. Dry-set Portland cement mortars: ANSI A108.1.
2. Latex-Portland cement mortars: ANSI A108.1.
3. Assure adhesives are compatible with cement backer board.
4. Waterproofing:
    a. Trowel applied elastomeric compound.
    b. Acceptable to tile manufacturer.
    c. Compatible with backing material and setting adhesive.
    d. Mapei "PRP 315 IN.
    e. Fiber mesh reinforcing: As recommended by waterproofing manufacturer.

B. Grout: Portland cement-based material, containing quartz aggregate, colorfast pigments and Portland cement.

C. Sealant: One or two component, non-sag, polyurethane or silicone sealant, as specified in Specification Section 07 92 00.

D. Leveling Compounds: As recommended by tile manufacturer.

### 2.3 MANUFACTURED UNITS

A. Wall Tile:
   1. Ceramic units conforming to ANSI A137.1.
   2. 5/16 IN thick.
   3. Size(s): As scheduled in PART 3.
   4. Tile selections shall be made by the Architect and may include:
      a. Designer accents.
      b. Matt.
      c. Textured.
      d. Bright.
      e. Crystal.
      f. Satin.
      g. High gloss smooth glaze.
      h. Designer strips/rounded moldings.
      i. Granite look.
      j. Scored design.

B. Tile Base and Associated Trim:
   1. Factory made trim shapes for all curbs, caps, corners, bullnose, bases, coves, beads, depressions, moldings, chair rails, etc.

### 2.4 MAINTENANCE MATERIALS

A. Extra Material:
   1. Furnish Owner with the following extra materials:
      a. 2 PCT of each different size, pattern, style and/or color of tile used including trim shapes with minimum of one full size tile of each for maintenance purposes.
      b. Enough extra grout mix of each different color and/or type to allow for full 2 PCT of tile to be replaced.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Locate expansion joints prior to product installation.

B. Verify that substrate is ready to accept tile installation.
   1. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

### 3.2 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions and ANSI A108.1.
   2. Place tile in pattern as shown on Drawings.
   3. Align tile joints on adjoining walls/floors.
   4. Lay out and center tile in both directions in each space or on each wall area.
   5. Avoid use of tile less than 1/2 size.
   6. Adjust tile to minimize cutting.
   7. Provide uniform joint widths insofar as practicable.
      a. Provide joint widths as recommended by tile manufacturer.
   8. Provide leveling beds as required.
   9. Provide edging at exposed edges where there is a change of level.

B. Install expansion joints where indicated on Drawings:
   1. If not indicated on Drawings, place joints 12 - 16 FT OC or on column lines each way (whichever is smaller).
      a. Provide expansion joints in accordance with TCA Handbook.
   2. Install over construction or expansion joints in backing.
   3. Install where backing material changes.
   4. Install where floors abut vertical surface.
   5. Maintain nominal 1/4 IN wide joint at perimeter of tiled floor areas and fill with sealant.
   6. Extend expansion joint thru setting bed on setting bed installations.

C. Mortar Set Installation for floor tile:
   1. Install mortar setting bed.
      a. Place in prepared areas to thickness indicated on Drawings or as required by manufacturer.
      b. Place continuous reinforcing, centered in setting bed, with sheets lapped at least one mesh.
      c. Do not run reinforcing through expansion or control joints.
      d. Finish setting bed to tolerance not exceeding 1 IN 50.
      e. After setting bed has set sufficiently to allow work, apply skim coat, nominal 1/16 IN thick, of neat cement over entire surface.

D. Installation of Tile on Floors and Walls Over Waterproofing and Setting Adhesive:
   1. Provide waterproofing for all tile installed on:
      a. Floors in toilet rooms, showers, janitor closets, locker rooms, vestibules and any other floor in a wet area.
         1) Extend up walls to height of base.
      b. Walls in shower rooms:
         1) Install full height of tile.
         2) Completely cover all curb surfaces to receive tile.
   2. Installation of Waterproofing Membrane:
      a. Prepare substrate in accordance with manufacturer's published recommendations.
      b. Apply base membrane with flat trowel.
         1) Maximum thickness: 5/64 IN per coat or as recommended by manufacturer.
         2) Allow membrane to cure between coats in accordance with manufacturer's instructions.
      c. Apply second coat with v-notch trowel and immediately flatten with flat trowel to a smooth, membrane, free of voids.
      d. Embed fiber mesh reinforcing into fresh membrane at all inside corners, vertical/horizontal intersections and where required for crack control.
         1) Do not bridge expansion joints with reinforcing or membrane.
      e. Apply additional coat (s) of membrane per manufacturer's published instructions to completely encapsulate fiber mesh reinforcing
   3. After waterproofing has cured/dried in accordance with manufacturer's recommendations, install tile using setting adhesive in accordance with manufacturer's recommendations.

## 3.3 CLEANING

A. After installation, clean in accordance with manufacturer's instructions.

## 3.4 PROTECTION

A. Permit no traffic on floors for 72 HRS after grouting and protect installed tile work with minimum 0.125 IN thick non-staining covering during construction to prevent damage.

## 3.5 SCHEDULES

A. Tile Shapes Schedule:

TBD during construction.

| TILE DESIGNATION | ROOM # | WALL SURFACE | | | | FLR | BASE | SIZE | TILE MANUFACTURER AND PART NUMBER | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | | | | | |
| CT-1 | | | | | | | | | | |
| CT-2 | | | | | | | | | | |
| CT-3 | | | | | | | | | | |
| CT-4 | | | | | | | | | | |
| CT-5 | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

B. Tile Color Schedule:

TBD during construction.

| TILE DESIGNATION | ROOM # | WALL SURFACE | | | | FLR | BASE | SIZE | TILE MANUFACTURER AND PART NUMBER | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | | | | | |
| CT-1 | | | | | | | | | | |
| CT-2 | | | | | | | | | | |
| CT-3 | | | | | | | | | | |
| CT-4 | | | | | | | | | | |
| CT-5 | | | | | | | | | | |
| | | | | | | | | | | |
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# SECTION 09 51 00
## ACOUSTICAL CEILINGS (ACT)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Acoustical Ceiling Systems (ACT) in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM A641/A641M Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. ASTM B633Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
   3. ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panels Ceilings.
   4. ASTM C636/C636M Standard Specification for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   5. ASTM E366 Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
   6. ASTM E488/E488M Standard Test Methods for Strength of Anchors in Concrete Elements.
   7. ASTM E580/E580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
   8. ASTM E1190 Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members

B. Site Classification and Seismic Design Categories as defined in the 2019 OREGON STRUCTURAL SPECIALTY CODE. (OSSC)

C. ASHRAE 2007 Handbook: Chapter 47 – Sound and Vibration Control

### 1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's specifications for each type of material and accessory.

B. Samples:
   1. Three samples of each type of tile listed in Drawing Finish Schedule.

C. Contract Closeout Information:
   1. Maintenance data.
      a. See Section 01 33 04.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Steel Suspension Systems:
   1. Base:
      a. Armstrong World Industries.
   2. Optional:
      a. USG Corporation
      b. Rockfon

B. Acoustical Ceiling Tile:
   1. Base:
      a. As noted for individual types in Drawings.

C. Other manufacturers desiring approval comply with Section 01 61 00.

## 2.2 MATERIALS

A. Acoustic Suspension Systems:
   1. Heavy duty systems, ASTM C635.
   2. Main runner jointing by spliced, interlocking ends, tab locks, pin locks, or other suitable connections.
   3. Cross runners interlocking with main runners.
   4. Include components and accessories necessary resist seismic loads and dead loads of items such as light fixtures and air diffusers.
   5. Hanger Wire:
      a. Pre-stretched, with a yield stress load of at least 5 times design load, but not less than 0.106 IN (12 GA) 2.7 MM.
      b. Utilize continuous lengths, without kinks and splices.
      c. Galvanized Steel:
         1) Galvanized, soft annealed steel wire conforming to ASTM A641/A641m.
   6. Suspension System Types:
      a. GR-1: Exposed grid, non-rated:
         1) Description: Galvanized, double web steel, main and cross runners.
         2) Face width: 15/16 IN 24 MM.
         3) Base Product:
            a) Prelude XL, by Armstrong.
            b) Donn DX/DXL by USG.
            c) 200 Series by Chicago Metallic.
            d) 1200 Series by Chicago Metallic.
         4) Finish on exposed surfaces: Smooth, flat white.

B. Acoustical Ceiling Tile:
   1. Scheduled finishes to be factory applied.
   2. Class A incombustible units.
   3. Fire rated units (when used): UL labeled.
   4. Edges uniformly fabricated, true, square.
   5. Sizes as required to fit scheduled suspension system.
   6. Standard tile/panel size: See Reflected Ceiling Plan.
   7. Concealed spline style: Edges kerfed for splines.
   8. Aluminum facing: Minimum 0.010 IN 0.25 MM thick aluminum sheet with white baked enamel or vinyl coating.
   9. Foil facing: Enhanced aluminum foil with white vinyl coating.
   10. Minimum recycled content: T.B.D.

C. Diffusers and Grilles:
   1. See Section 23 31 00.

D. Light Fixtures:
   1. See Section 26 50 00.

# PART 3 - EXECUTION

## 3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Examine installation site for irregularities having effect on quality and execution of work.

C. Consult other trades involved before start of ceiling work, to determine areas of potential interference

D. Do not start installation until interferences have been resolved.

E. Installation constitutes acceptance of responsibility for performance.

## 3.2 PREPARATION

A. Coordinate ceiling layout with sprinkler head spacing and work penetrating acoustical ceiling systems.

B. Tolerances:
   1. Comply with ASTM C635/C635M Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
   2. Deviation from level plane: 1/8 IN in 10 FT 3 MM in 3 M with no load applied maximum.
   3. Bow: 1/32 IN in 2 FT 0.8 MM in 610 MM maximum.
   4. Camber: 1/32 IN in 2 FT 0.8 MM in 610 MM maximum.
   5. Twist: 1 degree in 2 FT 1 degree in 610 MM maximum.

## 3.3 INSTALLATION

A. Suspension System:
   1. Install suspension system in accordance with manufacturers' instructions.
   2. Grid layout:
      a. See Reflected Ceiling Plans.
      b. Install grid based on electrical lighting fixture layout indicated in Electrical Drawings, unless otherwise indicated,
      c. In case of conflict notify Architect.
   3. Install grid square with room and with grid or acoustical panel center lines coinciding with center lines of room, each direction.
   4. Intersections between main tees and cross tees:
      a. Butt cut and notch as required.
   5. Wall angles:
      a. Install wall angles or moldings where ceilings meet walls, partitions, vertical elements, and other types of ceilings or ceiling fixtures.
         1) Secure angles to wall construction at stud locations.
            a) Maximum spacing from terminal ends: 3 IN 76 MM.
            b) Draw fasteners tight against vertical surfaces.
         2) Level tolerance: not more than 1 IN 1000.
         3) Miter cut inside and outside corners.
         4) Install with leg supporting bottom flange of runners.
   6. Hanger wires:
      a. Provide hangers and inserts necessary to support ceiling suspension systems and ceiling dead loads.
      b. Coordinate location and alignment with work of other trades.
      c. Install hanger wires plumb to main tees and cross tees.
         1) Do not suspend any part of suspension system from ducts, pipes, conduit, cable tray or equipment.
         2) Provide supplementary rough suspension system where necessary to support ceilings beneath pipes, ducts, equipment, cable trays.
         3) Splay hangers no greater than 30 DEG from vertical to avoid obstructions or other conditions that prevent plumb, vertical installation.
         4) Offset horizontal forces by bracing or counter-splaying.

d. Space hangers to prevent eccentric deflection and rotation due to loads from items in or on ceiling
    1) Provide supplemental hangers to support lighting fixtures and within 6 IN 150 MM from end of main runners and fixtures which exceed manufacturer's published load data.
    2) Do not bear runners on walls or partitions.
7. Main runners:
    a. Utilize wall angles to align and receive terminal ends of main tees without transferring load to wall angle.
    b. Space main tees as indicated to receive lay-in panels and fixtures.
    c. Support terminal ends of main tees by wires located within 6 IN 150 MM from boundary walls.
8. Cross runners:
    a. Space cross tees as indicated to receive lay-in panels and fixtures.
        1) Install cross runners with positive interlock.
    b. Utilize wall angles to align and receive terminal ends of cross tees without transferring load to wall angle.
    c. Support terminal ends of cross tees by wires located within 6 IN 150 MM from boundary walls.
9. Leave suspension system ready to accept installation of acoustic materials.

B. Lay-In Items:
1. Install acoustic materials in accordance with manufacturer's instructions.
2. Place lay-in panels, fixtures, diffusers, grilles, and similar items in manner not compromising suspension system performance.
3. Field cut materials to fit grid.
4. Tegular and similar tiles with articulated edges:
    a. Cut edges to match profile of factory edges and paint to match.
5. Ceiling paint:
    a. Touch-up minor surface scratches and blemishes.
    b. Cover field cut edges exposed to view.
    c. Armstrong SuperCoat Ceiling Panel Touch-up Paint.

C. Identify access tile with a white headed thumb tack.

## 3.4 CLEANING AND REPAIR

A. Perform cleaning of soiled units and replacement of defective or damaged units.

## END OF SECTION

# SECTION 09 91 10
ARCHITECTURAL PAINTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Surface Preparation.
   2. Field application of:
      a. Architectural Coatings.
      b. Special Coatings.
      c. Stains and varnishes.
      d. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Environmental controls for field application of coatings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 05 52 02 - Welded Aluminum Railings.
   5. Section 07 81 00 - Fireproofing.
   6. Section 08 11 00 - Metal Doors and Frames.
   7. Section 09 29 00 - Gypsum Board.
   8. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D523, Standard Test Method for Specular Gloss.
      b. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      c. D4259, Standard Practice for Abrading Concrete.
      d. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      e. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      f. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
      h. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. National Fire Protection Association (NFPA):
      a. 101, Life Safety Code.
   3. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors and Frames.
   4. The Society for Protective Coatings (SSPC):
      a. SP 1, Solvent Cleaning.
      b. SP 2, Hand Tool Cleaning.
      c. SP 3, Power Tool Cleaning.
      d. SP 16, Brush-off Blast Cleaning of Non-Ferrous Metals.
   5. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 6/NACE No. 3, Commercial Blast Cleaning.
      b. SP 7/NACE No. 4, Brush-off Blast Cleaning.

c. SP 13/NACE No. 6, Surface Preparation of Concrete.
6. United States Environmental Protection Agency (EPA).

B. Miscellaneous:
1. Coating used in all corridors and stairways shall meet requirements of NFPA 101 and ASTM E84.

## 1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified.

C. Exposed Exterior Surface:
1. Exterior surface which is exposed to view.
2. Exterior surface which is exposed to weather but not necessarily exposed to view.

D. Finished Area:
1. An area that is listed in or has finish called for on Room Finish Schedule.
2. An area that is indicated on Drawings to be painted.

E. Gloss Range:
1. Specular gloss measured in accordance with ASTM D523:
a. Flat: Below 15, at 60 DEG.
b. Eggshell: Between 20 and 35, at 60 DEG.
c. Semi-gloss: Between 35 and 70, at 60 DEG.
d. Gloss: More than 70, at 60-degrees.

F. Paint includes the following:
1. Architectural paints (AP) include: Acrylic latex or alkyd enamel coatings.
2. Special coatings (SC) include: Water-based pigmented resin particles suspended in acrylic latex solution.
3. Stains and varnish include: Alkyd stain and polyurethane varnish.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's surface preparation instructions.
c. Manufacturer's application instructions.

B. Samples:
1. Manufacturer's full line of colors for Engineer's preliminary color selection.
2. Gloss samples.
3. Provide two (2) 8 by 10 IN samples of each color and sheen scheduled.
a. Refer to Color Schedule in PART 3.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Test results.
3. Applicator's daily records:
a. Submit daily records at end of each week in which painting work is performed unless requested otherwise by Engineer's on-site representative.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
   1. Name or type number of material.
   2. Manufacturer's name and item stock number.
   3. Contents, by volume, of major constituents.
   4. Warning labels.
   5. VOC content.

B. Store materials in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 DEGF.

### 1.6 PROJECT CONDITIONS

A. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.
   1. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
      a. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by paint manufacturer.
      b. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
         1) Vent exhaust gases to exterior environment.
         2) No exhaust gases shall be allowed to vent into the space being painted or any adjacent space.
   2. Do not apply coatings in snow, rain, fog or mist.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Provide products from a single manufacturer to the greatest extent practicable.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Architectural paints:
      a. Benjamin Moore & Co.
      b. PPG IdeaScapes.
      c. Pratt & Lambert.
      d. Sherwin-Williams.
      e. Tnemec, Inc.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. For unspecified materials such as thinner, provide manufacturer's recommended products.
   2. Unless noted otherwise, products listed are manufactured by the manufacturer listed below.
      a. Products of other manufacturers will be considered for use provided that the product:
         1) Is of the same generic formulation.
         2) Has comparable application requirements.
         3) Meets the same VOC levels or better.
         4) Provides the same finish and color options.
   3. Coatings shall comply with the VOC limits of EPA
   4. Colors:
      a. Colors and gloss will be selected from the manufacturer's complete offering, including special colors and premium offerings.

B. Architectural Paints:

1. Product List:

| Generic Description | Product |
|---|---|
| Acrylic Primer | PPG Pure Performance 9-900 |
| Acrylic Latex | PPG Pure Performance 9-100/9-300/9-500 Series |
| Acrylic Gloss | PPG Speedhide 6-8534 Series |
| Concrete Filler/Surfacer | Tnemec Series 215 and/or Series 218 |
| CMU Block Filler | Tnemec Series 54 Masonry Filler |
| Dry-Fall Primer | Tnemec Series V115 Uni-Bond DF |
| Epoxy Barrier Coat | Tnemec Series 135 Chembuild |
| Fluoropolymer | Tnemec Series 1070V/1071V/1072V Fluoronar |
| HDP Acrylic | Tnemec Series 1028/1029 Enduratone |
| Organic Zinc Primer | Tnemec Series 94-H2O Hydro-Zinc |
| Polycarbamide | Tnemec Series 740/750 UVX |
| Waterborne Acrylate | Tnemec Series 156 Enviro-Crete |

## 2.3 PAINT SYSTEMS

A. General:
1. Refer to Specification Section 09 96 00 for:
   a. Items in corrosive or highly corrosive environments.
   b. Items subject to immersion service.
   c. Items subject to exterior exposure.
   d. Any other locations where High Performance Industrial Coatings (HPIC) are required.
2. Refer to Specification Section 07 81 00 for steel elements to receive fireproofing.

B. Schedule:

| **Substrate** | **Prime Coat[1]** | **Intermediate Coat(s)[1]** | **Finish Coat[1]** |
|---|---|---|---|
| Concrete | Concrete Filler/Surfacer as necessary to fill all voids and depressions | 100 to 200 SQFT/GAL Waterborne Acrylate | 100 to 200 SQFT/GAL Waterborne Acrylate |
| | | | |
| Structural Steel and Miscellaneous Metals[3] | 2.5 to 3.5 MIL Organic Zinc Primer | 2.0 to 3.0 MIL HDP Acrylic[2] | 2.0 to 3.0 MIL HDP Acrylic[2] |
| Galvanized Structural Steel and Miscellaneous Metals[3] | 2.0 to 4.0 MIL Dry-Fall Acrylic | XX | 2.0 to 3.0 MIL HDP Acrylic [2] |
| Galvanized Metal Deck[3] | 2.0 to 4.0 MIL Dry-Fall Acrylic | XX | 2.0 to 4.0 MIL Dry-Fall Acrylic |
| Factory Primed Metal Deck[3] | XX | 2.0 to 4.0 MIL Dry-Fall Acrylic | 2.0 to 4.0 MIL Dry-Fall Acrylic |

| Substrate | Prime Coat[1] | Intermediate Coat(s)[1] | Finish Coat[1] |
|---|---|---|---|
| Galvanized Steel Railings | 4.0 to 6.0 MIL Epoxy Barrier Coat | 2.5 to 3.5 MIL Polycarbamide Gloss | 2.5 to 3.5 MIL Polycarbamide Gloss |
| Steel Railings | 4.0 to 6.0 MIL Epoxy Barrier Coat | 2.0 to 3.0 MIL HDP Acrylic Gloss | 2.0 to 3.0 MIL HDP Acrylic Gloss |
| Exposed wood | 300 to 400 SQFT/GAL Acrylic Primer | 300 to 400 SQFT/GAL Acrylic Gloss | 300 to 400 SQFT/GAL Acrylic Gloss |
| | | | |
| Hollow Metal - Interior | 4.0 to 5.0 MIL DFT Epoxy Barrier Coat | 2.0 to 3.0 MIL HDP Acrylic[2] | 2.0 to 3.0 MIL HDP Acrylic[2] |
| Hollow Metal - Exterior | 4.0 to 5.0 MIL DFT Epoxy Barrier Coat | 2.5 to 3.5 MIL Polycarbamide[2] | 2.5 to 3.5 MIL Polycarbamide[2] |
| | | | |
| Gypsum Board scheduled to receive "AP" | 300 to 400 SQFT/GAL Acrylic Primer | 300 to 400 SQFT/GAL Acrylic Latex [2] | 300 to 400 SQFT/GAL Acrylic Latex [2] |
| Gypsum Board scheduled to receive "SC" | 250 to 350 SQFT/GAL Special Coating Acrylic Primer | 250 to 300 SQFT/GAL Special Coating Base Coat | 125 to 150 SQFTGAL Special Coating Finish Coat |

1. Application rates (SF/GAL) shown are for unthinned materials.
2. Sheen as scheduled or selected.
3. For steel elements to receive fireproofing, see Specification Section 07 81 00.

## PART 3 - EXECUTION

### 3.1 ITEMS TO BE PAINTED

A. Exterior surfaces, including but not limited to:
   1. Miscellaneous ferrous metal surfaces:
      a. Items specifically noted on Drawings to be painted.

B. Interior Areas:
   1. Refer to Room Finish Schedule on Drawings.
      a. If space is scheduled to be painted, paint all appurtenant surfaces within the space unless specifically noted otherwise.
      b. Provide coating manufacturer's recommended bonding primer.
      c. Appurtenant surfaces include but are not limited to:
         1) Columns, beams, bracing and similar components.
         2) Underside of roof or floor decks above.
         3) Conduit, boxes, covers and supports.
         4) Ductwork, duct insulation and duct supports.
         5) Piping, pipe insulation and jacketing.
         6) Miscellaneous ferrous metal surfaces.
   2. Concrete walls and columns.
   3. Concrete masonry.
   4. Doors and frames:
      a. Hollow metal doors and frames
      b. Hollow metal window frames.

## 3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article, unless noted otherwise.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical equipment.

D. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless steel surfaces.

H. Aluminum Surfaces Except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.
   4. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

I. Fiberglass Surfaces Except:
   1. Fiberglass piping where specifically noted to be painted.
   2. Piping supports where specifically noted to be painted.
   3. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

J. Galvanized steel items, unless specifically noted to be painted.

K. Structural steel or steel deck required to be fireproofed in accordance with Specification Section 07 81 00.
   1. Provide intumescent paint where indicated.

L. Architectural finishes:
   1. Exterior concrete indicated to receive another finish.
   2. Precast concrete surfaces, unless specifically indicated to be painted.
   3. Plastic laminate.
   4. Solid surface material.
   5. Standing and running trim.
   6. Fiberglass fabrications.
   7. Anodized aluminum.
   8. PVDF coated metals.
   9. Factory finished doors and frames.
   10. Aluminum windows, curtainwall and storefront framing systems.
   11. Finish hardware.
   12. Glass and glazing.
   13. Ceramic, porcelain, quarry tile or natural stone.
   14. Acoustical materials.
   15. Building specialties.
   16. Louvers.
   17. Casework and countertops.
   18. Pipe insulation and jacketing.
   19. Standing seam metal roof, fascia, trim, soffit and accessories.
   20. Insulated metal roof panel.
   21. Insulated metal wall panel.

## 3.3 EXAMINATION

A. Concrete:

1. Test pH of surface to be painted in accordance with ASTM D4262.
    a. If surface pH is not within paint manufacturer's required acceptable range, use methods acceptable to paint manufacturer as required to bring pH within acceptable range.
    b. Retest pH until acceptable results are obtained.
2. Verify that moisture content of surface to be painted is within paint manufacturer's recommended acceptable limits.
    a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
        1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869.
        2) Provide remedial measures as necessary to bring moisture content within paint manufacturer's recommended acceptable limits.
        3) Retest surface until acceptable results are obtained.

## 3.4 PREPARATION

A. General:
1. Prepare surfaces to be painted in accordance with paint manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
    a. Where discrepancy between paint manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of paint to surface.
3. Adhere to manufacturer's recoat time surface preparation requirements.
    a. Surfaces that have exceeded paint manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional paint in accordance with manufacturer's published recommendations.

B. Protection:
1. Protect surrounding surfaces not to be coated.
2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Existing Surfaces:
1. Wherever existing work is cut, patched or modified; repair and repaint to match new work.
2. Where a wall or ceiling is disturbed and patched, paint entire wall or ceiling.

E. Wood:
1. Sandpaper smooth, remove dust.
2. Opaque Finishes:
    a. Seal all knots, pitch and resinous sapwood after prime coat has dried.
    b. Putty holes and imperfections; sand smooth.
3. Transparent Finishes:
    a. Treat wood with compatible wash-coat prior to stain application.
    b. Putty holes and imperfections to match wood color; sand smooth.

F. Ferrous Metal:
1. Complete fabrication, welding or burning before beginning surface preparation.
    a. Chip or grind off flux, spatter, slag or other laminations left from welding.
    b. Remove mill scale.
    c. Grind smooth rough welds and other sharp projections.
2. Solvent clean in accordance with SSPC SP 1 to remove all dust, grease, oil, compounds, dirt and other foreign matter.

3. Exterior exposure:
    a. Commercial blast clean in accordance with SSPC SP 6/NACE No. 3.
4. Interior exposure:
    a. Hand tool cleaning in accordance with SSPC SP 2 and/or power tool cleaning in accordance with SSPC SP 3.

G. Hollow Metal:
1. Solvent clean in accordance with SSPC SP 1 to remove all dust, grease, oil, compounds, dirt and other foreign matter.
2. Lightly sand primed surfaces with fine grit sandpaper as recommended by hollow metal manufacturer.

H. Galvanized Steel and Non-ferrous Metals:
1. Solvent clean to remove all dust, grease, oil, compounds, dirt and other foreign matter.
2. Brush-off blast in accordance with SSPC SP 16 or hand tool cleaning in accordance with SSPC SP 2 to remove surface contaminants.

I. Gypsum Wallboard:
1. Repair minor irregularities left by finishers.
2. Avoid raising nap of paper face on gypsum wallboard.
3. Verify moisture content is less than 8 PCT before painting.
4. After application of prime coat and between subsequent coats, inspect surface and repair holes, dents, irregularities or other defects as necessary to provide a smooth, uniform finish.

J. Concrete:
1. Cure for minimum of 28 days.
2. Clean in accordance with ASTM D4258.
    a. Remove all soil, grease, oil, or other surface contaminants.
3. Grind fins and protrusions in accordance with ASTM D4259, flush to plane of wall.
4. Abrasive blast in accordance with ASTM D4259 and SSPC SP13/NACE No. 6.
    a. Remove all laitance, efflorescence, scabbing and other foreign matter.
    b. Provide minimum concrete surface profile CSP 3 per ICRI 310.2.
5. Test pH and moisture content in accordance with EXAMINATION article in this specification section.
6. Repair tie holes, voids, bugholes or other surface defects as necessary to provide smooth, uniform surface.

## 3.5 APPLICATION

A. General:
1. Thin, mix and apply paints in accordance with manufacturer's installation instructions.
    a. Where discrepancy exists between manufacturer's instructions and this Specification Section, the more stringent requirement shall apply.
    b. When materials have been thinned, adjust application rates as necessary to achieve film coverage indicated in Part 2 for unthinned materials.
    c. Backroll spray applied paints.
2. Temperature and weather conditions:
    a. Do not paint surfaces when surface temperature is below 50 DEGF unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
    b. Avoid painting surfaces exposed to hot sun.
    c. Do not paint on damp surfaces.
3. Apply materials under adequate illumination.
4. Evenly spread to provide full, smooth coverage.
    a. All paint systems are "to cover."
        1) When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.

b. Finished paint system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.

5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
6. Work each application of material into corners, crevices, joints, and other difficult to work areas.
7. When painting rough surfaces, hand brush and backroll paint to work into all recesses.
8. Smooth out runs or sags immediately, or remove and recoat entire surface.
9. Allow preceding coats to dry before recoating.
   a. Recoat within time limits specified by paint manufacturer.
   b. If recoat time limits have expired re-prepare surface in accordance with paint manufacturer's printed recommendations.
10. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
11. Finish colors not otherwise indicated shall be selected by Engineer from paint manufacturer's complete offering.

B. Fillers, surfacers or patching compounds:
   1. Provide fillers, surfacers or patching compounds in accordance with manufacturer's recommendations and as specified herein as necessary to provide a smooth, defect free substrate.

C. Prime Coat Application:
   1. Prime all surfaces indicated to be painted.
      a. Apply prime coat in accordance with paint manufacturer's written instructions and as written in this Specification Section.
   2. Ensure field-applied paints are compatible with factory-applied paints or existing coatings.
      a. Employ services of coating manufacturer's qualified technical representative.
         1) Certify through material data sheets.
         2) Perform test patch.
      b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
      c. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in the MATERIALS Article, Paint Systems paragraph of this Specification Section.
         1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.
   3. Special coatings prime coat application:
      a. Prime new gypsum board surfaces using sealer as recommended by manufacturer.
         1) Apply at rate per manufacturer's recommendation.
      b. Prime and fill new concrete and masonry using sealer coat as recommended by manufacturer followed by modified epoxy filler as specified.
      c. Prime filled concrete and masonry surfaces with primer at rates and as recommended by manufacturer.
   4. Back prime all wood scheduled to be painted, prior to installation.
   5. Touch up damaged primer coats prior to applying finish coats.
      a. Restore primed surface equal to surface before damage.

D. Finish Coat Application:
   1. Apply finish coats in accordance with paint manufacturer's written instructions and in accordance with this Specification Section.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
      a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3. Hollow metal frames and doors:
    a. Finish coats shall be spray applied only.
    b. Finish edges same as faces of doors.
4. Varnish:
    a. Apply first coat of varnish: Gloss.
        1) Allow to dry a minimum of 48 HRS.
    b. Apply second and third coats of varnish: Satin.
        1) Allow a minimum of 48 HRS between each coat.
    c. Lightly sand between coats as required and remove dust.

## 3.6 FIELD QUALITY CONTROL

A. Application Deficiencies:
1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.

B. Provide protection for painted surfaces.
1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Maintain Daily Records:
1. Record the following information during application of each coat of paint applied:
    a. Date, starting time, end time, and all breaks taken by painters.
    b. For exterior painting:
        1) Sky condition.
        2) Wind speed and direction.
    c. Air temperature.
    d. Relative humidity.
    e. Moisture content and surface temperature of substrate prior to each coat.
    f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
    g. Record environmental conditions, substrate moisture content and surface temperature information not less than once every four (4) hours during application.
        1) Record hourly when temperatures are below 50 DEGF or above 100 DEGF.
2. Record the following information daily for the paint manufacturer's recommended curing period:
    a. Date and start time of cure period for each item or area.
    b. For exterior painting:
        1) Sky conditions.
        2) Wind speed and direction.
    c. Record environmental conditions not less than once every 12 HRS.
        1) Record once every 4 HRS when ambient temperature is below 35 DEGF.
    d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
3. Format for daily record to be computer generated.

D. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

E. Measure substrate humidity with humidity gage specifically designed for such.

F. Provide wet paint signs.

## 3.7 CLEANING

A. Clean paint spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Remove masking, adhesive residue or other foreign materials.

C. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

D. Remove surplus materials, scaffolding, and debris.

## 3.8 COLOR SCHEDULE

A. TBD during construction

**END OF SECTION**

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# SECTION 09 96 00
## HIGH PERFORMANCE INDUSTRIAL COATINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 09 91 10 - Architectural Painting.
   5. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC).
   6. Division 26 - Electrical.
   7. Division 40 - Process Interconnections.
   8. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute/Steel Door Institute (ANSI/SDI):
      a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors and Frames.
   2. American National Standards Institute/Underwriters Laboratories (ANSI/UL):
      a. 723, Standard Test for Surface Burning Characteristics of Building Materials.
   3. ASTM International (ASTM):
      a. B499, Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals.
      b. D3359, Standard Test Methods for Rating Adhesion by Tape Test.
      c. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      d. D4259, Standard Practice for Abrading Concrete.
      e. D4261, Standard Practice for Surface Cleaning Concrete Masonry Units for Coating.
      f. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      g. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      h. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      i. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      j. D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage.
      k. D6677, Standard Test Method for Evaluating Adhesion by Knife.
      l. D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
      m. D7234, Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
      n. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

o. E337, Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
p. E648, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
q. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
r. F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

4. Environmental Protection Agency (EPA).
5. International Concrete Repair Institute (ICRI):
   a. 310.2, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
6. NACE International (NACE).
7. NSF International (NSF).
   a. 61, Drinking Water System Components - Health Effects.
8. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. SP 1, Solvent Cleaning.
   c. SP 2, Hand Tool Cleaning.
   d. SP 3, Power Tool Cleaning.
   e. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
9. The Society for Protective Coatings/ NACE International (SSPC/ NACE):
   a. SP 5/ NACE No. 1, White Metal Blast Cleaning
   b. SP 6/ NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/ NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/ NACE No. 2, Near-White Blast Cleaning.
   e. SP 13/ NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's technical representative shall be a NACE Certified Coatings Inspector, Level 3 minimum.
   2. Applicators shall have minimum of 10 years of experience in application of similar products on similar project.
      a. Provide references for minimum of three different projects completed in last five years with similar scope of work.
      b. Include name and address of project, size of project in value (coating) and contact person.
   3. NACE inspector shall be NACE Certified Coatings Inspector Level 3 minimum and shall have minimum of five years of experience of conducting inspections and tests as indicated in this Specification Section.

C. Mock-Ups:
   1. Construct sample floor areas demonstrating varying degree of slip resistance for Architect and Engineer review and acceptance.
      a. Provide two samples of each texture of slip resistant material for Architect and Engineer's selection.
      b. Size: minimum 2 FT by 2 FT each.
   2. If not acceptable, construct additional sample floor areas as required.
      a. After sample floor area is accepted destroy all other sample floor areas not accepted.
   3. Accepted sample floor area shall constitute minimum standard of quality for actual construction.
   4. Maintain sample floor area during construction and protect from damage.
   5. Subject to approval by Engineer, approved sample may be incorporated into the Work.

D. Miscellaneous:
   1. Furnish coating through one manufacturer unless noted otherwise.

E. Deviation from specified MIL thickness or product type is not allowed without written authorization of Engineer.

F. Material shall not be thinned unless approved, in writing, by coating manufacturer's technical representative.

## 1.3 DEFINITIONS

A. Applicator:
   1. Applicator is the person actually installing or applying the product in the field, at the Project site, or at an approved shop facility.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in Specification Section 01 61 03.

C. Appurtenant Surface: Accessory or auxiliary surface attached to or adjacent to a surface indicated to be coated.

D. Corrosive Environment:
   1. Immersion in or subject to:
      a. Condensation, spillage or splash of a corrosive material such as water, wastewater or chemical solution.
      b. Exposure to corrosive caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions.
      c. For purposes of this Specification Section, corrosive environments include:
         1) Exterior areas not otherwise identified as highly corrosive.
         2) Piping galleries.
         3) Calcium Thiosulfate Room
         4) Chemical Room
            a) Chemicals storage and feed areas
         5) Surfaces within 2 FT of high water level.
         6) Exterior Atmosphere or Surface: Outdoor atmosphere or surface exposed to weather and/or direct sunlight.

E. Finished Area: A room or area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be coated.

F. Highly Corrosive Environment:
      a. For purposes of this Specification Section, highly corrosive environments include; chemicals storage and feed areas:
         1) Aluminum Sulfate (Alum)
            a) 49% Concentration
            b) MSDS: 2 - Aluminum Sulfate Solution SDS.pdf
         2) Sodium Hypochlorite
            a) 12.5% Concentration
            b) MSDS: 3 - Sodium Hypochlorite SDS.pdf
         3) Sodium Carbonate (Liquid)
            a) 20% Concentration
            b) MSDS:
         4) Sodium Hydroxide (Caustic)
            a) 25% Concentration
            b) MSDS: 1 - Sodium Hydroxide SDS.pdf
         5) Calcium Thiosulfate
            a) 24% Concentration
            b) MSDS: 6 - Calcium Thiosulfate SDS.pdf
         6) Filter Aid Polymer

a) 40% Concentration
b) MSDS: 5 - Filter Aid Example SDS.PDF

7) Settling Aid Polymer
a) 40% Concentration
b) MSDS: 4 - Settling Aid Example SDS.pdf

G. Holiday:
1. A void, crack, thin spot, foreign inclusion, or contamination in the coating that significantly lowers the dielectric strength of the coating.
2. May also be identified as a discontinuity or pinhole.

H. HPIC: High performance industrial coatings.
1. Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

I. Interior Atmosphere or Surface: Indoor atmosphere or surface not exposed to weather and/or direct sunlight.

J. Immersion Service:
1. Any surface immersed in water or some other liquid.
2. Surface of any pipe, valve, or any other component of the piping system subject to frequent wetting.
3. Surfaces within two feet above high water level in water bearing structures.

K. Piping System: Pipe, valves, fittings and accessories.

L. Surface Hidden from View:
1. Within pipe chases.
2. Between top side of ceilings and underside of floor or roof structures above.

M. Vapor Space: Interior space within tankage, closed structures, or similar elements that is above the low liquid line and subject to the accumulation of fumes, vapor and/or condensation.

N. Water level for purposes of coating: .

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Applicator experience qualifications.
a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
3. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by a NACE Certified Coatings Inspector employed by the coating manufacturer.
a. Submittals not including this certification will be returned without review.
4. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's surface preparation instructions.
c. Manufacturer's application instructions.
1) Manufacturer's standard details, including but not limited to penetrations, transitions, and terminations for:
a) High-build coatings on concrete.
b) Secondary containment coatings.
c) Other special conditions as applicable.
d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section, provide complete individual data sheet comparison of proposed products with specified products including:
1) Application procedure.

2) Coverage rates.
3) Certification that product is designed for intended use and is equal or superior to specified product.

e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
f. Coating manufacturer's recommendation on abrasive blasting.
g. Coating manufacturer's technical representative's written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
h. Manufacturer's recommendation for universal barrier coat.
i. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.

5. Results of discontinuity testing indicating any corrective action taken.
6. Manufacturer's statement regarding applicator instruction on product use.

B. Samples:
1. Manufacturer's full line of colors for Engineer's preliminary color selection.
2. After preliminary color selection by Engineer provide two, 3 x 5 IN samples of each final color selected.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Approval of application equipment.
3. Applicator's daily records:
a. Submit daily records at end of each week in which coating work is performed unless requested otherwise by Engineer's on-site representative.
4. Certification that coating systems requiring holiday detection testing are free of pinholes or other material defects.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
1. Name or type number of material.
2. Manufacturer's name and item stock number.
3. Contents, by volume, of major constituents.
4. Warning labels.
5. VOC content.

B. Store materials in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 DEGF.

## 1.6 PROJECT CONDITIONS

A. Pre-application Conference:
1. Prior to commencement of surface preparation or coating application, the Contractor shall convene a pre-application conference with all affected parties, including but not limited to: the applicator, coating manufacturer's technical representative, Owner's representative, and Engineer's representative(s).
2. The meeting shall discuss all aspects of the Project including but not limited to:
a. Schedule.
b. Material storage and handling.
c. Examination of surfaces to be coated.
d. Protection of surfaces not to be coated.
e. Surface preparation.
f. Coating application:
1) Environmental conditions for application of coatings.
2) Temporary environmental controls.

g. Field quality control requirements:
    1) Manufacturer's technical representative responsibilities.
    2) Contractor performed testing.
        a) Instrumentation requirements.
        b) Frequency of testing.
        c) Record keeping.
    3) NACE inspector performed testing.

B. Verify that atmosphere in area where coating is to take place is within coating manufacturer's acceptable temperature, humidity and sun exposure limits.
    1. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
        a. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by coating manufacturer.
        b. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
            1) Vent exhaust gases to exterior environment.
            2) No exhaust gases shall be allowed to vent into the space being coated or any adjacent space.
    2. Do not apply coatings in snow, rain, fog or mist.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. High Performance Industrial Coatings:
        a. Carboline Protective Coatings.
        b. PPG.
        c. The Sherwin-Williams Company.
        d. Tnemec.
        e. AkzoNobel.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. "Or-Equal" Submittals:
    1. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the manufacturers listed.
    2. Provide satisfactory documentation from the proposed "or-equal" manufacturer that proposed materials meets or exceeds the following:
        a. Is of the same generic resin.
        b. Requires comparable surface preparation.
        c. Has comparable application requirements.
        d. Meets the same VOC levels or better.
        e. Provides the same finish and color options.
        f. Is suitable for the intended service.
        g. Resistance to abrasion and physical damage.
        h. Resistance to chemical attack.
        i. Resistance to UV exposure.
        j. Ability to recoat in future.
        k. Dry film thickness per coat.
            1) Where manufacturer's product data sheet indicates a minimum MIL thickness per coat that is greater than specified herein, MIL thickness for entire coating system shall be increased proportionately.
        l. Minimum and Maximum time between coats.
        m. Compatibility with other coatings.

n. Temperature limitations in service and during application.
o. Type and quality of recommended undercoats and topcoats.
p. Ease of application.
q. Ease of repairing damaged areas.
r. Stability of colors.

3. The cost of all testing and analyzing of the proposed substitute materials shall be borne by the CONTRACTOR.

## 2.2 MATERIALS

A. Coatings used for interior finishes shall meet the requirements of the building code and NFPA 101.
   1. Wall and ceiling finishes: ASTM E84 or ANSI/UL 723.
      a. Class A: Flame spread index 25 or less; smoke-developed index 450 or less.
   2. Interior floor finishes: NFPA 253 or ASTM E648
      a. Class II: Critical radiant flux not less than 0.22W/CM$^2$

B. Coatings shall comply with the VOC limits of EPA:

C. For unspecified materials such as thinner, provide manufacturer's recommended products.

D. High Performance Industrial Coatings:

| COATING CODE | GENERIC DESCRIPTION | MANUFACTURER | |
|---|---|---|---|
| | | TNEMEC | SHERWIN WILLIAMS |
| AAE | Acrylic/Acrylate Emulsion | Series 180<br>WB Tneme-Crete | Cement Plex 875 |
| ARE<br>SCAQMD Compliant | Abrasion-Resistant Epoxy | Series 435<br>Perma-Glaze | Duraplate 6000 |
| AREL | Abrasion-Resistant Epoxy Lining | Series 435<br>Perma-Glaze | Duraplate 5900 |
| CRM | Cementitious Repair Mortar | Series 217<br>MortarCrete | Cemtec<br>Silatec MSM |
| CRU | Corrosion Resistant Urethane | Series 290 CRU | Polylon HP |
| DFA | Dry-fall Acrylic | Series 115<br>Uni-Bond DF | DFA Dry Fall Acrylic |
| EBF | Epoxy Block Filler | Series 1254 Epoxoblock WB | Kem Cati Coat HS |
| ESF | Epoxy Surfacer/Filler | Series 215 Surfacing Epoxy | Steel Seam FT 910 |
| EMM | Epoxy Modified Cementitious Mortar | Series 218 MortarClad | Duraplate 2300 |
| EF | Epoxy Flooring | Series 237<br>Power-Tread | GP3746 |
| GFRE | Glass Flake Reinforced Epoxy | Series 142 | Sher-Glass FF |
| HREM | H2S-Resistant Epoxy Mortar | Series 434<br>Perma-Shield $H_2S$ | Duraplate 5900 Mortar |

| COATING CODE | GENERIC DESCRIPTION | MANUFACTURER | |
|---|---|---|---|
| | | TNEMEC | SHERWIN WILLIAMS |
| HRU | H2S-Resistant Urethane | Series 446<br>Perma-Shield MCU | |
| HU | Hybrid Urethane | Series 740 UVX | Acrolon Ultra |
| MIO | MIO Polyurethane | Series 1 Omnithane | Corothane 1 MIO |
| | | | |
| MPE<br>SCAQMD Compliant | Multi-Purpose Epoxy | Series L69<br>Hi-Build Epoxoline II | Macropoxy 646-100 |
| MTEP | Moisture-Tolerant Epoxy Primer | Series 201 Epoxoprime | Corobond 100 |
| | | | |
| NSFE<br>SCAQMD Compliant | NSF Epoxy<br>(NSF 61) | Series L140<br>Pota-Pox Plus | Macropoxy 5500 |
| REL | Reinforced Epoxy Lining | Series 436<br>Perma-Shield FR | Duraplate 6000 |
| SCE | Secondary Containment Epoxy | Series 237SC Chembloc | Cor Cote HP |
| SCEP | Secondary Containment Epoxy Primer | Series 206SC Chembloc | GP3552 |
| STEP | Surface-Tolerant Epoxy Primer | Series 135 Chembuild | Macropoxy 646 |
| UHSE | Ultra-High Solids Epoxy<br>(NSF 61) | Series 22<br>Epoxoline | Duraplate UHS |
| VEP | Vinyl Ester Primer | Series 251SC Chembloc | Corobond Vinyl Ester Primer |
| VESC | Vinyl Ester Secondary Containment | Series 252SC Chembloc | Cor Cote VEN FF |
| ZRU | Zinc-Rich Urethane | Series 94-$H_20$ Hydro-Zinc | Corothane 1 Galvapak |

E. High Temperature Coatings:

| COATING CODE | GENERIC DESCRIPTION | MANUFACTURER | | |
|---|---|---|---|---|
| | | PPG | TNEMEC | SHERWIN WILLIAMS |
| HTZRP | High Temperature Zinc Rich Primer | Dimetcote 9 Series | Series 1505<br>Endura-Heat ZR | Zinc Clad II Plus |
| HTSAF | High Temperature Silicone Acrylic Finish | Hi Temp 500V | Series 1552<br>Endura-Heat | Heat Flex Hi Temp 500 |

| COATING CODE | GENERIC DESCRIPTION | MANUFACTURER | | |
|---|---|---|---|---|
| | | PPG | TNEMEC | SHERWIN WILLIAMS |
| HTSSF | High Temperature Silicone Hybrid Finish | Hi Temp 1000V | Series 1558 Endura-Heat DTM | Heat Flex Hi Temp 1000 |

| COATING CODE | GENERIC DESCRIPTION | MANUFACTURER | |
|---|---|---|---|
| | | TNEMEC | SHERWIN WILLIAMS |
| AIC | Acrylic Insulating Coating | Series 971 Aerolon Acrylic | Heat Flex 3500 |
| AP | Acrylic Polymer | Series 1028T Enduratone | Sher-cryl HPA |
| WBCE | Water-Based Cementitious Epoxy | Series 1224 Epoxoline WB | Macropoxy 646 |
| ZRP | Zinc-Rich Primer | Series 90-97 Tneme-Zinc | Corothane 1 Galvapak |

## 2.3 COATING SYSTEMS

A. The following tables indicate coating systems by material and environment, unless a specific application is indicated.

| Environment/ Application | Surface Preparation | Prime Coat | Intermediate Coats | Finish Coat |
|---|---|---|---|---|
| **Ferrous Metals (Structural & Miscellaneous Metals)** | | | | |
| Interior atmospheric | SSPC-SP 6/ NACE No. 3 | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE |
| Interior atmospheric (corrosive environment) | SSPC-SP 10/ NACE No. 2, min. 2 MIL anchor profile | 2.5 to 3.5 MIL ZRU | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE |
| Interior atmospheric (highly corrosive environment) | SSPC-SP 10/ NACE No. 2, min. 2 MIL anchor profile | 2.5 to 3.5 MIL ZRU | 3.0 to 4.0 MIL MPE | 2.0 to 3.0 MIL CRU |
| Immersion - NSF | SSPC-SP / NACE No.1 | 4.0 to 5.0 MIL NSFE | 4.0 to 5.0 MIL NSFE | 4.0 to 5.0 MIL NSFE |
| Exterior atmospheric | SSPC-SP 6/ NACE No. 3 | 2.5 to 3.5 MIL ZRU | 3.0 to 5.0 MIL MPE | 2.5 to 3.5 MIL HU |
| Hollow Metal Doors | SSPC-SP 3 | 2.5 to 3.5 MIL STEP | | 2.5 to 3.5 MIL HU |
| Bar Joists Interior atmospheric | SSPC SP-3 SSPC Rust Grade Condition C | | | 2.0 TO 3.5 MIL DFA |
| Bar Joists (corrosive environment) | SSPC SP-3 SSPC Rust Grade Condition C | 2.5 to 3.5 MIL MIO | | 3.0 to 4.0 MIL MPE |

| Environment/ Application | Surface Preparation | Prime Coat | Intermediate Coats | Finish Coat |
|---|---|---|---|---|
| Factory Primed Metal Deck Interior atmospheric | SSPC SP-3 SSPC Rust Grade Condition C | | | 2.0 TO 3.5 MIL DFA |
| Factory Primed Metal Deck (corrosive environment) | SSPC SP-3 SSPC Rust Grade Condition C | 4.0 to 6.0 MIL STEP | | 2.0 to 3.0 MIL MPE |
| Thermal Break Coating | SSPC-SP 6/ NACE No. 3 | 2.5 to 3.5 MIL ZRP | Two coats AIC at 40 to 50 MIL per coat | 2.0 to 3.0 MIL AP |
| **Galvanized Steel** | | | | |
| Interior atmospheric | SSPC-SP 16 | 4.0 to 6.0 MIL STEP | | 2.0 to 3.0 MIL MPE |
| Immersion - NSF | SSPC-SP 16 | 3.0 to 4.0 MIL NSFE | | 3.0 to 4.0 MIL NSFE |
| Bar Joists (corrosive environment) | SSPC-SP 16 | 2.5 to 3.5 MIL MIO | | 3.0 to 4.0 MIL MPE |
| Metal Deck (corrosive environment) | SSPC-SP 16 | 4.0 to 6.0 MIL STEP | | 2.0 to 3.0 MIL MPE |
| Exterior atmospheric | SSPC-SP 16 | 4.0 to 6.0 MIL STEP | | 2.5 to 3.5 MIL HU |
| Field cut pipe threads | SSPC-SP 3 | 4.0 to 6.0 MIL STEP | Coat per exposure above | Coat per exposure above |
| Thermal Break Coating | SSPC-SP 6/ NACE No. 3 | 4.0 to 10.0 MIL WBCE | Two coats AIC at 40 to 50 MIL per coat | 2.0 to 3.0 MIL AP |
| **Non Ferrous Metals, including piping** | | | | |
| Dissimilar Materials Protection | SSPC-SP 2 | 4.5 to 5.5 MIL MPE | | |
| Interior atmospheric | SSPC-SP 2 | 3.0 to 4.0 MIL MPE | | 3.0 to 4.0 MIL MPE |
| Immersion - NSF | SSPC-SP 16 | 4.0 to 5.0 MIL NSFE | 4.0 to 5.0 MIL NSFE | 4.0 to 5.0 MIL NSFE |
| Exterior atmospheric | SSPC-SP 2 | 4.0 to 6.0 MIL MPE | | 2.5 to 3.5 MIL HU |

| Environment/ Application | Surface Preparation | Prime Coat | Intermediate Coats | Finish Coat |
|---|---|---|---|---|
| Thermal Break Coating | SSPC-SP 6/ NACE No. 3 | 4.0 to 10.0 MIL WBCE | Two coats AIC at 40 to 50 MIL per coat | 2.0 to 3.0 MIL AP |
| **Ferrous Piping** | | | | |
| Interior atmospheric | SSPC-SP 6/ NACE No. 3 | 2.5 to 3.5 MIL ZRU | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE |
| Immersion - NSF | SSPC-SP 5/ NACE No.1 | 4.0 to 5.0 MIL MPE | 4.0 to 5.0 MIL MPE | 4.0 to 5.0 MIL MPE |
| Exterior atmospheric | SSPC-SP 10/ NACE No. 2 | 2.5 to 3.5 MIL ZRU | 3.0 to 4.0 MIL MPE | 2.5 to 3.5 MIL HU |
| Backwash Air Piping | SSPC-SP 10/ NACE No. 2 | 2.5 to 3.5 MIL ZRP | 2 coats at 40 to 50 MIL per coat AIC | 3.0 to 5.0 MIL AP |
| **Ductile Iron Piping** | | | | |
| Interior atmospheric | Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05 | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE |
| Immersion - NSF | Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05 | 3.0 to 4.0 MIL NSFE | | 20.0 to 25.0 MIL UHSE |
| Exterior atmospheric | Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05 | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE | 2.5 to 3.5 MIL HU |

| Environment/ Application | Surface Preparation | Filler/Surfacer | Prime Coat | Intermediate Coat(s) | Finish Coat |
|---|---|---|---|---|---|
| **Concrete*** | | | | | |
| Walls, ceilings, and appurtenant surfaces Interior atmospheric | SSPC-SP 13/ NACE No. 6 ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 250 to 300 SQFT/GAL MPE | | 250 to 300 SQFT/GAL MPE |
| Interior floors | SSPC-SP 13/ NACE No. 6 ICRI CSP 5 | ESF as necessary to fill holes and depressions | 175 to 225 SQFT/GAL EF clear | 200 to 250 SQFT/GAL EF pigmented | 200 to 250 SQFT/GAL EF pigmented |
| | | | broadcast slip-resistant aggregate into wet intermediate coat on walking surfaces | | |

| Environment/ Application | Surface Preparation | Filler/Surfacer | Prime Coat | Intermediate Coat(s) | Finish Coat |
|---|---|---|---|---|---|
| Interior Safety Striping | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 3 | ESF and/or EMM as necessary to fill holes and depressions | | | 6.0 to 8.0 MIL<br>EF Pigmented |
| Interior - Secondary Containment | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 6.0 to 8.0 MIL<br>MTEP | 60 to 80 MIL<br>SCEP<br>Fiberglass mat Saturated with 8.0 to 12 MILS SCE | 10 to 12 MIL<br>SCE |
| Interior - Secondary Containment (Highly Corrosive) | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 6.0 to 8.0 MIL<br>VEP | 60 to 80 MIL<br>VESC<br>Fiberglass mat Saturated with 8.0 to 12 MILS VESC | 6.0 to 8.0 MIL<br>VESC |
| Immersion - NSF | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | 1/16 to 1/4 IN EMM | | | 16 to 20 MIL<br>UHSE |
| Exterior atmospheric Corrosive Environment | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 150 to 175 SQFT/GAL AAE | | 150 to 175 SQFT/GAL AAE |
| Exterior atmospheric Highly Corrosive Environment | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | 1/16 IN EMM | 3.0 to 4.0 MIL MPE | 3.0 to 4.0 MIL MPE | 2.5 to 3.5 MIL HU |
| Exterior - Secondary Containment | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 6.0 to 8.0 MIL<br>MTEP | 60 to 80 MIL<br>SCEP<br>Fiberglass mat Saturated with 8.0 to 12 MILS SCE | 10 to 12 MIL<br>SCE<br>20. to 3.0 MIL<br>CRU |
| Exterior - Secondary Containment (Highly Corrosive) | SSPC-SP 13/ NACE No. 6<br>ICRI CSP 5 | ESF and/or EMM as necessary to fill holes and depressions | 6.0 to 8.0 MIL<br>VEP | 60 to 80 MIL<br>VESC<br>Fiberglass mat Saturated with 8.0 to 12 MILS VESC | 6.0 to 8.0 MIL<br>VESC<br>20. to 3.0 MIL<br>CRU |

* For repair of deteriorated existing concrete, provide additional surface preparation as specified in PREPARATION article in this Specification Section.

## PART 3 - EXECUTION

### 3.1 ITEMS TO BE COATED

A. Exterior Surfaces, including but not limited to:
   1. Concrete:
      a. Components of concrete tankage:
         1) Walls, columns, beams:

a) Coat from 1 FT below low water level to top of component.
2) Troughs, launders, weirs.
3) Underside of concrete walkways within 2 FT of high water level.
b. Secondary containment enclosures.
c. Pretreatment Building pipe trench.
d. Chemical fill stations.
1) Paving where indicated on Drawings.
2) Spill containment sumps.
2. Piping, valves, fittings, hydrants and supports:
a. As scheduled in Specification Section 40 05 00.
3. Pumps and motors.
4. Ferrous metal tankage.
5. Ferrous metal process equipment.
6. Structural steel:
a. Columns, beams and bracing.
b. Field welded connections of factory coated structural steel.
c. Pre-engineered metal building frames, girts, purlins and bracing.
7. Miscellaneous ferrous metal surfaces:
a. Steel components of concrete lintels.
b. Items specifically noted on Drawings to be coated.
8. Miscellaneous galvanized steel surfaces:
a. Pipe Bollards.
b. Embed Plates.
c. Railings.
d. Loose lintels.
e. Steel components of concrete lintels.
f. Items specifically noted on Drawings to be coated.
9. Doors and frames:
a. Hollow metal doors and frames
b. Hollow metal window frames.
10. Appurtenant surfaces attached to or adjacent to a surface indicated to be coated:
a. Conduit, boxes, covers and supports.

B. Interior Areas:
1. Refer to Room Finish Schedule on Drawings.
a. If space is scheduled to be coated, coat all appurtenant surfaces within the space unless specifically noted otherwise. Appurtenant surfaces include but are not limited to:
1) Columns.
2) Equipment pads.
3) Equipment supports.
4) Underside of roof or floor decks above:
a) Including semi-exposed or concealed from view unless noted otherwise.
5) Conduit, boxes, covers and supports.
6) Miscellaneous ferrous metal surfaces.
2. Concrete:
a. Components of concrete tankage:
1) Walls, columns, beams:
a) Coat from 1 FT below low water level to top of component.
2) Troughs, launders, weirs.
3) Underside of concrete walkways within 2 FT of high water level.
b. Chemical Room flooring.
c. Chemical storage areas:
1) Flooring where scheduled or indicated on Drawings.
2) Secondary containment enclosures.
3. Piping, valves, fittings, hydrants and supports:

a. Do not coat piping scheduled to be insulated.
4. Pumps and motors.
5. Ferrous metal tankage.
6. Ferrous metal process equipment.
   a. Clarifier mechanisms.
   b. Equipment bridges.
   c. Gates and operators.
   d. Items specified to be Coated.
7. Miscellaneous galvanized steel surfaces:
   a. Pipe Bollards.
   b. Embed Plates.
   c. Railings.
   d. Loose lintels.
   e. Steel components of concrete lintels.
   f. Seismic angles at masonry partitions.
   g. Items specifically noted on Drawings to be coated.
8. Doors and frames:
   a. Hollow metal doors and frames
   b. Hollow metal window frames.
   c. Four-fold industrial doors.
   d. Sectional overhead doors.
9. Safety Striping:
   a. Equipment Pads: Coat vertical face and return 3 IN onto horizontal surface of pad.
   b. Pipe supports, columns, piers and similar vertical elements: .
   c. As shown on Drawings.

## 3.2 ITEMS NOT TO BE COATED

A. General: Do not coat items listed in this Article, unless noted otherwise.

B. Items with Approved Factory Finish: These items may require repair of damaged coated areas or coating of welded connections.

C. Electrical Equipment.

D. Moving parts of mechanical and electrical units where coating would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless Steel Surfaces, except:
   1. Dissimilar metals in immersion service.
   2. Piping where specifically noted to be coated.
   3. Banding as required to identify piping.

H. Aluminum Surfaces, except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.
   4. Appurtenant surfaces as described in the ITEMS TO BE COATED article.

I. Fiberglass Surfaces, except:
   1. Fiberglass piping where specifically noted to be coated.
   2. Piping supports where specifically noted to be coated.
   3. Appurtenant surfaces as described in the ITEMS TO BE COATED article.

J. Mechanical piping scheduled to be insulated.

K. Interior of Pipe, Ductwork, and Conduits.
   1. See Division 23 for ductwork.
   2. See Division 40 for pipe linings.
   3. Nuts and bolts on all flanges of any piping system. If nuts and bolts end up painted, Contractor shall remove coatings or replace nuts and bolts at no cost to Owner.

L. Galvanized Steel Items, unless specifically noted to be coated.

M. Architectural Finishes:
   1. Exterior concrete indicated to receive another finish.
   2. Precast concrete surfaces, unless specifically indicated to be coated.
   3. Plastic laminate.
   4. Solid surface material.
   5. Standing and running trim.
   6. Fiberglass fabrications.
   7. Anodized aluminum.
   8. PVDF coated metals.
   9. Factory finished doors and frames.
   10. Aluminum windows, curtainwall and storefront framing systems.
   11. Finish hardware.
   12. Glass and glazing.
   13. Ceramic, porcelain, quarry tile or natural stone.
   14. Acoustical materials.
   15. Building specialties.
   16. Louvers.
   17. Casework and countertops.
   18. Pipe insulation and jacketing.
   19. Standing seam metal roof, fascia, trim, soffit and accessories.
   20. Insulated metal wall panels.
   21. Insulated metal roof panels.

N. If any above elements are coated, inadvertently or otherwise, Contractor shall carefully remove coatings without damage, or replace products at no cost to Owner.

## 3.3 EXAMINATION

A. Concrete:
   1. Test pH of surface to be coated in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
      b. Retest pH until acceptable results are obtained.
   2. Verify that moisture content of surface to be coated is within coating manufacturer's recommended acceptable limits.
      a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
         1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869 or ASTM F2170.
         2) Provide remedial measures as necessary to bring moisture content within coating manufacturer's recommended acceptable limits.
         3) Retest surface until acceptable results are obtained.

## 3.4 PREPARATION

A. General:
   1. Prepare surfaces to be coated in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.

a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent surface preparation shall be provided unless approved otherwise, in writing, by the Engineer.

2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
3. Adhere to manufacturer's recoat time surface preparation requirements.
   a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
      1) Minimum SSPC-SP 7/ NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
   3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and coat before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
   1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
      a. All piping, pumps, valves, fittings and any other component used in the water piping system that requires preparation for coating shall be prepared in accordance with requirements for immersion service.
      b. Prepare all areas requiring patch coating in accordance with recommendations of manufacturer and NAPF.
      c. Remove bituminous coating per piping manufacturer, coating manufacturer and NAPF recommendations.
         1) The most stringent recommendations shall apply.
   2. Complete fabrication, welding or burning before beginning surface preparation.
      a. Chip or grind off flux, spatter, slag or other laminations left from welding.
      b. Remove mill scale.
      c. Grind smooth rough welds and other sharp projections.
   3. Solvent clean in accordance with SSPC-SP 1.
   4. Restore surface of field welds and adjacent areas to original surface preparation.

E. Galvanized Steel and Non-ferrous Metals:
   1. Solvent clean in accordance with SSPC-SP 1 followed by brush-off blast clean in accordance with SSPC-SP 16 to remove zinc oxide and other foreign contaminants.
      a. Provide uniform 1 MIL profile surface.

F. Hollow Metal Doors and Frames:
   1. Verify factory-applied prime coat is in accordance with ANSI/SDI A250.10.

G. Concrete:
   1. Cure for minimum of 28 days.
   2. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
   3. Abrasive blast concrete surfaces in accordance with ASTM D4259 and SSPC-SP 13/ NACE No. 6.
      a. Provide profile per ICRI 301.2 as listed in MATERIALS article of this Specification Section.
   4. Test pH and moisture content in accordance with EXAMINATION article in this Specification Section.

H. Preparation by Abrasive Blasting:

1. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before coating.
2. Provide compressed air for blasting that is free of water and oil.
   a. Provide accessible separators and traps.
3. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
4. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of coatings.
   a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
5. Perform additional blasting and cleaning as required to achieve surface preparation required.
   a. Re-blast surfaces not meeting requirements of these Specifications.
   b. Prior to coating, re-blast surfaces allowed to set overnight and surfaces that show rust bloom.
   c. Surfaces allowed to set overnight or surfaces which show rust bloom prior to coating shall be re-inspected prior to coating application.
6. Profile depth of blasted surface: Not less than 1 MIL or greater than 2 MILS unless required otherwise by coating manufacturer.
7. Ensure abrasive blasting operation does not result in embedment of abrasive particles in coating.
8. Confine blast abrasives to area being blasted.
   a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
   b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation.

I. All Plastic Surfaces:
   1. Sand using 80-100 grit sandpaper to scarify surfaces.

## 3.5 APPLICATION

A. General:
   1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
      a. Application equipment must be inspected and approved in writing by coating manufacturer.
      b. Hollow metal shall be spray applied only.
   2. Temperature and weather conditions:
      a. Do not coat surfaces when surface temperature is below 50 DEGF unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and coating manufacturer's technical representative.
      b. Avoid coating surfaces exposed to hot sun.
      c. Do not coat damp surfaces.
      d. Apply coating to concrete or masonry surfaces in descending temperatures, in accordance with coating manufacturer's application instructions.
   3. Apply materials under adequate illumination.
   4. Provide complete coverage to MIL thickness specified.
      a. Thickness specified is dry MIL thickness.
   5. Evenly spread to provide full, smooth coverage.
      a. All coating systems are "to cover."
         1) In situations of discrepancy between manufacturer's square footage coverage rates and MIL thickness, MIL thickness requirements govern.

b. When color or undercoats show through, apply additional coats until coating is of uniform finish and color.
c. Finished coating system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.

6. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
7. Work each application of material into corners, crevices, joints, and other difficult to work areas.
8. Provide coating manufacturer's recommended details at all terminations, penetrations, embedments, cracks, joints and changes in substrate direction.
9. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contamination.
   a. Clean contaminated surfaces before applying next coat.
   b. Intercoat surface cleanliness shall be inspected and approved by the Engineer prior to application of each coat.
10. Smooth out runs or sags immediately, or remove and recoat entire surface.
11. Allow preceding coats to dry before recoating.
    a. Recoat within time limits specified by coating manufacturer.
    b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
12. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
13. Coat all aluminum in contact with dissimilar materials.
14. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses provided that the maximum DFT is not exceeded.
15. Backroll surfaces if coatings are spray applied.

B. Employ services of coating manufacturer's technical representative to ensure that field-applied coatings are compatible with factory-applied or existing coatings.
   1. Certify through material data sheets.
   2. Perform test patch.
      a. Prepare existing coating surface to receive specified coating system.
      b. Apply coating to a minimum 1 SQFT area and allow to cure in accordance with manufacturer's recommendations.
      c. Evaluate adhesion to existing coating:
         1) Concrete or Masonry substrates: ASTM D4541.
         2) All other substrates: ASTM D6677 and ASTM D3359 (X-cut method).
   3. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
      a. Perform test patch as described above.
   4. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate coating system listed in the MATERIALS Article, Coating Systems paragraph of this Specification Section.
      a. All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.

C. Prime Coat Application:
   1. Apply structural steel and miscellaneous steel prime coat in the factory.
      a. Finish coats shall be applied in the field
      b. Prime coat referred to here is prime coat as indicated in this Specification.
         1) Prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
   2. Prime all surfaces indicated to be coated.
      a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.

3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
4. Apply zinc-rich primers while under continuous agitation.
5. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
6. Touch up damaged primer coats prior to applying finish coats.
   a. Restore primed surface equal to surface before damage.
7. All surfaces of steel lintels and steel components of concrete lintels used in wall construction shall be completely coated with both prime and finish coats prior to placing in wall.

D. Finish Coat Application:
1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
2. Touch up damaged finish coats using same application method and same material specified for finish coat.
   a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.
3. Broadcast abrasive aggregate into top coat of floor coatings as required to achieve degree of skid resistance desired by the Owner.

## 3.6 COLOR CODING

A. Per Specification Section 10 14 00 - IDENTIFICATION DEVICES.

## 3.7 FIELD QUALITY CONTROL

A. Application Deficiencies:
1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.
   a. Epoxy surfaces showing evidence of chalking or amine blush shall be prepared and recoated as follows:
      1) Solvent clean surfaces in accordance with SSPC-SP1 and abrasive blast in accordance with SSPC-SP7/ NACE No. 4.
      2) Recoat with intermediate and finish coats in accordance with coating system specified herein.

B. Provide protection for coated surfaces.
1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Contractor Performed Testing:
1. Provide ongoing testing and inspection, including but not limited to the following:
   a. Measurement and recording of environmental conditions as specified herein.
   b. Measurement and recording of substrate conditions as specified herein.
   c. Thickness Testing:
      1) Wet film thickness during application in accordance with ASTM D4414.
      2) Dry Film Thickness (DFT) in accordance with SSPC-PA 2.
      3) Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

D. NACE inspection:
1. The Owner reserves the right to retain a NACE Level 3 coating inspector to perform observation, inspection and testing as deemed necessary to document the quality of the Work.
   a. All work shall be done to the satisfaction of the Owner's inspector.

b. Any portion of the coating that does not satisfactorily pass the inspection and testing requirements shall be repaired or replaced by the Contractor at no additional cost to the Owner.
c. Additional testing and/or inspection may be done at the discretion of the Owner.
1) The Contractor will provide all equipment, materials, and labor to perform the testing.

2. Inspection, testing or observation by the Owner's inspector shall not relieve the Contractor of responsibility for surface preparation, inspection or quality control specified herein.

E. Instrumentation:
1. Provide instrumentation as necessary to measure and record atmospheric and substrate conditions, including but not limited to:
a. Dry Film Thickness Gauge:
1) Ultrasonic: ASTM D6132.
2) Magnetic: ASTM B499.
b. Wet Film Thickness Gauge: ASTM D4414.
c. Sling Psychrometer: ASTM E337.
d. Surface Temperature Gauge.
e. Anemometer.
f. Moisture Meter.
g. Adhesion test apparatus:
1) Steel: ASTM D4541.
2) Concrete: ASTM D7234.

F. Maintain Daily Records:
1. Record the following information during application:
a. Date, starting time, end time, and all breaks taken by applicators.
b. Air temperature.
c. Relative humidity.
d. Dew point.
e. Moisture content and pH level of concrete or masonry substrates prior to coating.
f. Surface temperature of substrate.
g. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind-blown dust and debris from contaminating the wet coating.
h. For exterior coating, also record:
1) Sky condition.
2) Wind speed and direction.
i. Record environmental conditions, substrate moisture content and surface temperature information not less than once every 4 HRS during application.
1) Record hourly when temperatures are below 50 DEGF or above 100 DEGF.
2. Record the following information daily for the coating manufacturer's recommended curing period:
a. Date and start time of cure period for each item or area.
b. For exterior coating, also record:
1) Sky conditions.
2) Wind speed and direction.
3) Air temperature.
a) Dry Bulb.
b) Wet Bulb.
4) Relative humidity.
5) Dew point.
6) Surface temperatures.
c. Record environmental conditions not less than once every 4 HRS.
1) Record hourly when temperatures are below 50 DEGF or above 100 DEGF.

d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.

3. Format for daily record to be computer generated.

G. Provide wet paint signs.

## 3.8 CLEANING

A. Clean coating spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Upon completion of coating, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

D. Remove all wetting agent and residue remaining after completion of discontinuity testing.

## 3.9 COLOR SCHEDULE

A. Pipe Bollards: 02SF Safety Yellow.

1. Water Treatment Plant Piping Color Schedule:

| SERVICE | PIPE COLOR | BANDING COLOR |
|---|---|---|
| Wastewater Piping: | | |
| Sump | - | 14SF-Safety Purple |
| Rain leader | 32GR-Gray | 06SF-Safety Red |
| Secondary rain leader | 32GR-Gray | 06SF/08SF-Safety Red/Safety Green |
| Settled primary | 32GR-Gray | YB24-Brown |
| Settled final | 32GR-Gray | 07SF-Red |
| Condensate drain | - | 02SF-Safety Yellow |
| Filtered | 32GR-Gray | 05SF/35GR-International Orange/Black |
| Vent | 46GR-Sinker Gray | 11WH/08SF-White/Safety Green |
| Final effluent | 32GR-Gray | 05SF/YB24-International Orange/Brown |
| Process drain | 32GR-Gray | 02SF/06SF-Safety Yellow/Safety Red |
| Sanitary drain line | 32GR-Gray | 11SF-Safety Blue |
| Supernatant | 32GR-Gray | 08SF-Safety Green filtrate or centrate |
| Filter to waste | 32GR-Gray | 08SF/02SF-Safety Green/Safety Yellow |
| Filter backwash waste | 32GR-Gray | 08SF-Safety Green |
| Steam Piping - High Pressure: | | |
| Saturated | 05SF-InternationalOrange | 11WH-White |
| Super heated | 05SF-InternationalOrange | 11WH/32GR/08SF-White/Gray/Safety Green |
| Steam Piping - Low Pressure: | | |
| Saturated | 05SF-InternationalOrange | 11WH/32GR-White/Gray |
| Super heated | 05SF-InternationalOrange | 11WH/32GR/02SF-White/Gray/Safety Yellow |
| Sludge Piping: | | |

| SERVICE | PIPE COLOR | BANDING COLOR |
|---|---|---|
| Clarified | YB24-Brown | 32GR/35GR/07SF-Gray/Black/Red |
| Gravity thickener effluent | YB24-Brown | 32GR/07SF/08SF-Gray/Red/Safety Green |
| Processed | YB24-Brown | 05SF/35GR/02SF-International Orange/Black/Safety Yellow |
| Recycled | YB24-Brown | 32GR/07SF-Gray/Red |
| Dewatered | YB24-Brown | 11SF/35GR-Safety Blue/Black |
| Thickened residuals forcemain | YB24-Brown | 32GR/35GR-Gray/Black |
| Thickened residuals | YB24-Brown | 07SF/05SF-Red/International Orange |
| Solids | YB24-Brown | 05SF/35GR-International Orange/Black |
| Equalized return | YB23-Dk. Brown | 11SF-Safety Blue |
| Equalization basin overflow | YB23-Dk. Brown | 11WH-White |
| Decant overflow | YB23-Dk. Brown | 08SF-Safety Green |
| Decant forcemain | YB23-Dk. Brown | 02SF-Safety Yellow |
| Decant | YB23-Dk. Brown | 11SF/02SF/08SF-Safety Blue/Safety Yellow/Safety Green |
| Foul Water Piping: | | |
| Supernatant, filtrate or centrate | YB23-Dk. Brown | 11SF-Safety Blue |
| Filter backwash | YB23-Dk. Brown | 08SF-Safety Green |
| Condensate | YB23-Dk. Brown | 02SF-Safety Yellow |
| Water Piping: | | |
| Fire | 06SF-Safety Red | - |
| Service | 08SF-Safety Green | 35GR-Black |
| Solids contact basin influent | 08SF-Safety Green | 11SF/07SF-Safety Blue/Red |
| Nonpotable | 08SF-Safety Green | 32GR-Gray |
| Make-up | 08SF-Safety Green | YB24-Brown |
| Solids contact basin effluent | 08SF-Safety Green | 11SF/YB24/07SF-Safety Blue/Brown/Red |
| Gravity thickener | 08SF-Safety Green | 07SF-Red |
| Potable water hot | - | 05SF-InternationalOrange |
| Potable water hot circulating | - | 05SF/02SF-International Orange/Safety Yellow |
| Cooling | 08SF-Safety Green | 11SF-Safety Blue |
| Sample water | - | 02SF-Safety Yellow |
| Treated water | 08SF-Safety Green | - |
| Filter wash | 08SF-Safety Green | 11WH-White |
| Filter influent | 08SF-Safety Green | 35GR/32GR-Black/Gray |
| Condensate | 08SF-Safety Green | 35GR/32GR-Black/Gray |
| Filter backwash supply | 08SF-Safety Green | 11WH-White |

| SERVICE | PIPE COLOR | BANDING COLOR |
|---|---|---|
| Filter surface wash | 08SF-Safety Green | 35GR/YB24-Black/Brown |
| Filter effluent | 08SF-Safety Green | 35GR/YB24-Black/Brown |
| Potable water cold | - | 35GR/07SF-Black/Red |
| Deionized water | - | 11SF/02SF/35GR-Safety Blue/Safety Yellow/Black |
| High service discharge | 08SF-Safety Green | 11SF/35GR-Safety Blue/Black |
| Low service discharge | 08SF-Safety Green | 09SF-Spearmint Safety Green |
| Low service suction | 08SF-Safety Green | 02SF/11SF/07SF-Safety Yellow/Safety Blue/Red |
| Well | 08SF-Safety Green | 11SF/35GR-Safety Blue/Black |
| Surface | 08SF-Safety Green | 11SF/YB24-Safety Blue/Brown |
| Pretreatment, presedimentation, aeration, prechlorination, grit removal | 08SF-Safety Green | 11SF/07SF-Safety Blue/Red |
| Plant influent | 08SF-Safety Green | 11SF/05SF-Safety Blue/International Orange |
| Softened | 08SF-Safety Green | 11SF/02SF-Safety Blue/Safety Yellow |
| Filtered | 08SF-Safety Green | 11SF/02SF/35GR-Safety Blue/Safety Yellow/Black |
| Finished water | 08SF-Safety Green | 11SF/02SF/05SF-Safety Blue/Safety Yellow/International Orange |
| Plant effluent | 11SF-Safety Blue | - |
| GAC wash | 08SF-Safety Green | 11WH-White |
| Gas, Fuel and Air Piping: | | |
| Oxygen, gas | 02SF-Safety Yellow | 35GR-Black |
| Oxygen, liquid | 02SF-Safety Yellow | 35GR/32GR-Black/Gray |
| Chlorine, gas | 02SF-Safety Yellow | 32GR/YB24-Gray/Brown |
| Chlorine, liquid | 02SF-Safety Yellow | 32GR/07SF-Gray/Red |
| Chlorine, solution | 02SF-Safety Yellow | 32GR/05SF-Gray/International Orange |
| Ammonia, gas | 02SF-Safety Yellow | YB24/35GR-Brown/Black |
| Aqueous ammonia | 02SF-Safety Yellow | YB24/07SF/08SF-Brown/Red/Safety Green |
| Ammonia, liquid | 02SF-Safety Yellow | YB24/07SF-Brown/Red |
| Reverse osmosis | - | 32GR/05SF/08SF-Gray/International Orange/Safety Green |
| Reverse osmosis return | - | 32GR/02SF/08SF-Gray/Safety Yellow/Safety Green |
| L-P or natural | 02SF-Safety Yellow | 06SF/35GR-Safety-Red/Black |
| Gasoline | 02SF-Safety Yellow | 06SF/11WH-Safety Red/White |
| Fuel oil return supply | 02SF-Safety Yellow | 06SF/08SF/YB24-Safety Red/Safety Green/Brown |

| SERVICE | PIPE COLOR | BANDING COLOR |
|---|---|---|
| Fuel oil | 02SF-Safety Yellow | 06SF/08SF-Safety Red/Safety Green |
| Acetylene | 02SF-Safety Yellow | 06SF/05SF-Safety Red/International Orange |
| Ozone | 02SF-Safety Yellow | 05SF-InternationalOrange |
| Vacuum | 02SF-Safety Yellow | 11SF-Safety Blue |
| Filter air backwash | 02SF-Safety Yellow | 11WH/08SF-White/Safety Green |
| Air | 02SF-Safety Yellow | 11WH/32GR-White/Gray |
| Compressed air | 02SF-Safety Yellow | 11WH/YB24-White/Brown |
| Ultra pure air | 02SF-Safety Yellow | 11WH/07SF-White/Red |
| Carbon dioxide vapor | - | 07SF/05SF-Red/International Orange |
| Carbon dioxide liquid | - | 07SF/11 SQFT-Red/Safety Blue |
| Carbon dioxide solution | - | 07SF/11SF/05SF-Red/Safety Blue/International Orange |
| Lime dust | 11WH-White | 32GR/14SF-Gray/Safety Purple |
| Lime (dry) | 11WH-White | 32GR/YB24-Gray/Brown |
| Lime slurry | - | 32GR/07SF-Gray/Red |
| Refrigerant | 11SF-Safety Blue | 32GR-Gray |
| Fluoride | - | YB24-Brown |
| Acidic | 11WH-White | 32GR/YB24-Gray/Brown |
| Caustic | 11WH-White | 32GR/07SF-Gray/Red |
| Powder activated carbon | 11WH-White | 35GR-Black |
| Powder activated carbon dust | 11WH-White | 35GR/32GR-Black/Gray |
| Powder activated carbon slurry | - | 35GR/09SF-Black/Spearmint Safety Green |
| Powder activated carbon slurry exhaust | - | 35GR/02SF-Black/Safety Yellow |
| Powder activated carbon vent | - | 35GR/07SF-Black/Red |
| Sodium permanganate | - | 14SF-Safety Purple |
| Potassium permanganate | - | 14SF/06SF-Safety Purple/Safety Red |
| Chlorine | 11WH-White | 07SF/11SF-Red/Safety Blue |
| Sodium hypochlorite | 11WH-White | 07SF/11SF/05SF-Red/Safety Blue/International Orange |
| Sodium hexametaphosphate | | |
| Brine | | |
| Ferric sulfate | | |
| Finished brine | | |
| Preheated brine | | |
| Cold brine | | |
| Depleted brine | | |

| SERVICE | PIPE COLOR | BANDING COLOR |
|---|---|---|
| Brine recirculation | | |
| Copper sulfate | 11WH-White | 07SF/05SF-Red/International Orange |
| Algae Suppressant Piping: | | |
| Copper sulfate | 11WH-White | 05SF/11SF-International Orange/Safety Blue |
| n-hexadecanol | 11WH-White | 05SF/YB24-International Orange/Brown |
| Anionic coagulant | 11WH-White | 08SF/35GR/32GR-Safety Green/Black/Gray |
| Cationic coagulant | 11WH-White | 08SF/35GR/YB24-Safety Green/Black/Brown |
| Nonionic coagulant | 11WH-White | 08SF/35GR/07SF-Safety Green/Black/Red |
| Coagulant air | 11WH-White | 08SF/YB24-Safety Green/Brown |
| Anionic flocculent | 11WH-White | 08SF/07SF/32GR-Safety Green/Red/Gray |
| Cationic flocculent | 11WH-White | 08SF/07SF/05SF-Safety Green/Red/ International Orange |
| Nonionic flocculent | 11WH-White | 08SF/07SF/11SF-Safety Green/Red/Safety Blue |

**END OF SECTION**

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# SECTION 09 96 46
## INTUMESCENT COATINGS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Fire resistive coating (intumescent coating).
   2. Topcoat protective decorative finish.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 12 00 - Structural Steel.
   4.
   5. Section 07 81 00 - Fireproofing.
   6. Section 07 84 00 - Firestopping.
   7. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D2240, Standard Test Method for Rubber Property—Durometer Hardness.
      b. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      c. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      e. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   2. Association of the Wall and Ceiling Industry (AWCI):
      a. Technical Manual 12-B, Third Edition; Standard Practice for the testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials, an Annotated Guide – 117.
   3. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.

B. Qualifications:
   1. Applicator licensed or approved in writing by manufacturer.
   2. Applicator shall have minimum five years application experience using products specified with minimum three years of experience using the product proposed for use.
   3. Manufacturer's field service representative shall have minimum 10 years of experience in application methods and inspection of applied product.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Qualifications for independent testing laboratory.
4. Qualifications of manufacturer's field service representative.
5. Applicator qualifications.
6. Certification from manufacturer that applicator is authorized to apply material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Carboline.
   2. Isolatek International (Cafco).
   3. Sherwin-Williams.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Primer:
   1. As required by coating manufacturer for UL assembly required.

B. Intumescent Coating:
   1. Thin film intumescent fire protection coating for structural steel.
   2. Surface burning characteristics:
      a. ASTM E84, Class A.
         1) Flame spread: Less than 25.
         2) Smoke developed: Less than 25.
   3. Durometer Hardness: ASTM D2240, Shore D, 70.
   4. Bond Strength: ASTM D4541, minimum 200 PSI.
   5. Carboline "Thermo-Sorb VOC".

C. Topcoat:
   1. Manufacturer's recommended thin-film epoxy topcoat compatible with Fire Resistive Coating.

### 2.3 SOURCE QUALITY CONTROL

A. Fire Resistive Coating shall be tested in accordance with ASTM E119 and UL listed for interior conditioned spaces and interior general purpose.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. See Specification Section 09 96 00 for preparation of surfaces to be coated.

B. Coordinate work with Specification Section 01 73 20 and Specification Section 07 84 00 for openings, penetrations and joint assemblies.

### 3.2 APPLICATION

A. Apply products in accordance with manufacturer's instructions and UL requirements.

B. Provide all primers, adhesives, tamping and sealers, etc.

C. Fireproof all items appurtenant to primary structural framing system including seismic and lateral bracing, struts, outriggers and similar items.

D. Apply only when ambient temperatures are above 50 DEGF and will remain so during cure period.

E. Cure in accordance with manufacturer's recommendations.

## 3.3 FIELD QUALITY CONTROL

A. Provide manufacturer's field service representative prior to and during application to:
   1. Check surfaces to which fireproofing is to be applied to assure proper preparation.
   2. Provide instruction and technical assistance to applicator.

B. Provide continuous wet-film thickness testing in accordance with ASTM D4414 throughout application.

C. Special Inspections:
   1. Fire Resistive Coatings will be subject to Special Inspections in accordance with the building code.
      a. Refer to Specification Section 01 45 33.
   2. Fire Resistive Coatings shall be inspected and certified to be in accordance with building code requirements prior to application of topcoat.

D. Cost of all retesting due to test failure paid by Contractor.

E. After initial testing and conformance has been verified, any subsequent damage to applied fireproofing caused by work of other trades shall be repaired and retested at Contractor's expense.

**END OF SECTION**

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# SECTION 09 96 53
## CORROSION RESISTANT ELASTOMERIC LINING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Cleaning and surface preparation of substrate.
   2. Sprayed Polyurethane corrosion-resistant lining.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      b. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      c. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      d. D4414, Practice for Measurement of Wet Film Thickness by Notch Gages
      e. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      f. D4787, Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
      g. D6386, Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
      h. D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage.
      i. D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
      j. D7234, Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
      k. E337, Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
      l. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
      m. F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
      n. F2659, Standard Guide for Preliminary Evaluation of Comparative Moisture Condition of Concrete, Gypsum Cement and Other Floor Slabs and Screeds Using a Non-Destructive Electronic Moisture Meter.
   2. International Concrete Restoration Institute (ICRI)
      a. 310.2R, Selecting and Specifying Concrete Surface Preparation.
   3. NACE International (NACE):
      a. SP0188, Standard Practice-Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates,

4. NSF International (NSF).
    a. 61, Drinking Water System Components - Health Effects.
5. The Society for Protective Coatings (SSPC):
    a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness.
    b. PA 9, Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages.
    c. SP 1, Solvent Cleaning.
    d. SP 16, Brush-off Blast Cleaning of Non-Ferrous Metals.
6. The Society for Protective Coatings/NACE International (SSPC/NACE):
    a. SP 5/NACE No. 1, White Metal Blast Cleaning.
    b. SP 13/NACE No. 6, Surface Preparation of Concrete.
    c. SP WJ 1/NACE WJ-1, Waterjet Cleaning of Metals—Clean to Bare Substrate.
    d. TR 3/NACE 6A192, Dehumidification and Temperature Control During Surface Preparation, Application, and Curing for Coatings/Linings of Steel Tanks, Vessels, and Other Enclosed Spaces.

B. Qualifications:
1. Applicator to be licensed or approved, in writing, by manufacturer.
2. Applicator must own application equipment; equipment shall be approved, in writing, by manufacturer.
3. Applicator to have successfully completed minimum of three projects in last five years with similar scope.
4. Provide references for minimum of three projects in last five years including:
    a. Project type.
    b. Material installed.
    c. Size of project, including square footage and dollar value.
    d. Contact information for project Contractor (if applicable).
    e. Contact information for end user.

C. Mock-Ups:
1. Construct mock-up area minimum 10 FT by 10 FT utilizing all specified or required components for Engineer review and acceptance.
2. Step construction of mockup to demonstrate all components used in application, including but not limited to:
    a. Surface Preparation.
    b. Primer
    c. Intermediate coat(s).
    d. Finish coat(s).
    e. Slip-resistant walkway surface.
3. Mock-up shall include all corners, coves, terminations and other special detailing as required by Project conditions.
    a. Mock-up surface shall have same finish as finish to be expected in the actual Work.
4. Area shall constitute minimum standard of quality for actual construction.
    a. Maintain area during construction.
5. If not acceptable, construct additional areas as required.
6. Remove when directed by Engineer.
7. Area shall not be built into permanent construction.

## 1.3 DEFINITIONS

A. Defective:
1. Lining will be considered defective if, in the opinion of the Engineer, any of the following conditions exist in the final product:
    a. Dry film thicknesses have not been met.
    b. Debris is embedded in material.

c. Surface exhibits any defect, including but not limited to:
    1) Pinholes.
    2) Voids.
    3) Honeycombing.
    4) Loss of adhesion.
    5) Discoloration.

B. Immersion Service:
    1. Any surface immersed in water or some other liquid.
    2. Surface of any pipe, valve, or any other component of the piping system, including pipe supports, subject to condensation.

C. Installer or Applicator:
    1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
    2. Installer and applicator are synonymous.

D. PPM: Parts per million.

## 1.4 SYSTEM DESCRIPTION

A. Multi-component corrosion-resistant liner system, including but not limited to:
    1. Modified epoxy mortar parge coat.
    2. Epoxy primer.
    3. High-build polyurethane liner.
    4. Slip-resistant walkway surface.

B. Lining must be capable of withstanding continuous immersion in finished drinking water treated with chlorine and/or ammonia (chloramine).
    1. Concentration: 4 PPM, maximum.

## 1.5 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Applicator's qualifications and references.
    3. Product technical data including:
        a. Acknowledgement that products submitted meet requirements of standards referenced.
            1) Complete physical and chemical characteristics.
            2) Chemical-resistance information.
        b. Manufacturer's installation instructions.
        c. Manufacturer's recommendations for adhesives, primer, and miscellaneous materials used.
        d. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
        e. Manufacturer's application and curing instructions.

B. Informational Submittals:
    1. Manufacturer's statement regarding applicator instruction on product use.
    2. Manufacturer's written certification of substrate preparation and application conditions per the Field Quality Control Article of this Specification Section.
    3. Manufacturer's authorized representative's written record of visual inspection, including documentation of deficiencies and repairs.
    4. Applicator's daily records:
        a. Submit daily records at end of each week in which Work is performed.
        b. Provide certified copy of daily record to Owner as part of project close out documents.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
   1. Name or type number of material.
   2. Manufacturer's name and item stock number.
   3. Contents, by volume, of major constituents.
   4. Warning labels.
   5. VOC content.

B. Store material in accordance with manufacturer's recommendations.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Sprayed Polyurethane Corrosion-Resistant Lining:
      a. CIM Industries, Inc.
      b. Polycoat Products.
      c. Raven Lining Systems.
      d. Sherwin-Williams.
      e. Tnemec, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. Liner system, in its entirety, shall be certified to NSF 61.

B. Filler-Surfacer:
   1. 100 PCT solids epoxy.
      a. Aggregate reinforced.
   2. As recommended by lining manufacturer.

C. Primer:
   1. Polyamide Epoxy.
   2. Solids by volume: Minimum 60 PCT.
   3. Similar to Tnemec Series 20 H.S.

D. Sprayed Polyurethane Corrosion-Resistant Lining:
   1. Plural component, high build elastomeric polyurethane.
   2. Solids by volume: Minimum 87 PCT mixed.
   3. Similar to Tnemec Series 264 Elasto-Shield.
   4. Color: .

E. Slip-Resistant Aggregate:
   1. Aluminum oxide.
   2. Profile: Angular.
   3. Size: As required to provide degree of slip-resistance determined in mockup.

### 2.3 ACCESSORIES

A. Provide all primers, crack filler, sealants, thinners, etc., as required and as recommended by the lining manufacturer.

## 2.4 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Performance Characteristics:
   1. Abrasion resistance: ASTM D4060, less than 120 MG lost (CS17 wheel, 1000 G, 1000 cycles).
   2. Concrete adhesion: ASTM D4541, 300 PSI.
   3. Tensile strength: ASTM 638, 1500 PSI.
   4. Elongation: ASTM D638, 40 PCT.
   5. Durometer hardness: ASTM D2240, Shore D, 35.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Steel surfaces:
   1. Solvent clean in accordance with SSPC SP 1.
   2. Grind all welds smooth.
   3. White metal blast clean in accordance with SSPC/NACE SP 5/NACE No. 1.

B. Galvanized steel surfaces:
   1. Brush blast in accordance with SSPC SP 16 and ASTM D6386.

C. Verify suitability of substrate to accept installation.
   1. Ensure that surfaces have been prepared in accordance with lining manufacturer's instructions and this Specification Section.
      a. Where discrepancy between lining manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided.
   2. Steel appurtenances:
      a. Shop coated steel painted in accordance with Specification Section 09 96 00:
         1) Prepare as recommended by lining manufacturer.
         2) Observe recoat windows.
      b. Uncoated steel:
         1) Solvent clean in accordance with SSPC SP 1.
         2) Grind all welds smooth.
         3) White metal blast cleaning, SSPC/NACE SP 5/NACE No. 1.
   3. Remove spent blasting material and dust.
   4. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of lining to surface.
   5. Adhere to manufacturer's recoat time surface preparation requirements.

D. Employ services of lining manufacturer's qualified technical representative to ensure that lining system is compatible with factory-applied or existing coatings.
   1. Certify through material data sheets.
   2. Perform test patch.
      a. Prepare existing coating surface to receive specified lining system.
      b. Apply lining system to a minimum 1 SQFT area and allow to cure in accordance with manufacturer's recommendations.
      c. Evaluate adhesion to existing coating:
         1) Concrete or Masonry substrates: ASTM 7234.
         2) All other substrates: ASTM D4541.
   3. If field-applied coating is found to be not compatible, require the lining manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
      a. Perform test patch as described above.
   4. At Contractor's option, existing coatings may be removed, and surface prepared in accordance with this Specification Section.

5. All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.

E. Verify that atmosphere is within manufacturer's acceptable temperature and humidity limits.
   1. Provide temporary heating and/or dehumidification as required to bring area within acceptable limits.
      a. Provide in accordance with SSPC TR 3/ NACE 6A192.
      b. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by lining manufacturer.
      c. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
         1) Vent exhaust gases to exterior environment.
         2) No exhaust gases shall be allowed to vent into the space being coated or any adjacent space.

## 3.2 APPLICATION

A. General:
   1. Apply materials under adequate illumination.
   2. Application shall be performed when substrate is in descending temperatures.
   3. Evenly spread to provide full, smooth coverage.
   4. Work each application of material into corners, crevices, joints, and other difficult to work areas.

B. Apply primer and finish coats in accordance with manufacturer's recommendations.
   1. Apply primer in single coat to thickness recommended by manufacturer.
      a. After application of primer, inspect surface for pinholes, voids or other defects.
      b. Repair pinholes, voids or defects as recommended by lining manufacturer.
   2. Apply finish material to a total minimum 80 MILS dry film thickness.

C. Provide lining manufacturer's recommended details at all terminations, penetrations, embedments, cracks, joints and changes in substrate direction:
   1. Provide saw-cut keyway terminations.
      a. Size: Minimum 1/4 IN by 1/4 IN, unless indicated otherwise by lining manufacturer.
      b. Keyways shall be dry and clean; free of dust and residual particles.
      c. Mask edges of keyways to provide clean, abrupt termination.
   2. All piping and penetrations shall have fillet radius or cant cove as recommended by lining manufacturer.
   3. Provide fillet radius or cant cove at all changes in direction of substrate.

D. Finished surface shall be uniform and free of pinholes, voids, honeycombing or other imperfections.

E. Maintain minimum temperatures before, during, and after lining application to assure proper curing.

F. Ensure a monolithic lining and uniform thickness during the application process.

G. Measure wet lining with wet film thickness gages in accordance with ASTM D4414.

H. Apply lining to the following structures:
   1. Interior lining of Clearwell.

## 3.3 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative during lining application, substrate preparation and after all lining work is completed.
   1. Certify that surface has been prepared in accordance with lining manufacturer's recommendations.
   2. Certify that substrate moisture content and pH are within manufacturer's acceptable limits.

3. Certify that ambient temperature and temperature of substrate to be coated are within manufacturer's acceptable limits.
4. Certify that lining has been properly applied to required mil thickness.
5. Visual Inspection:
    a. A visual inspection shall be made by the manufacturer's representative.
    b. Any deficiencies in the finished lining shall be marked and repaired according to the procedures in the manufacturer's published installation instructions.

B. Owner Provided Observation, Inspection and Testing:
1. A NACE International Level III inspector will be assigned by the Owner to perform observation, inspection and testing as deemed necessary to document the quality of the Work.
    a. All Work shall be done to the satisfaction of the Owner's inspector.
    b. Any portion of the lining that does not satisfactorily pass the inspection and testing requirements shall be repaired or replaced by the Contractor at no additional cost to the Owner.
    c. Additional testing and/or inspection may be done at the discretion of the Owner. The Contractor will provide all equipment, materials, and labor to perform the testing.
2. Inspection, testing or observation by the Owner's inspector shall not relieve the Contractor of responsibility for surface preparation, inspection or quality control specified herein.

C. Contractor Performed Testing:
1. Provide ongoing testing and inspection as specified herein, including but not limited to the following:
    a. Thickness Testing:
        1) Wet film thickness during application in accordance with ASTM D4414.
        2) Dry Film Thickness (DFT) in accordance with SSPC PA 2 and ASTM D7091.
    b. Bond Strength:
        1) Measure bond strength of the lining system to the concrete substrate in accordance with ASTM D7234.
            a) Bond strength of the lining to the concrete shall be greater then the tensile strength of the concrete.
            b) One 50 MM dolly shall be fixed to each location and pulled in accordance with ASTM D7234.
                (1) For each test that fails, two additional tests shall be performed in the adjacent area.
                (2) Further bond tests may be performed to determine the extent of potentially deficient bonded areas at no additional cost to the Owner.
                (3) Repairs shall be made by applicator in strict accordance with manufacturer's recommendations.
                (4) The number of test sites and locations to be tested shall be determined by the Owner after application of lining. The Contractor will apply the dollies, perform the tests and repair the lining in the presence of the Owner.
                (5) Any lined areas that do not pass the bond strength tests shall be removed and replaced at the expense of the Contractor.
    c. Holiday Testing (Spark Testing):
        1) Test completed lining system in accordance with NACE SP0188 using high-voltage holiday detection equipment.
            a) Set spark tester at initial setting of 100 volts per MIL (25 microns) of film thickness applied.
                (1) Adjust as necessary to detect the induced holiday.
        2) Metallic substrates: Test in accordance with ASTM D5762.
        3) Concrete substrates: Test in accordance with ASTM D4787.
        4) All detected holidays shall be marked and repaired.
            a) Abrade the lining surface with grit disk paper or other hand tooling method.

b) After proper abrading and cleaning, additional protective lining material can be applied to the repair area.
c) All touch-up/repair procedures shall follow the protective lining manufacturer's recommendations.

5) Following manufacturer's recommended cure time for repaired areas, measure dry film thickness:
a) Ensure the specified thickness has been achieved.

6) Provide certification that completed lining system is free of pinholes or other material defects.

D. Instrumentation:
1. Utilize instrumentation as necessary to measure, monitor and record environmental surface conditions as indicated, including but not limited to the following:
a. Dry film thickness gauge:
1) Ultrasonic: SSPC PA 9 and ASTM D6132.
2) Magnetic: SSPC PA 2 and ASTM D7091.
b. Wet Film Thickness Gauge: ASTM D4414.
c. Sling Psychrometer: ASTM E337.
d. Surface Temperature Thermometer.
e. Anemometer.
f. Moisture Meter: ASTM F2659.
g. Adhesion test apparatus: ASTM D4541.
2. Instrumentation shall be adequate to measure and record applicable data within the tolerance indicated in the standard referenced for specific tests.
a. Calibrate all instrumentation prior to each use.

E. Maintain Daily Records:
1. Record the following information during application of each coat applied:
a. Date, starting time, end time, and all breaks taken by painters.
b. Air temperature:
1) Dry Bulb.
2) Wet Bulb.
c. Relative humidity.
d. Dew point.
e. Moisture content of concrete substrate prior to coating.
f. pH level of concrete substrate prior to coating.
g. Surface temperature of substrate.
h. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
i. Record environmental conditions, substrate moisture content and surface temperature information not less than once every 4 HRS during application.
1) Record hourly when:
a) Temperatures are below 50 DEGF or above 100 DEGF.
b) Significant changes in weather conditions occur.
c) Precipitation is imminent or occurring.
2. Record the following information daily for the lining manufacturer's recommended curing period:
a. Date and start time of cure period for each item or area.
b. Record environmental conditions not less than once every 12 HRS.
1) Record not less than once every 4 HRS when:
a) Ambient temperature is below 35 DEGF.
b) Significant changes in weather conditions occur.
c) Precipitation is imminent or occurring.

c. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.

3. Format for daily record to be computer generated.
4. Daily record shall be accessible to Engineer anytime during normal project working hours.

F. Repair all defective lining in accordance with manufacturer's printed recommendations.

**END OF SECTION**

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# DIVISION 10

## SPECIALTIES

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# SECTION 10 14 00
## IDENTIFICATION DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, conduits, valves, pumps, and similar items.
   2. Hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   2. The International Society of Automation (ISA).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. Z535.1, Safety Color Code.
      b. Z535.2, Environmental and Facility Safety Signs.
      c. Z535.3, Criteria for Safety Symbols.
      d. Z535.4, Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 704, Standard System for the Identification of Hazards of Materials for Emergency Response.
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Catalog information for all identification systems.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.
   4. Schedule of Hazard and Safety Signage indicating text and graphics.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
   2. Panduit.
   3. Seton.

4. National Band and Tag Co.
5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MANUFACTURED UNITS

A. Type A2 - Rectangle Metal Tags
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type B1- Square Nonmetallic Tags
   1. Materials: Fiberglass reinforced plastic.
   2. Size:
      a. Surface: 2 x 2 IN minimum.
      b. Thickness: 100 MILS.
   3. Fabrication:
      a. 3/16 IN mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant for a 10 year minimum outdoor durability..
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.

C. Type B2 - Nonmetallic Signs
   1. Materials: Fiberglass reinforced or durable plastic.
   2. Size:
      a. Surface: As required by text.
      b. Thickness: 60 MILS minimum.
   3. Fabrication:
      a. Rounded corners.
      b. Drilled holes in corners with grommets.
      c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.
   5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

D. Type F - Underground Warning Tape
   1. Materials: Polyethylene.
   2. Size:
      a. 6 IN wide (minimum).
      b. Thickness: 3.5 MILS.
   3. Fabrication:
      a. Legend: Preprinted and permanently imbedded.
      b. Message continuous printed.
      c. Tensile strength: 1750 PSI.
   4. Color: As specified.

E. Underground Tracer Wire
   1. Materials:
      a. Wire:
         1) 12 GA AWG.
         2) Solid.
      b. Wire nuts: Waterproof type.
      c. Split bolts: Brass.

### 2.3 ACCESSORIES

A. Fasteners:
   1. Bead chain: #6 brass, aluminum or stainless steel.
   2. Plastic strap: Nylon, urethane or polypropylene.
   3. Screws: Self-tapping, stainless steel.
   4. Adhesive, solvent activated.

### 2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
   1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
   1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:
   1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
   2. Continuous pass from each valve box and above grade at each structure.
   3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
   4. 1,000 FT maximum spacing between valve boxes.
   5. If split bolts are used for splicing, wrap with electrical tape.
   6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
   7. Use continuous strand of wire between valve box where possible.
      a. Continuous length shall be no shorter than 100 FT.

### 3.2 SCHEDULES

A. Hazard and Safety Signage
   1. Permit Required Confined Space signage
      a. Tag Type: Type B2 - Nonmetallic Signs.
      b. Fastener: Screw or adhesive.
      c. Size: 10 IN x 14 IN.
      d. Location: Provide at any confined space.

e. Location: Field located as directed by.
    1) Allowance: Provide 30 signs.
f. Legend:
    1) OSHA Danger sign.
    2) Description of hazard: "PERMIT REQUIRED CONFINED SPACE DO NOT ENTER".

2. Miscellaneous OSHA hazard signage
    a. Tag Type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 10 IN x 14 IN.
    d. Location: Location determined by Owner during Construction.
        1) Allowance: Provide 30 OSHA Danger, Caution, Safety Instruction or Biohazard signs as directed by.
    e. Legend:
        1) Description of hazard shall be determined by.
        2) Provide international graphic symbology where indicated.
3. No Smoking Signage:
    a. Tag Type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 10 IN x 14 IN.
    d. Location: On the doors entering into the rooms with flammable gas or other material requiring No Smoking signage.
    e. Location: Field located as directed by.
        1) Allowance: Provide 20 "NO SMOKING" signs.
    f. Legend: "NO SMOKING" with international graphic symbology, adhering to the International Fire Code.
4. Hazardous Material Identification Signage:
    a. Tag Type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size (NFPA Diamond): Per NFPA 704, 10" minimum.
    d. Size (Hazardous Material name, with concentration % where applicable): 2 IN minimum letters, directly below corresponding NFPA Diamond.
    e. Location: On the doors entering into the rooms with Hazardous Material and on the tanks or storage containers of Hazardous Materials, as indicated on the Drawings.
    f. Location: Field located as directed by.
        1) Allowance: Provide 20 NFPA 704 Diamond signs.
        2) Allowance: Provide 20 for Hazardous Material Name.
    g. Legend:
        1) NFPA 704 Diamond hazard numbers: As directed by appropriate for the Hazardous Material.
        2) Hazardous Material name: As directed by.

B. Process Systems:
1. General:
    a. Provide arrows and markers on piping.
        1) At 20 FT maximum centers along continuous lines.
        2) At changes in direction (route) or obstructions.
        3) At valves, risers, "T" joints, machinery or equipment.
        4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
    b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
        1) If flow is in both directions use double headed arrow markers.
    c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:
   a. Tag type: Type F - Underground Warning Tape
   b. Location: Halfway between top of piping and finished grade.
   c. Letter height: 1-1/4 IN minimum.
   d. Potable water:
      1) Color: Blue with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED WATER LINE BELOW"
   e. Storm and sanitary sewer lines:
      1) Color: Green with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED SEWER LINE BELOW"
   f. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
      1) Color: Green with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED NONPOTABLE WATER LINE BELOW"
   g. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.):
      1) Color: Yellow with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED CHEMICAL LINE BELOW"
   h. Other piping (e.g., irrigation, sample, etc.):
      1) Color: Yellow with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED PIPE LINE BELOW"
3. Yard valves, buried, with valve box and concrete pad:
   a. Tag type: Type A2 - Rectangle Metal Tags.
   b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
4. Valves and slide gates:
   a. Tag type:
      1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
      2) Indoor noncorrosive:
         a) Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
      3) Indoor corrosive:
         a) Stainless steel Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
   b. Fastener:
      1) Type A1: Chain of the same material.
      2) Type B1: Stainless steel chain.
   c. Color: Per ASME A13.1 corresponding to the piping system.
   d. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, mixers, scraper drive mechanism, strainers, injection quills, hydrocyclones, vaporizers, ozone generators, chillers, etc.):

a. Tag type:
   1) Type B2 - Nonmetallic Signs.
   2) Type D - Self-Adhesive Tape Tags and Signs.
   3) Type G - Stenciling System.
b. Fastener:
   1) Self.
   2) Screws.
   3) Adhesive.
c. Legend:
   1) Letter height: 1/2 IN minimum.
   2) Equipment designation as indicated on the Drawings (e.g., "Primary Sludge Pump P-xxx").

6. Piping systems:
   a. Tag type:
      1) Outdoor locations: Type G - Stenciling System.
      2) Indoor locations:
         a) Type D - Self-Adhesive Tape Tags and Signs.
         b) Type G - Stenciling System.
   b. Fastener: Self.
   c. Color: Per ASME A13.1.
   d. Legend:
      1) Letter height: Manufacturers standard for the pipe diameter.
      2) Mark piping in accordance with ASME A13.1.
      3) Use piping designation as indicated on the Drawings.
      4) Arrow: Single arrow.
7. Process tanks (over 1000 GAL) and basins, (e.g., chemical storage, clarifiers, filters, wet wells, clearwells, etc.):
   a. Tag type:
      1) Type B2 - Nonmetallic Signs.
      2) Type G - Stenciling System.
   b. Fastener:
      1) Screw.
      2) Self.
   c. Location as directed by Owner.
   d. Legend:
      1) Letter height: 4 IN minimum.
      2) Equipment designation as indicated on the Drawings (e.g., "Clarifier CL-xxx").
8. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):
   a. Tag type:
      1) Type D - Self-Adhesive Tape Tags and Signs.
      2) Type G - Stenciling System.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 2 IN minimum.
      2) Equipment designation as indicated on the Drawings (e.g., "Polymer Storage Tank Txxx")
9. Equipment that starts automatically:
   a. Tag type:
      1) Type B2 - Nonmetallic Signs.
      2) Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener:
      1) Type B2 - Screw or adhesive.
      2) Type D - Self.
   c. Size: 5 IN x 7 IN

d. Location: Field located as directed by Engineer.
   1) Allowance: Provide 30 signs.
e. Legend:
   1) OSHA Warning Sign.
   2) Description of Warning: "THIS MACHINE STARTS AUTOMATICALLY".

C. Instrumentation Systems:
1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
   a. Tag type:
      1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
      2) Indoor noncorrosive:
         a) Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
      3) Indoor corrosive:
         a) Stainless steel Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
   b. Fastener:
      1) Type A1: Chain of the same material.
      2) Type B1: Stainless steel chain.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Equipment ISA designation as indicated on the Drawings (e.g., "FIT-xxx").
2. Enclosure for instrumentation and control equipment, (e.g., PLC contrr: Screws.
   a. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers):
   a. Tag type: Type D - Self-Adhesive Tape Tags.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "PLC-xxx" or "CR-xxx").
4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

D. Electrical Systems:
1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
   a. Tag type: Type F - Underground Warning Tape.
   b. Letter height: 1-1/4 IN minimum.
   c. Location:
      1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
      2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
   d. Electrical power (e.g., low and medium voltage):
      1) Color: Red with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION".
         b) Second line: "BURIED ELECTRIC LINE BELOW".
   e. Communications (e.g., telephone, instrumentation, LAN, SCADA):

1) Color: Orange with black letters.
2) Legend:
   a) First line: "CAUTION CAUTION CAUTION".
   b) Second line: "BURIED COMMUNICATION LINE BELOW".

2. Exterior pad mounted equipment (e.g., transformers, switchgear):
   a. Tag type: Type D - Self-Adhesive Tape Tags.
   b. Fastener: Self.
   c. General legend:
      1) Letter height:
         a) First line: 1-1/2 IN minimum.
         b) Subsequent lines: 1/2 IN minimum.
      2) First line: Equipment name (e.g., "TRANSFORMER Txxx").
      3) Second line: System voltage (e.g., "13,800 V: 480/277 V").
      4) Third line: Date installed (e.g., "INSTALLED JULY 20xx").
   d. Each section/cubical legend:
      1) Letter height: 1-1/2 IN minimum.
      2) Description of source or load (e.g., "MAIN DISCONNECT" or "TO SWITCHGEAR SGxxx" or "TO TRANSFORMER Txxx").
3. Switchgear, switchboards and motor control centers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Main equipment legend:
      1) Letter height:
         a) First line: 1 IN minimum.
         b) Subsequent lines: 3/8 IN minimum.
      2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
      3) Second line:
         a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
         b) Include the building name or number if the source is in another building.
      4) Third line: System voltage and phase (e.g., "480/277 V, 3PH").
      5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
   d. Main and feeder device legend:
      1) Letter height: 3/8 IN minimum.
      2) Description of load (e.g., "MAIN DISCONNECT", "PUMP Pxxx" or "PANELBOARD HPxxx").
4. Panelboards and transformers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height:
         a) First line: 3/8 IN minimum.
         b) Subsequent lines: 3/16 IN minimum.
      2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
      3) Second line (panelboards only): System voltage and phase (e.g., "208/120V, 3PH").
      4) Third line:
         a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
         b) Include the building name or number if the source is in another building.
      5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
5. Transfer switches:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height:

a) First line: 3/8 IN minimum.
b) Subsequent lines: 3/16 IN minimum.

2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").
3) Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCCxxx").
4) Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGENxxx").
5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").

6. Safety switches, separately mounted circuit breakers and motor starters, VFD's, etc.:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
      3) Second line:
         a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
         b) The source of power room number is only required when there are multiple electrical rooms, if the source is in another building, the building name or number shall be used.
7. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
8. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").
9. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
10. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag conductor at both ends.
    d. Legend:
       1) Letter height: 1/8 IN minimum.
       2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
11. Conductors in cable trays.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag all conductors at the same location in the tray at 50 FT maximum intervals.
    d. Legend:
       1) Letter height: 1/8 IN minimum.

2) Circuit number or wire number as scheduled on the Drawings.

12. Conductors in handholes and manholes.
    a. Tag type: Type A3 - Metal Tape Tags.
    b. Fastener: Nylon strap.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings.
13. Grounding conductors associated with grounding electrode system in accordance with the following:
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
14. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.
15. Poles:
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener:
        1) Metal pole: Self.
        2) Wood pole:
            a) Self mount tag on aluminum utility panel.
            b) Panel thickness: 20 MILS.
            c) Two mounting holes.
            d) Screw or nail panel to pole.
    c. Color: Yellow with black letters.
    d. Legend:
        1) Letter height: 1 IN minimum.
        2) Pole number as scheduled on the Drawings.
16. Power cable trays:
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location:
        1) Every 50 FT maximum.
        2) Label each barriered section of tray.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger, (e.g., "UP TO 480 VOLTS").
17. Control cable trays:
    a. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Every 50 FT maximum.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger, (e.g., "LESS THAN 50 VOLTS, CLASS 2 OR 3 IN or "ANALOG INSTRUMENTATION" or "DIGITAL COMMUNICATION").
18. Telecommunication cable trays:
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.
c. Location: Every 20 FT maximum.
d. Legend:
    1) Letter height: 1/4 IN minimum.
    2) Description of tray, (e.g., "TELECOMMUNICATIONS").

19. Entrances to electrical rooms:
    a. Tag type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 5 IN x 7 IN.
    d. Location: Each door to room.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: "HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY".
20. Entrances to Telecommunications Rooms:
    a. Tag type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 5 IN x 7 IN.
    d. Location: Each door to room.
    e. Legend:
        1) OSHA Warning Sign.
        2) Description of Warning: "TELECOMM ROOM, AUTHORIZED PERSONNEL ONLY".
21. Equipment where more than one voltage source is present:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: "MULTIPLE VOLTAGE SOURCES".
22. Equipment with more than one service disconnect:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 5 IN x 7 IN.
    d. Location: Near service disconnect.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: "THIS EQUIPMENT HAS ___(fill in applicable)__SERVICE DISCONNECTS".
23. Buildings with more than one service entrance:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.

c. Size: 5 IN x 7 IN.
d. Location: On service entrance equipment, near service disconnect.
e. Legend:
   1) OSHA Danger Sign.
   2) Description of Danger: "THIS IS ONE OF _____(_provide #_)SERVICE DISCONNECTS FOR THE BUILDING. OTHER SERVICE DISCONNECTS ARE LOCATED ____(provide location)_".

**END OF SECTION**

# SECTION 10 14 23
SIGNAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Room identification signs.
   2. Other identification signs:
      a. Fire and/or smoke barrier identification signs.
   3. Aluminum letters.
   4. Site signs and traffic signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. B26, Standard Specification for Aluminum-Alloy Sand Castings.

### 1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

B. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the following rooms or areas are considered wet and/or corrosive:
   1. Pump rooms.
   2. Chemical storage rooms.
   3. Maintenance rooms.
   4. Process equipment rooms.
   5. Rooms containing open basins of water or wastewater.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color charts for Engineer's color selection.
         1) Color selection shall be made from manufacturer's complete color line including all premium and special colors.
   3. Schedule of all signs indicating text and graphics.
   4. Layout drawings of all signage showing size, letter style, text, border, finish, and installation detail.
      a. Provide drawings for:
         1) Room, exit, and stair identification signs.
         2) Fire and/or smoke barrier identification signs.
         3) Aluminum letters.

4) Site traffic signs.

B. Samples:
1. Room and exit identification signs.
2. Fire and/or smoke barrier identification signs.
3. Aluminum letters.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Room, exit and stair identification signs:
   a. ASE - Architectural Signs and Engraving.
   b. ASI Signage Innovations.
   c. Best Sign Systems.
   d. Mohawk Sign Systems.
   e. Nelson-Harkins.
   f. Southwell Co.
   g. Stamprite Supersine Identification Specialists.
2. Fire and/or smoke barrier identification signs:
   a. Brady.
   b. Panduit.
   c. Seton.
   d. Carlton Industries.
3. Aluminum letters:
   a. A R K Ramos Manufacturing Co., Inc.
   b. ASI Signage Innovations.
   c. Leeds Architectural Letters.
   d. Metal Arts.
   e. Metallic Arts.
   f. The Southwell Co.
4. Site signs:
   a. ASI Signage Innovations.
   b. Stamprite Supersine Identification Specialists.
   c. Best Sign Systems.
5. Aluminum logo graphics:
   a. Any manufacturer capable of meeting specifications.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Room, Exit, and Stair Identification Signs:
1. Interior:
   a. Dry, non-corrosive areas: Melamine plastic suitable for raised lettering and Braille.
   b. Wet and/or corrosive areas: Aluminum or fiberglass suitable for raised lettering and Braille.
2. Exterior: Aluminum or fiberglass suitable for raised lettering and Braille.

B. Fire and/or Smoke Barrier Identification Signs:
1. Self-adhesive vinyl tape or vinyl cloth.

C. Aluminum Letters:
1. Cast aluminum ASTM B26.
2. For machine cut letters, provide aluminum of appropriate alloy and hardness.

D. Site Signs: Aluminum.

E. Logo Graphics: Aluminum.

## 2.3 FABRICATION

A. Room and Exit Identification Signs:
   1. General:
      a. Raised text, border and graphics.
         1) Minimum 1/32 IN height.
         2) Provide international graphic symbology for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
         3) Provide handicap symbol on all signs for rooms meeting handicap requirements.
      b. Grade 2 Braille.
      c. Finish: Eggshell.
         1) Color: To be selected.
      d. Text:
         1) Typeface: Sans Serif.
         2) Size: Minimum 3/4 IN high.
      e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.
      f. Exterior signs shall be rated for exterior use.
      g. All signs shall comply with requirements of ADA state or local authority, if appropriate.

B. Stair Identification Signs:
   1. Minimum 18 IN by 12 IN sign:
      a. Raised text, border and graphics height: Minimum 1/32 IN.
      b. Indicate;
         1) Floor level.
         2) Terminus of top and bottom of exit enclosure.
         3) Identification of stair.
         4) Story of and direction to exit discharge.
         5) Availability of roof access from enclosure.
   2. Grade 2 Braille.
   3. Text and number height:
      a. Letters designating stair enclosure: Minimum 1.5 IN.
      b. Number designating floor level: Minimum 5 IN, in center of sign.
      c. Other letters and numbers: Minimum 1 IN.
   4. Finish:
      a. Eggshell.
      b. Color: To be selected.
   5. All signs shall comply with requirements of ADA.

C. Fire and/or Smoke Barrier Identification Signs:
   1. Self-adhesive tape tags and signs:
      a. Materials: Vinyl tape or vinyl cloth.
         1) Indoor/Outdoor grade.
         2) Weather and UV resistant inks.
         3) Permanent adhesive.
      b. Size:
         1) Surface: As required by text.
         2) Thickness: 5 MILS minimum.
      c. Color: White with black lettering.
   2. Typeface: Helvetica Medium.
   3. Text Size:
      a. Height: 3 IN minimum.
      b. Stroke: 3/8 IN minimum.
      c. Text: As indicated in the SCHEDULES Article in PART 3Fabrication:

D. Hazard Communication Signage (NFPA and OSHA signage): See Specification Section 10 14 00.

E. Aluminum Letters:
   1. General:
      a. Cast aluminum, machine cut or laser cut aluminum.
      b. Finish: Anodized.
      c. Color:T.B.D.
      d. Mounting:
         1) 1 IN projected.
         2) Provide stainless steel mounting studs.
      e. Text: Per copy provided by Owner.
   2. Provide true angles, crisp corners and straight edges with no burrs or pitting in the surface.

F. Site Signs:
   1. All aluminum construction: Details T.B.D.

### 2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Room Identification Signs:
   1. Install signs using foam tape for interior signs and stainless steel screws (minimum of two) for exterior signs.
      a. Stainless steel screws shall be painted to match sign color.
   2. Mounting Locations:
      a. Tactile characters on signs shall be located 48 IN minimum above the finished floor or ground surface, measured from the baseline of the lowest tactile character and 60 IN maximum above the finish floor or ground surface, measured from the baseline of the highest tactile character.
      b. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf. Where a tactile sign is provided at double doors with two active leafs, the sign shall be located to the right side of the right hand door. Where there is no wall space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.
      c. Signs containing tactile characters shall be located so that a clear floor space of 18 IN minimum by 18 IN minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
   3. Interior and exterior signs identifying permanent rooms and spaces shall comply with ADA state or local authority, if appropriate.

B. Stair Identification Signs:
   1. Install signs on walls adjacent to door leading from enclosure into corridor, in a position readily visible when doors are in open and closed positions.
   2. Mount 60 IN above finish floor to centerline of top row of text.
   3. Exit Signs:
      a. Doors at exit passageways, exit discharge and exit stairways shall be identified by tactile signs complying with requirements of ADA.
      b. Mounting Locations: Refer to paragraph for Room Identification Signs above.

C. Fire and/or Smoke Barrier Identification Signs:
   1. Provide marking and identification in compliance with building code.

2. Locate in accessible concealed floor, floor-ceiling, or attic spaces.
3. Locate within 15 FT of the end of each wall or partition and at intervals not exceeding 30 FT horizontally.

D. Aluminum Letters:
1. Install letters where indicated on Drawings.
2. Mount to walls with 1 IN projection in accordance with manufacturer's instructions.

E. Site Signs: Set posts in concrete minimum 24 IN into earth or as recommended by manufacturer.

## 3.2 SCHEDULES

A. Room and Exit Identification Signs: Provide signage at each door, matching room name and number per floor plans.

B. Stair Identification Signs:
1. Refer to Stair Identification Signs in the FABRICATION Article in PART 2 of this Specification Section for specific information requirements.

C. Fire and/or Smoke Barrier Identification Signs:

| ASSEMBLY | VERBIAGE |
|---|---|
| Fire and Smoke Barriers | ___1__HR FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS |
| Fire and Smoke Partitions | ___1__HR FIRE AND SMOKE PARTITION - PROTECT ALL OPENINGS |

1. Indicate hourly rating of assembly.
2. Verify exact verbiage with AHJ prior to fabricating signage.

D. Aluminum Letters: T.B.D.
1. As indicated on the Drawings.

E. Site Signs: T.B.D.
1. AUTHORIZED VEHICLES ONLY BEYOND THIS POINT
2. VISITOR PARKING
3. HANDICAP PARKING ONLY
4. PRIVATE DRIVE
5. MAINTENANCE ADMINISTRATION
6. PUMP BUILDING
7. ELECTRICAL
8. CHEMICAL AND OZONE
9. VISITORS AND DELIVERIES

**END OF SECTION**

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# SECTION 10 21 16
## PREFABRICATED SHOWER STALLS - NON-RECESSED

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Prefabricated Shower Stalls – Non-recessed, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM F462 Consumer Safety Specifications for Slip-Resistant Bathing Facilities.
   2. ASTM E162 Standard Test Method for Surface Flammability of Materials using Radiant Heat Energy Source.

B. National Fire Protection Association (NFPA):
   1. NFPA 258 Determining Smoke Generation of Solid Materials.

C. U.S. Department of Justice:
   1. ADA Standards for Accessible Design, current addition.

D. American National Standards Institute (ANSI):
   1. ANSI Z124.2 Plastic Shower Receptors and Shower Stalls.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Detail drawings including:
      a. Room layout.
      b. Component sizes and dimensions.
      c. Attachment details and coordination with adjacent work.

B. Product Data:
   1. Manufacturer's product data sheets, details and installation instructions for Prefabricated Shower Stalls, components and accessories.

C. Contract Closeout Information:
   1. Maintenance data.
      a. See Section 01 33 04.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Prefabricated Shower Stalls – Non-Recessed:
   1. Base:
      a. Best Bath Systems.
   2. Optional:
      a. Aquarius.

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 MATERIALS

A. Prefabricated Shower Stalls:
   1. Institutional Grade, to meet or exceed ANSI Z124.1 and ANSI Z124.2, and ANSI Z117.1.

2. Base product:
    a. Product name: ADA Compliant Transfer Shower.
    b. Product Name: ADA Compliant Roll-in Shower.
    c. Model number: LSS4038A5T by Best Bath Systems.
3. Shape: As indicated on Drawings; left-hand and right-hand configuration, and plumbing.
4. Size: 40 inches wide x 38 inches deep x 79IN high.
5. Floor materials:
    a. 1/4 inches fiberglass laminate with integral level support compound bonded to underside of laminate floor material.
    b. Sloping threshold, 1/2 inches high.
    c. Slip resistant floor.
    d. Collapsible rubber water retainer; flattens under wheelchair:
        1) Model Number: TWR.
        2) Size: 1-1/2 inches high x 1 inch wide x 3/32 inches thick.
        3) Material: Neoprene rubber.
        4) Color: Grey.
        5) Hardness: 50 Durometer.
        6) Installation: Epoxy adhesive applied.
        7) Apply to floor threshold, full width, cut to fit.
6. Wall materials:
    a. Formaldehyde free plywood inner core layer 3/8 inches thick.
    b. Fiberglass laminate layer: Minimum 15% fiberglass content and filled resin encapsulating plywood inner core.
    c. Fiberglass skin layer: Glass fiber and polyester resin layer laminated to fiberglass laminate encapsulating plywood core.
    d. Barrier coat layer: Ceramic fiber filled polyester resin, gloss enhancer and surface hardness coating.
        1) Provides resilient skin for gelcoat layer.
    e. Gelcoat Finish Layer:
        1) Finish: Sanitary ware grade gelcoat.
        2) Thickness, minimum cured: 0.105 inches.
        3) Gelcoat Finish Color: White.
        4) Surface Pattern: Classic 4 inches simulated tile.
    f. Reinforce for attached items.
7. Flame spread rating: Less than 75 inches accordance with ASTM E162.
8. Smoke generation: Less than 450 inches accordance with NFPA 258.

B. Accessories:
1. Grab bar:
    a. Size and configuration: 18 inches x 33 inches x 1.25 inches O.D., "L" shaped, concealed flange corner grab bar.
    b. Material and finish: Powder Coat, White.
    c. Heliarc welded flange forming a single structural unit, with 1-1/2 inches clearance to wall.
    d. Secure to concealed mounting plates of plated steel and stainless steel vandal proof set screws.
    e. Reinforce with steel or water resistant plywood, laminated in shower stall walls and attach mounting plates for grab bars to withstand a minimum of 250 pound of pull and shear.
    f. Mounting: Wall mounted, 34 inches AFF to center line of grab bar.
2. Shower Seat:
    a. Fold-down with stainless steel frame.
        1) Frame material: 304 stainless steel.
    b. Seating surface: Phenolic slats; color: white.
    c. Size: 34 inches x 21 inches.

d. Mounting: Wall mounted, 18 inches AFF to top of seat.
    1) Factory installed with tee-nuts and stainless steel machine screws anchored to integral plywood backing.
3. Soap dish:
    a. Integrally formed recessed soap dish.
    b. Stainless steel or chrome plated brass, recessed, soap dish.
4. Shower curtain rod:
    a. 18 gauge, stainless steel rod, satin finish.
    b. Size: 1 inch O.D. full width of shower opening.
    c. Accessories:
        1) Mounting flanges.
            a) Model number: AQA No. 22.
            b) Material: Injection Molded Plastic.
            c) Color: White.
            d) Spring loaded keeper.
        2) Curtain rings.
5. Shower Curtain:
    a. Material: 10 gauge, flame resistant sheet vinyl.
    b. Size: 42 inches x 76 inches.
    c. Color: White.
    d. Quantity: Provide 1, plus 2 extra for each shower.
6. Plumbing:
    a. Mixing valve:
        1) Pressure balanced lever handle valve factory plumbed.
        2) Symmons Valve No. 15-1-X-FG, factory installed.
        3) Mount centerline valve 40 inches AFF.
    b. Hand shower on glide bar:
        1) Glide bar/hand shower kit and hose assembly.
        2) Hand-held shower: Alsons No. 462 BG.
        3) Glide bar: Hansgrohe No. 27712.
        4) Mount bottom of glide bar 46 inches AFF.
    c. Shower drain:
        1) Model number: Sioux Chief Drain, No. 827-2B.
        2) Stainless steel or plated brass body with removable strainer.
        3) Fasten strainer with minimum of 2 stainless steel flush topped bolts to allow removal for cleaning.

C. Sealant:
1. See Section 07 92 00.

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Correct unsatisfactory conditions.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.
1. Install shower enclosure unit directly on top of flooring and in compliance with ADA 1/2 inches maximum curb height requirement.
2. Coordinate with finish flooring outside shower.
3. Proper installation shall include following manufacturer's instructions:
    a. Hole around drain shall be 8 inches diameter.
    b. Adhere unit to floor with epoxy adhesive provided by shower manufacturer.

B. Install barrier free shower units level, plumb, and square with adjacent flat wall surfaces.

C. Protect shower stall during construction.

D. Touch-up minor damaged surfaces, or replace damaged components.

E. Caulk as required to ensure water tight installation.

**END OF SECTION**

# SECTION 10 28 13
## TOILET AND BATH ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Toilet and bath accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. A269/A269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      b. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendation on fasteners.
   3. Schedule of items being provided for each room. Reference rooms using room number designated on Drawings.
   4. Catalog cut sheet of each item proposed.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original packaging.

B. Store materials in a dry, conditioned location, until ready for installation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Product numbers scheduled are manufactured by Bobrick.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. American Specialties, Inc.
   2. Bobrick Washroom Equipment, Inc.

3. Bradley.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Toilet Accessories:
   1. General: ASTM A480/A480M, stainless steel.
   2. Grab bars: ASTM A269/A269M, stainless steel.

B. Anchoring Devices:
   1. Stainless steel.

### 2.3 FABRICATION

A. Toilet Accessories:
   1. General:
      a. Satin finish.
      b. Items shall meet design requirements of ADA.
   2. Grab bars:
      a. Concealed mounting.
      b. 3 IN DIA flange.
      c. 1-1/2 IN OD.
      d. Peened finish on gripping surface.

B. Anchoring Devices:
   1. Designed to withstand minimum concentrated load of 250 LB applied at any point on grab bar.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify adequate backing has been provided in wall or toilet partition.
   1. See Specification Section 10 21 13.

### 3.2 INSTALLATION

A. Install in accordance with manufacturer's instruction and in accordance with ADA.

B. Install in locations indicated on Drawings.

C. Mount all items using manufacturer's recommended anchorage devices for the substrate to which the accessory is to be mounted.

### 3.3 SCHEDULE

A. See Drawings for locations.

B. Model numbers indicated are Bobrick, unless noted otherwise.
   1. TA-1: Robe Hook - B-6727.
   2. TA-2: Toilet Tissue Dispenser (double non-controlled) - B-2740.
   3. TA-3: Paper Cup Dispenser - B-235.
   4. TA-4: Feminine Napkin-Tampon Dispenser - or B-3706 (ADA semi-recessed).
   5. TA-5: Feminine Napkin Disposal - B-270.
   6. TA-6: Paper Towel Dispenser - B-262.
   7. TA-7: Waste Receptacle - B-279.
   8. TA-8: Liquid Soap Dispenser - B-2112.
   9. TA-9: Mop and Broom Rack - B-223 x 36 IN.
   10. TA-10: Shower Curtain Rod - B-6047 length required.
   11. TA-11: Soap Dish - B-4380 or 438 as required for wall construction.
   12. TA-12: Mirror - B-290 x size indicated on Drawings.

13. TA-13: NOT USED.
14. TA-14: Metal Shelf - B-295 x 24 IN.
15. TA-15: Towel Bar - B-5806.99 x 24 IN.
16. TA-16: Shower Seat - Special unit, B-5181 or 5171 x full depth of stall.
17. TA-17: Shower curtains - 204-3 with 204-1 hooks as necessary.
18. TA-18: Grab Bar - B-6806.99 x length indicated on Drawings.
19. TA-19: Grab Bar - B-6893.99 (52 IN horizontal).
20. TA-20: Grab Bar - B-6861.99 (30 x 16 IN "L" or 36 IN x 36 IN shower).
21. TA-21: Waste Receptacle - Bradley 359.

**END OF SECTION**

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# SECTION 10 41 00
## EMERGENCY ACCESS CABINETS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Emergency Key Cabinets.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 92 00 - Joint Sealants.
   4. Division 26 - Electrical.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. Society of Automotive Engineers (SAE).
   3. Underwriters Laboratories Inc. (UL):
      a. 1037, Standard for Antitheft Alarms and Devices.
   4. Fire code:
      1) Oregon Structural Specialty Code (OSSC) , 2019.including all amendments, referred to herein as Fire Code.

B. Qualifications:
   1. Manufacturer shall be acceptable to the local Authority Having Jurisdiction (AHJ).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

### 1.4 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

B. Galvanize, Galvanized or Galvanizing:
   1. Sheet metal: Hot-dip zinc coated in accordance with ASTM A653/A653M, G60 minimum.
   2. Steel fabrications and hardware: Hot-dip zinc coated in accordance with ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

### 1.5 SEQUENCING AND SCHEDULING

A. Delivered products to be incorporated into the Work in a timely manner for coordination with related trades.
   1. Coordinate installation of recessed mounting boxes with reinforcing steel in concreteconstruction.
      a. See applicable Division 3 Specification Sections.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Emergency Key Cabinets:
      a. Knox Company.
   2. Locks:
      a. Medeco by ASSA ABLOY.

B. or substitutionSubmit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. Emergency Information Cabinets:
   1. Knox 1300 Series.
   2. Listed: UL 1037.
   3. Surface mounted.
   4. Fully welded steel case.
      a. Steel, minimum 10 GA.
      b. Size: Nominal 18 IN high x 14-1/2 IN wide x 5 IN deep.
      c. Configured for storage of documents and/or keys.
         1) Key capacity: Up to 231 keys.
   5. Hinged door:
      a. Steel:
         1) Thickness: 10 GA.
         2) Front guard plate and lock protecting hard plate: 1/4 IN thick.
         3) 1 IN security overlap.
      b. Weather resistant door gasket.
      c. Stainless steel hinge.
         1) Welded deadbar hinge protection.
   6. Dual Locks:
      a. UL Listed.
      b. Double-action rotating tumblers.
      c. Hardened steel pins.
      d. Biased cut key.
      e. Hinged lock cover: Stainless steel, 1/8 IN thick.
   7. Latch: 7-point interlock.
   8. Finish:
      a. TGIC polyester powder coat.
      b. Zinc phosphate undercoat.
      c. Weather resistant.
      d. Color: Light Grey.

B. Emergency Key Cabinets:
   1. Knox 4100 Series.
   2. Listed: UL 1037.
   3. Recessed mounting.
   4. Surface mounted.
   5. High-security key box:
      a. Fully welded steel case.
      b. Minimum 1/4 IN thick steel.
      c. Size: Nominal 6 IN wide x 6 IN high x 4-1/2 IN deep.
      d. Integral flange on wall mounted locations
      e. No flange on post mounted locations.
   6. Hinged door:
      a. Steel, 1/2 IN thick.
      b. Weather resistant door gasket.
      c. Stainless steel hinge.
   7. Lift-off door:
      a. Steel: 1/2 IN thick.
      b. Weather resistant door gasket.
   8. Dual Locks:
      a. UL listed.
      b. Double-action rotating tumblers.
      c. Hardened steel pins.
      d. Biased cut key.
      e. Hinged lock cover: Stainless steel, 1/8 IN thick.
   9. Finish:
      a. Manufacturer's proprietary finishing process.
      b. Corrosion resistant aluminized substrate.
      c. Color: Dark Bronze.

### 2.3 ACCESSORIES

A. Recessed mounting shell and hardware for installation in cast-in-place concrete wall construction.
   1. Galvanized steel.
   2. Size: 6 IN wide x 6 IN high x 4 IN deep.

B. Mounting Hardware:
   1. Bolts:
      a. SAE Grade 5 or 8.
      b. Carriage head.
      c. Zinc chromate plated or galvanized.
      d. Emergency Information Cabinets: 5/16 IN DIA by length required.
      e. Emergency Key Cabinets: 3/8 IN DIA by length required.
   2. Nuts and washers:
      a. Match bolts.
      b. Provide fender washer under bolt head and nut.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
   1. Prior to installation; verify locations and mounting heights shown on drawings with the AHJ.
      a. AHJ direction takes precedence over Drawings.
   2. Install units in accordance with manufacturer's instructions and Fire Code.

B. Emergency Information Cabinets: Surface-mount with through-bolted connection as recommended by manufacturer.

C. Emergency Key Cabinets:
   1. Surface-mount with through-bolted connection as recommended by manufacturer.

D. Tamper Detection Switches: Connect tamper detection switches to control system.

**END OF SECTION**

# SECTION 10 44 33
## FIRE PROTECTION SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Portable fire extinguishers.
   2. Fire extinguisher cabinets.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Metal Fabrications.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. 2010 ADA Standards for Accessible Design.
   2. National Fire Protection Association (NFPA):
      a. 10, Standard for Portable Fire Extinguishers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 8, Water Based Agent Fire Extinguishers.
      b. 154, Carbon Dioxide Fire Extinguishers.
      c. 299, Dry Chemical Fire Extinguishers.
      d. 626, Water Fire Extinguishers.
      e. 711, Rating and Fire Testing of Fire Extinguishers.
      f. 2129, Halocarbon Clean Agent Fire Extinguishers.
   4. Warnock Hersey (WH).

### 1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Ratings and classification of extinguishers.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire extinguishers:
      a. Amerex Corporation.
      b. Ansul – Tyco Fire Protection Products.
      c. Badger Fire Protection.
      d. United Technologies - Kidde.
      e. Buckeye Fire Equipment.
   2. Fire extinguisher cabinets:
      a. J. L. Industries.
      b. Larsen's Manufacturing Co.
      c. Nystrom Building Products.
      d. Modern Metal Products.
      e. Potter - Roemer Inc.
   3. Fire extinguisher signs:
      a. Seton.
      b. Compliance Signs.
      c. Safety Sign.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. Fire Extinguisher Cabinet (FEC-2):
   1. Semi-recessed mounting.
      a. Meet projection limitations per ADA.
   2. 22 GA epoxy coated steel box.
   3. Flat trim.
   4. Epoxy-coated door and trim.
   5. Clear convex acrylic bubble.
   6. Provide secure closures.
   7. Provide FIRE EXTINGUISHER decal for face of each cabinet.
   8. Provide 10 LB 4A:60BC extinguisher.
   9. Provide listed cabinets in fire-rated walls.
      a. Cabinets in rated walls shall be listed for 1 and 2 HR combustible and non-combustible walls.

B. Fire Extinguisher (FEXT):
   1. Steel bodied, all metal top (head) and valves.
   2. Multi-purpose dry chemical extinguisher with hose and nozzle.
   3. Provide one listed 10 LB. 4A-60BC extinguisher for each fire extinguisher location (FEXT) indicated on Drawings.
   4. Finish: Red with epoxy finish coat.

C. Fire Extinguisher (FEXCA):
   1. Steel bodied, all metal top (head) and valves.
   2. Multi-purpose clean agent extinguisher with hose and nozzle.
   3. Provide one listed. 1A-10BC extinguisher for each fire extinguisher location (FEXCA) indicated on Drawings in communications and electrical rooms.
   4. FM Approved

D. Wall Brackets:
   1. Bracket type to fit specified extinguisher.
   2. Furnish bracket for each extinguisher not in cabinet.
   3. Bracket to be finished in red or black enamel.

E. Fire Extinguisher Signage:
   1. Single faced: SETON #21999.
   2. Double faced: SETON #22001.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and NFPA 10.
   1. Install units with extinguisher top not over 48 IN above floor.
   2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.
      a. See Specification Section 03 15 19.

B. Install FEC with top of unit at 60 IN above floor.

C. Fire extinguisher locations shown on Drawings are approximate locations.
   1. Verify all extinguisher mounting locations with the AHJ.

D. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
   1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

**END OF SECTION**

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# SECTION 10 51 13
## METAL LOCKERS AND LOCKER BENCHES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Metal lockers and locker benches.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 92 00 - Joint Sealants.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. A540/A540M, Standard Specification for Alloy-Steel Bolting Materials for Special Applications.
      b. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Baked Hardenable.
      c. B108/B108M, Standard Specification for Aluminum-Alloy Permanent Mold Castings.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Drawings showing location, numbering sequence, anchoring method and locking.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color chart showing manufacturer's full line of available colors for preliminary color selection by Engineer.

B. Samples:
   1. After preliminary color selection has been made, provide actual metal color samples, three (3) each, minimum 2 x 3 IN of colors selected for final color selection.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Lockers and locker benches:
      a. Art Metal Products.

b. DeBourgh Manufacturing.
c. List Industries, Inc.
d. Lyon LLC.
e. Penco Products.
f. Republic Steel.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Steel: ASTM A1008/A1008M.

B. Fasteners: Cadmium-plated steel ASTM A540/A540M.

C. Hooks and Hanger Rods: Cadmium-plated steel ASTM A540/A540M or cast aluminum ASTM B108/B108M.

## 2.3 ACCESSORIES

A. Hooks:
1. Provide one double-prong ceiling hook and three single-prong wall hooks for single-tier and double-tier lockers.
2. One wall hook and one ceiling hook for multi-tier lockers 12 IN and less in width.

B. Provide hat shelf.

C. Provide hanger rod minimum 5/8 IN DIA, in lieu of ceiling hook, in single tier lockers 18 IN deep or deeper.

D. Number Plates:
1. Manufacturer's standard etched, embossed, or stamped, non-ferrous metal number plates.
2. Three-digit numerals not less than 3/8 IN high.
3. Sequence numbers as directed by Owner.
4. Attach plates centered, near top of each locker door, with two fasteners of same finish as number plate.
5. Provide on each locker door.

E. Metal Base:
1. Minimum 20 GA.
2. Cover entire front of base of lockers without additional fastening devices.
3. Flange bottoms inward 3/4 IN for stiffening.
4. Factory-finish base to match lockers.

F. Trim:
1. 18 GA.
2. Provide at jambs and head of recessed lockers.
3. 2 IN or 3 IN wide as necessary.
4. Factory-finish to match lockers.
5. Secure to lockers with concealed fastening clips.

G. ADA Compliant Locker Bench:
1. Bench top: Solid hardwood.
2. 1-1/8 IN thick minimum x 91/2 IN wide minimum.
   a. All edges and corners rounded and sanded on all surfaces.
   b. Length: As noted on Drawings.
3. Sealer: Manufacturer's standard.
4. Pedestal:
   a. Base minimum 14 GA with 1-5/8 IN tubing uprights.
   b. Manufacturer's standard anchors.
   c. Finish to match lockers.
   d. Provide pedestal supports at 6 FT maximum spacing.

## 2.4 FABRICATION

A. General:
   1. Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion.
   2. Ease all exposed metal edges.
   3. Weld frames together.
   4. Weld, bolt, or rivet other connections per manufacturer's standard.
   5. Grind exposed welds flush.
   6. Chemically pretreat metal with degreasing and phosphatizing process.
   7. Apply baked-on enamel finish to all surfaces, exposed and concealed, except plated and non-ferrous metal.
   8. Finished film thickness of not less than 0.75 MIL for all exterior surfaces and not less than 0.5 MIL for all interior surfaces.

B. Lockers:
   1. Frames:
      a. Minimum 16 GA channels or 12 GA angles, with corners electrically welded to form solid one-piece structure.
      b. Provide door stops at door openings.
      c. Provide adjusting devices at legs to permit at least 1/2 IN vertical adjustment.
      d. Provide minimum 16 GA horizontal members between doors of other than single-tier lockers.
   2. Backs and sides:
      a. Minimum 24 GA.
      b. Flange backs on vertical edges and sides where they intermember with backs, making double-flanged rear corners.
   3. Exposed ends of non-recessed lockers: Minimum 16 GA.
   4. Tops, bottoms and shelves: Minimum 24 GA, flanged on all sides.
   5. Sloped tops: Continuous, minimum 20 GA.
   6. Doors:
      a. One-piece, minimum 16 GA, flanged at all edges, with corners.
      b. Extra bracing or reinforcing on inside of doors over 15 IN wide.
      c. Construct to prevent springing when opening or closing.
      d. Door swing of 180 DEG.
      e. Stamped louvered vents in door faces.
         1) Double-tier lockers: Not less than three 6 IN louver openings in top and bottom of each door.
   7. Door hinges:
      a. Full-loop, five-knuckle, tight pin.
      b. Not less than 0.050 IN thick steel, 2 IN high.
      c. Continuous weld hinges to inside of frame and secure to door with not less than two factory-installed fasteners, completely concealed and tamperproof when door is closed.
      d. Minimum three hinges for each door 42 IN high and over.
      e. Minimum two hinges for each door less than 42 IN high.
   8. Latching:
      a. Positive, automatic, prelocking, pry-resistant latch and pull.
      b. Rubber silencers.
      c. Chromium-plated, vandalproof or kickproof lift-up handle, containing strike and hole for padlock.
      d. Enclose latch on four sides in a boxed receptacle in lock bar channel, and engaging latch hooks on frame opposite hinges.
      e. Two-point latching for double-tier lockers.
   9. Provision for padlock: Latch pull with hole to accept padlock.
   10. ADA compliant lockers:

a. Single tier locker in same construction as standard lockers specified and provide with the following modifications:
    1) Shelves:
        a) Bottom shelf located not less than 9 IN above finished floor.
            (1) Provide full width closure panel from bottom shelf to locker floor.
        b) Top shelf located not more than 54 IN above finished floor.
    2) Top of hanger rod located not more than 48 IN above finished floor.
    3) Single-prong wall hooks located not more than 46 IN above finished floor.
    4) Door latching device:
        a) Lever handle, push type or U-shaped design.
        b) Operating device to be located 48 IN above finished floor.
        c) Spring loaded.
    5) Keyed lock to be self-locking when door is closed.
b. Top of locker to align with adjacent lockers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install plumb, level, rigid and flush.

C. Space fasteners not over 48 IN on center:
    1. Install through suitable reinforcing plates where necessary to prevent metal distortion.
    2. Conceal all fasteners wherever possible.

D. Provide and install filler and closure pieces as required.

E. Install benches by anchoring to floor construction.
    1. Seal flange to floor with sealant.
    2. See Section 07 92 00.

### 3.2 FIELD QUALITY CONTROL

A. Touch-up any damaged finishes or replace as directed by Engineer.
    1. Use only materials and finishes as recommended or furnished by locker manufacturer.

### 3.3 ADJUSTMENT

A. Adjust doors and latches to operate easily without bind.
    1. Verify satisfactory operation of integral locking devices.

### 3.4 SCHEDULES

A. Locker Types and Sizes:
    1. Type B: Double tier 12 x 18 x 36 IN.
    2. Type D: ADA compliant lockers, single tier 15 x 18 x 72 IN.

## END OF SECTION

# SECTION 10 71 13
## EXTERIOR SUN CONTROL DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services required for fabrication and installation of Exterior Sun Control Devices as indicated in the drawings.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
   3. ASTM D2244 Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

B. American Society of Civil Engineers (ASCE):
   1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

C. Provide Exterior Sun Control Devices engineered to support dead, live, and lateral, wind or seismic, loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

### 1.3 SUBMITTALS

A. Product Data:
   1. For each type of material and accessory.

B. Shop Drawings:
   1. Layout and dimensions.
   2. Sections and details indicating profiles.
   3. Connection details and fasteners.
   4. Outline method or systems to isolate dissimilar metals.
   5. Indicate method of compensating for thermal expansion

C. Samples:
   1. Range of anodic finishes.

D. Project Information:
   1. Structural calculations for Exterior Sun Control Devices indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Exterior Sun Control Devices:
   1. Base:
      a. Construction Specialties.
   2. Optional:

a. American Warming and Ventilating
b. The Airolite Company, LLC.
c. Ruskin Manufacturing.

B. Other manufacturers desiring approval comply with Section 01 61 00.

## 2.2 DESIGN CRITERIA

A. Design Exterior Sun Control Devices and anchorage to meet design loads.
1. Wind load: Use the most restrictive of the following:
a. Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
1) Wind pressures defined by Building Code as locally adopted and amended.
b. 40 psf minimum.
2. Snow load: Use the most restrictive of the following:
a. Snow load listed in Design Requirements on Structural Drawings.
b. Snow load defined by Building Code as locally adopted and amended.
c. Adjust both of above snow load values for possible drift conditions.
d. 20 psf minimum.
3. Limit deflection to L/175 and allowable stress with a safety factor of 1.65
a. Comply with local Building Code where more restrictive.

## 2.3 MATERIALS

A. Fixed Shade Units:
1. Provide in maximum panel length.
2. Include supports, anchorage and accessories required for complete assembly.
3. Shades shall be radius curved at areas indicated on drawings.

B. Extruded Aluminum:
1. 6063-T5 alloy and temper per ASTM B221.

C. Sheet Aluminum:
1. 6061-T6 alloy and temper per ASTM B209.

D. Finish:
1. Clear Anodized.
a. Quality: 0.7 mil coating complying with AA-C22A41.

E. Substructure:
1. Cantilever support from curtainwall mullions.

F. Mounting Brackets:
1. Minimum thickness 0.375 inches aluminum plate
2. Design to receive and anchor the outrigger to substructure.

G. Outriggers:
1. Flat bar 0.375 inches thick aluminum or tube
2. 0.081 inches wall profile
3. Configuration:
a. Wedge

H. Fascia:
1. Extruded aluminum.
2. Minimum 0.081 inches wall thickness.
3. Configuration:
a. Bullnose

I. Blades:
1. Extruded aluminum.
2. Minimum 0.081 inches wall thickness

3. Configuration:
   a. Airfoil
4. Size:
   a. 6 inches

J. Connections:
   1. Stainless steel screws.
   2. For tube to tube connection, use shear blocks with mechanical attachment.
   3. Spot weld only where mechanical fastening of parts is not possible.
   4. No exposed perimeter welds acceptable.
   5. Provide a means to isolate dissimilar metals at bolted connections to shear tabs and other locations where dissimilar metals come into contact.
   6. Provide spacers, slotted holes, or other means to compensate for thermal expansion.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify substrate conditions installed under other Sections are acceptable for product installation and in accordance with manufacturer's instructions.

B. Identify unsatisfactory conditions and report them to the Contractor for correction.

C. Installation constitutes acceptance of conditions and responsibility for performance.

### 3.2 INSTALLATION

A. Anchor sunshade to building substructure as indicated on Drawings.

B. Miter sunshade units at corners.

C. Maximum gap between any two components, other than at expansion compensation, shall not exceed 0.0625 inches.

D. Cut and trim units during erection only with the approval of the manufacturer and in accordance with their recommendations. Restore finish completely.

**END OF SECTION**

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# SECTION 10 73 13
## AWNINGS AND CANOPIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services required for fabrication and installation of Awnings and Canopies as indicated in the drawings.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Minimum of 5 years of experience fabricating and installing like systems.

B. Provide Awnings and Canopies engineered to support dead, live, and lateral, wind or seismic, loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include headers and reinforcing members around openings.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

### 1.3 SUBMITTALS

A. Product Data:
   1. For each type of material and accessory.

B. Shop Drawings:
   1. Plans and elevations showing full extent of installation and connections to supporting structural elements.
   2. Details for entire system at typical and unique conditions.

C. Samples:
   1. Fabric for color selection.

D. Project Information:
   1. Structural calculations for Awnings and Canopies indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
      a. Submit concurrent with Shop Drawings.
   2. Manufacturer's installation instructions and recommendations.
   3. Certification of installer qualifications.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Awnings and Canopies:
   1. Base:
      a. Trivantage.
   2. Optional:
      a. Anchor Industries, Inc.
      b. Sunmaster.

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 DESIGN CRITERIA

A. Design Loads:

1. Design anchorage to meet Design Loads.
    a. Wind loads: Use the most restrictive of the following:
        1) Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
        2) Wind pressures defined by Building Code as locally adopted and amended.
        3) 20 psf minimum.
    b. Deflection values: Use the most restrictive of the following:
        1) Limit deflection to values specified for "Uniform Design Load Test".
        2) Limit deflection to comply with Building Code as locally adopted and amended.
        3) Limit deflection to L/175 or 3/4 inches maximum.
        4) Wind Pressures as required by local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
        5) Wind Pressures defined by Building Code as locally adopted and amended.
        6) 40 psf minimum.
2. Snow or Roof Load: Use the most restrictive of the following:
    a. Snow load listed on Design Requirements on Structural Drawings.
    b. Snow load defined by Building Code as locally adopted and amended.
    c. Adjust both of the above snow load values for possible drift conditions.
    d. 20 psf minimum.
3. Limit deflection to L/175 and allowable stress with a safety factor of 1.65
    a. Comply with local Building Code where more restrictive.

B. Thermal Expansion and Structural Movement:
1. Expansion and contraction, caused by changes in surface temperature equal to DT (delta T).
    a. DT for this project: 200 deg F.
    b. Thermal contraction/expansion in this range shall not cause buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.
    c. Operating windows and doors shall function normally over this temperature range.
2. Structural movements of building structure:
    a. Inter-story drift caused by wind or earthquake forces.
        1) h/[_____] or [_____] inches maximum.
    b. Live load deflection of the supporting members.
        1) L/[_____] or [_____] inches maximum.

## 2.3 MATERIAL

A. Frame:
1. Extruded aluminum, square tubing, uniframe.
2. Minimum 2 inches tubes with minimum 0.065 inches walls.
3. Weld and grind smooth.
4. Anodized clear.

B. Canopy Supports:
1. Extruded aluminum, square tubing.
2. Minimum 4 inches tubes with minimum 0.125 inches walls.
3. Weld and grind smooth.
4. Anodized clear.

C. Fabric:
1. 100 percent woven, solution dyed acrylic.
2. Sunmaster, Argonaught or Unitex.

D. Thread: UV resistant, color matched to fabric.

E. Lacing: UV resistant, color matched to fabric.

F. Grommets: Brass.

### 2.4 FABRICATION

A. Prefabricate frames in shop in maximum possible sizes.

B. Fabricate fabric in 1 piece for field installation.
   1. Leave no exposed cut edges.
   2. Double hem edges.
   3. Perform sewing with lockstitch.
   4. Install grommets, nominal 6 inches on-center, evenly spaced.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Start of work constitutes acceptance of conditions and responsibility for performance.

### 3.2 PREPARATION

A. Correct unsatisfactory substrates prior to start of work.

### 3.3 INSTALLATION

A. Install to walls with secure fasteners to withstand design loading.

B. Install posts in sleeves with non-shrink grout and sealant.

C. Attach fabric to frame using aluminum extrusions.

D. Tighten by lacing in place.

### 3.4 CLEANING

A. Just prior to completion, clean as required.

**END OF SECTION**

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# DIVISION 11

**EQUIPMENT**

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# SECTION 11 24 26
## SHOP AND STORAGE EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Shop and storage equipment:
      a. Storage cabinets.
      b. Shelving.
      c. Storage bins.
      d. Storage racks.
      e. Tool storage units.
      f. Work benches.
      g. Shop stools.
      h. Shop desks.
      i. Safety storage cabinets.
      j. Gas cylinder hand trucks.
      k. Step ladders.
      l. Pallet racks.
      m. Drum cradles.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 30, Flammable and Combustible Liquids Code.
   2. Occupational Safety and Health Administration (OSHA).
   3. Manufacturer model numbers listed in this Section establish the minimum construction quality standards and functional requirements.

### 1.3 SYSTEM DESCRIPTION

A. Provide single-source responsibility for equipment listed by this Specification Section.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
      a. Fabrication details and rough-in diagrams.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Samples:
   1. Full range of colors available for Engineer color selection.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. See Section 01 65 50.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Shop and storage equipment:
      a. Lyon Metal Products, Inc.
      b. Equipto.
      c. Republic Storage Systems Company, Inc.
      d. McMaster-Carr.
      e. Curtin Matheson Scientific Company.

B. Not all manufacturers are approved for each item.
   1. See Schedule listed in Article 2.2 EQUIPMENT for listing.

C. Where listed, manufacturer or supplier catalog numbers are taken from the following catalogs:
   1. Lyon Metal Products Inc.: 100-G Catalog.
   2. Equipto: Catalog 802.
   3. McMaster-Carr: Catalog 94.
   4. Curtin Matheson Scientific: 21st Edition.

D. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 EQUIPMENT

A. General:
   1. Items scheduled below are designated SS-1, etc.
      a. For items that are various types and widths such as SS-3, they are designated SS-3a1 for 1 FT deep unit, SS-3a1.5 for 1.5 FT deep unit, etc.
      b. Work benches SS-14 are designated for size such as SS-14a6028 for 60 IN W x 28 IN D size.

B. Schedule of Items: T.B.D.
   1. SS-13 work bench:
      a. Heavy-duty work bench made of steel channels for leg upright and cross members of double thickness for greater strength.
         1) Bench to include steel stringer and 3/4 IN depth shelf.
      b. Finish:
         1) Durable, baked-on enamel in manufacturer's standard color.
         2) Work bench with steel top:
            a) Lyon #2522 (60 x 28 x 34 IN); #2524 (72 x 28 x 34 IN); #2523 (60 x 34 x 34 IN); #2525 (72 x 34 x 34 IN).
            b) Equipto #2323-5 (60 x 29 x 34 IN) #2323-6 (72 x 29 x 34 IN) #2333-5 (60 x 36 x 34 IN) #2333-6 (72 x 36 x 34 IN)
         3) Work bench with laminated hardwood top.
            a) Lyon #2550 (60 x 28 x 34 IN); #2552 (72 x 28 x 34 IN); #2551 (60 x 34 x 34 IN); #2553 (72 x 34 x 34 IN).
            b) Equipto #2323-5W (60 x 29 x 35-1/4 IN); #2323-6W (72 x 29 x 35-1/4 IN); #2333-5W (60 x 36 x 35-1/4 IN); #2333-6W (72 x 36 x 35-1/4 IN).
         4) Furnish work benches with the following accessories:

a) Back and end stops: Heavy-duty back and end stops, 3 IN high at back and end stops that taper to 1-1/2 IN at the front:
b) Lyon #2602 (for 60 x 28 IN bench); #2604 (for 72 x 28 IN bench); #2603 (for 60 x 34 IN bench); #2605 (for 72 x 34 IN bench).
c) Equipto #7402 w/7412 R and 7412 L; (for 60 x 29 IN bench) #7403 w/7412 R and 7412 L; (for 72 x 29 IN bench) #7402 w/7413 R and 7413 L; (for 60 x 36 IN bench) #7403 w/7413 R and 7413 L; (for 72 x 36 IN bench).
d) Shelf riser:
   (1) Heavy-duty steel shelf riser, mounted at back of work bench and attached securely by four bolts.
   (2) Size 12 IN H x 10-1/2 IN D:
e) Lyon #2625 (for bench 60 IN long); #2626 (for bench 72 IN long).
f) Equipto #225-5 (for 60 IN long bench); #226-72 (for 72 IN long bench).
g) Electrical outlet strip:
   (1) Three-wire electrical outlet to be mounted to the back stop.
   (2) Outlet strip capacity to be 15A, 125V.
h) Bench drawers:
   (1) Heavy-duty steel bench drawers.
      (a) Drawers to operate on ball bearing rollers within their own complete case.
      (b) Each drawer to contain automatic stops; sliding drawer tray and padlock attachment.
   (2) Lyon #2789 (21-3/4 IN W x 20 IN D x 6-3/4 IN H).
   (3) Equipto #222 (21-1/2 x 23-3/4 x 7-3/4 IN).

### 2.3 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Furnish Owner two, 12 OZ spray cans of touch-up paint for each equipment color provided.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. Comply with Section 10 14 00 for identification and tagging.

## END OF SECTION

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# SECTION 11 24 27
## SHOP MATERIALS HANDLING EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Shop equipment and furnishings: Materials handling equipment.
      a. Drum and barrel handling equipment.
      b. Hoists and lifting devices for equipment and personnel.
      c. Trucks, forklift and hand, manual and engine powered.
      d. Gantries.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 01 61 03 - Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute/Scaffold Industry Association (ANSI/SIA):
      a. A92.3, Manually Propelled Elevating Aerial Platforms.

B. Standards:
   1. Suppliers' catalog numbers listed establish the minimum fabrication quality and functional features required.

### 1.3 SYSTEM DESCRIPTION

A. Provide single source coordination responsibility.
   1. System shall include but not necessarily be limited to the following:
      a. Materials handling equipment.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Technical information covering the equipment furnished.

B. Warranties: Provide copies of equipment warranties and list of service sources.

C. Certifications:
   1. Where weight or volume capacities are specified, submit certification that equipment provided meets those capacity requirements.
   2. Statement concerning proper startup of equipment.

D. Submit all system components information in a single coordinated transmittal.
   1. Partial submittals will not be accepted.

E. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Hoists and lifting devices (materials):
      a. B E Wallace Products Corp.; Frazer, PA 19355.
      b. C&H Distributors, Inc.
      c. Standard Handling Devices, Inc.
      d. McMaster-Carr Supply Co.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Catalog numbers, where referenced, are taken from the following catalogs:
   1. McMaster - Carr: Catalog 94.
   2. C&H Distributing: Catalog 872.
   3. Allis Chalmers: Catalog MH1150 15M 2/87 BP.
   4. Dynamic Industries: Bulletin 5M1186R.
   5. B E Wallace: Form 418 (6-88).
   6. Ballymore Co.: Catalog 1000.

### 2.2 MINIMUM DESIGN CRITERIA

A. Hoists and Lifting Devices (Equipment)

| CATALOG NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|
| C&H-72-498A | Econo-crane, portable, 500 LB capacity | 1 |
| MH-3248T15 and 3248T25 | Adjusta-base portable hydraulic crane w/extension boom, 2-ton capacity | 1 |
| C&H-72-239AM | Chain hoist, triple spur geared, 1/2 ton capacity, 15 FT lift | 1 |
| C&H-72-242AM | Chain hoist, triple spur geared, 2 ton capacity, 15 FT lift | 1 |
| C&H-72-194D | Lever hoist, heavy duty, 3000 LB capacity, 10 FT lift | 1 |

B. Gantries:
   1. Provide one tri-adjustable steel gantry with aluminum I-Beam.
      a. Furnish Wallace Model #S2T10-A10G.
      b. Rated for 1 ton capacity with a maximum span of 10 FT.
      c. Unit consisting of I-beam, upper main support leg, lower main support leg, leg brace, caster frames, casters and other appurtenances necessary for proper operation.
      d. Adjustable in vertical height, span length, and caster frame spread.
      e. Cable to prevent over spread while adjusting caster frame spread.
      f. Detachable jack kit which enables adjustment of gantry height and caster frame spread.

C. Comply with Section 01 61 03.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Comply with Section 10 14 00 for identification and tagging and for warning or caution signs.

## 3.2 FIELD QUALITY CONTROL

A. For engine-driven equipment covered by this Specification:
   1. Employ and pay for services of equipment manufacturer's field service representative(s) to:
      a. Inspect equipment covered by these Specifications.
      b. Supervise adjustments and installation checks.
      c. Conduct startup of equipment and perform operational checks.
      d. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.
      e. Instruct Owner's personnel for 4 HRS at jobsite on operation and maintenance.

**END OF SECTION**

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# SECTION 11 24 28
MAINTENANCE EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Shop equipment and furnishings: Maintenance equipment.
      a. Hand tools.
      b. Safety tools: Non-sparking, non-magnetic.
      c. Power tools: Pneumatic, electric, and hydraulic.
      d. Calibration and testing equipment.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 01 61 03 - Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. FM Global (FM).

B. Standards:
   1. Manufacturer or supplier catalog or model numbers listed establish the minimum fabrication quality standards and functional requirements.

### 1.3 SYSTEM DESCRIPTION

A. Work identified by this Specification shall be provided as an integrated system.
   1. Provide single source coordination responsibility through the shop equipment and furnishings supplier.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Technical information concerning equipment furnished.

B. Warranties: Provide copies of manufacturer warranty(s).

C. Submit all system components in a single coordinated transmittal.
   1. Partial submittals will not be accepted.

D. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Hand tools:
      a. Snap-On.
      b. MAC.
      c. Proto/Ingersol Rand.
   2. Safety tools; non-sparking, non-magnetic:
      a. Ampco Metals.
      b. Cabot (Berylco).
   3. Power tools:
      a. Snap-On.
      b. Sioux Tools.
      c. Wilton.
      d. Wellsaw.
   4. Calibration and testing equipment:
      a. Jensen Tools Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Catalog or model numbers listed by this Specification are taken from the following catalogs:
   1. Hand tools:
      a. Snap-On: Product Bulletin SS808, SM-B; 88-89 Catalog.
   2. Safety tools:
      a. Ampco Metals: Bulletin ST-11-187.
   3. Power tools:
      a. Snap-On: 88-89 Catalog.
      b. Sioux Tools: Catalog 87I.
   4. Calibration and testing:
      a. Jensen Tools, Inc.: Spring 1988 and Supplement.

### 2.2 MAINTENANCE EQUIPMENT

A. General:
   1. All tools shall be of heavy-duty industrial grade construction.
   2. For safety tools, provide only non-ferrous alloy tools recognized as non-sparking, by the United States Government and FM.

B. Hand Tools:

1. Provide one tool set Snap-On #2272WPEG-B Basic Primary-Secondary Tool Set with industrial finish.
    a. Tool set to consist of the following items:
        1) Pliers:
            a) 7-1/4 IN heavy-duty diagonal cutters.
            b) 8 IN needle nose.
            c) 7-1/2 IN heavy-duty combination.
            d) Retaining ring pliers set-internal and external pliers with assorted tips.
            e) Snap ring pliers set-internal and external pliers with assorted tips.
            f) 7 IN vise grip.
            g) 11 IN vise grip.
        2) Hammers:
            a) 24 OZ compothane.
            b) 32 OZ compothane.
            c) 64 OZ compothane.
            d) 7-1/2 LB compothane sledge.
            e) 16 OZ compothane ball peen.
            f) 8 LB sledge.
        3) Metal working tools:
            a) Punch and chisel set: 23 punches and chisels, chisel gage, holder and kit bag.
            b) Half round file set, four files: 6, 8, 10 and 12 IN long in kit bag.
            c) Mill file set, six files: 6, 8, 10, 12, 14, and 16 IN long in kit bag.
            d) File handle, six each.
            e) Hacksaw frame.
            f) Hacksaw blades, 24 tooth x 12 IN long.
            g) Straight cut shears, 10 IN OA length.
            h) Tinners snips, 12 IN OA length.
            i) Drill bit set 29 bits 1/16 to 1/2 IN.
        4) Threading:
            a) Tap and die set-NF/NC taps and dies 1/4 to 1 IN, die stocks, tap handles, and plastic boxes.
            b) External rethreading tool.
        5) Measuring tools:
            a) Tape measure 12 FT long.
            b) Torqometer, 600 LB FT, 3/4 IN SQ DR.
        6) Screwdrivers:
            a) Standard screwdriver set:
                (1) 3-1/4 IN long.
                (2) 6-1/8 IN long.
                (3) 7-5/16 IN long.
                (4) 10-3/4 IN long.
                (5) 12-3/4 IN long.
            b) Heavy-duty standard screwdriver, 23-13/16 IN long.
            c) Phillips screwdriver set:
                (1) #2 tip, 3-1/4 IN long.
                (2) #1 tip, 6-1/4 IN long.
                (3) #2 tip 7-15/16 IN long.
                (4) #3 tip, 10-3/8 IN long.
                (5) #4 tip, 10-11/16 IN long.
            d) Ratchet and bit set.
            e) Screw starter, 5 IN aluminum handle.
        7) Prybars: 16 IN prybar.
        8) Pullers:
            a) Medium duty puller set: Two and three jaw pullers to 12-1/2 tons capacity with puller storage board.

b) Bearing separator:
   (1) 1/4 to 1-1/8 IN.
   (2) 3/8 to 2-3/8 IN.
   (3) 5/8 to 4-1/2 IN.
   (4) 1-1/2 to 6-1/8 IN.

9) Miscellaneous wrenches:
   a) Hex head wrench set, 20 wrenches, 0.028 to 3/4 IN in a kit bag.
   b) Adjustable wrench set:
      (1) 4 IN long, 1/2 IN jaw capacity.
      (2) 6 IN long, 3/4 IN jaw capacity.
      (3) 8 IN long, 15/16 IN jaw capacity.
      (4) 10 IN long, 1-1/8 IN jaw capacity.
      (5) 12 IN long, 1-5/8 IN jaw capacity.
      (6) 15 IN long, 1-11/16 IN jaw capacity.
   c) Pipe wrench:
      (1) 10 IN.
      (2) 14 IN.
      (3) 18 IN.
      (4) 24 IN.
   d) Hook spanner set:
      (1) 3/4 to 2 IN capacity.
      (2) 1-1/4 to 3 IN capacity.
      (3) 2 to 4-3/4 IN capacity.
      (4) 4-1/2 to 6-1/2 IN capacity, kit bag.
   e) Adjustable pin spanner wrench set:
      (1) 3/4 to 2 IN capacity.
      (2) 1-1/4 to 3 IN capacity.
      (3) 2 to 4-3/4 IN capacity.
      (4) 4-1/2 to 6-1/4 IN capacity, kit bag.
   f) Valve persuader wrench.

10) Open end wrenches:
   a) Open end wrench set:
      (1) 1/8 x 5/16 IN.
      (2) 3/8 x 7/16 IN.
      (3) 1/2 x 9/16 IN.
      (4) 5/8 x 11/16 IN.
      (5) 3/4 x 13/16 IN.
      (6) 7/8 x 15/16 IN.
      (7) 1 x 1-1/16 IN.
      (8) 1-1/8 x 1-3/16 IN.
      (9) 1-1/4 x 1-5/16 IN, kit bag.
   b) Short open end wrench set:
      (1) 3/16 x 7/32 IN.
      (2) 1/4 x 9/32 IN.
      (3) 5/16 x 11/32 IN.
      (4) 3/8 x 7/16 IN.
      (5) 1/2 x 9/16 IN, kit bag.

11) Combination wrenches:
   a) Long handle combination wrench set:
      (1) 3/8 IN.
      (2) 7/16 IN.
      (3) 1/2 IN.
      (4) 9/16 IN.
      (5) 5/8 IN.
      (6) 11/16 IN.

(7) 3/4 IN.
(8) 13/16 IN.
(9) 7/8 IN.
(10) 15/16 IN.
(11) 1 IN.

12) 3/8 IN drive tools:
a) 3/8 IN drive tool set with 12-point sockets:
(1) 1/4 IN.
(2) 5/16 IN.
(3) 11/32 IN.
(4) 3/8 IN.
(5) 7/16 IN.
(6) 1/2 IN.
(7) 9/16 IN.
(8) 5/8 IN.
(9) 11/16 IN.
(10) 3/4 IN.
(11) 13/16 IN.
(12) 7/8 IN.
(13) 15/16 IN.
b) Speeder.
c) Sliding T-handle.
d) Breaker bar.
e) Short shank driver.
f) Ratchet adductor.
g) Ratchet.
h) Ratchet spinner.
i) Universal joint.
j) Extensions:
(1) 2 IN.
(2) 4 IN.
(3) 6 IN.
(4) 12 IN.
k) Flextension: 8 IN.
l) Weatherhead socket:
(1) 3/8 IN.
(2) 7/16 IN.
(3) 1/2 IN.
(4) 9/16 IN.
(5) 11/16 IN.
(6) 3/4 IN.
m) Impact driver set:
(1) Heavy-duty screwdriver: 11/16 IN.
n) Clutch driver:
(1) 3/8 IN.
(2) 19/64 IN.
o) Screwdriver:
(1) 1/4 IN.
(2) 5/16 IN.
(3) 3/8 IN.
p) Hexdriver:
(1) 3/16 IN.
(2) 7/32 IN.
(3) 1/4 IN.
(4) 5/16 IN.

(5) 3/8 IN.

q) Phillips driver:
(1) #2.
(2) #3.
(3) #4.
(4) Long #4.

r) Pozi-drive driver:
(1) 3/8 IN impact socket-6 point.
(2) 7/16 IN impact socket-6 point.
(3) 1/2 IN impact socket-6 point.
(4) 9/16 IN impact socket-6 point.
(5) 5/8 IN impact socket-6 point.
(6) 11/16 IN impact socket-6 point.
(7) 3/4 IN impact socket-6 point.

s) Extra roll pins.

t) Impact driver.

u) Metal box.

13) 1/2 IN drive tools:

a) 1/2 IN drive tool set - standard 12 point sockets:
(1) 3/8 IN.
(2) 7/16 IN.
(3) 1/2 IN.
(4) 9/16 IN.
(5) 5/8 IN.
(6) 11/16 IN.
(7) 3/4 IN.
(8) 13/16 IN.
(9) 7/8 IN.
(10) 15/16 IN.
(11) 1 IN.
(12) 1-1/16 IN.
(13) 1-1/8 IN.
(14) 1-3/16 IN.
(15) 1-1/4 IN.
(16) 1-5/16 IN.

b) Deep 12 point sockets:
(1) 1/2 IN.
(2) 9/16 IN.
(3) 5/8 IN.
(4) 11/16 IN.
(5) 3/4 IN.
(6) 13/16 IN.
(7) 7/8 IN.
(8) 15/16 IN.
(9) 1 IN.
(10) 1-1/16 IN.
(11) 1-1/8 IN.

c) Flex 6 point sockets:
(1) 9/16 IN.
(2) 5/8 IN.
(3) 11/16 IN.
(4) 3/4 IN.
(5) 13/16 IN.
(6) 7/8 IN.
(7) 15/16 IN.

d) Ratchet spinner.
e) Speeder 19-1/2 IN long.
f) Universal joint.
g) Sliding T-handle.
h) Ratchet adductor.
i) Ratchet 10 IN long.
j) Breaker bar.
k) Extensions:
(1) 2 IN.
(2) 5 IN.
(3) 10 IN.

14) Miscellaneous tools and shop equipment:
a) Standard wire brush.
b) Barlow knife.
c) Mechanical pick-up tool.
d) Parts washer.
e) Extractor set.
f) Flashlight.
g) Safety goggles.
h) Chisel edge scraper.
i) Magnetic pick-up tool.
j) Tote tray.
k) Heavy-duty roll cab.

2. Provide one tool set Snap-On #2532WPEG-B Master Primary-Secondary Tool Set with industrial finish.
a. Tool set to consist of the following items:
1) Pliers:
a) 7 IN lineman's pliers.
b) 7-1/2 IN heavy-duty diagonal cutters.
c) 9-1/4 IN adjustable joint pliers.
d) 8 IN needle nose pliers.
e) 7-1/2 IN heavy-duty combination pliers.
f) 7-15/16 IN pin gripping pliers.
g) 20 IN adjustable joint pliers.
h) 15-11/16 IN internal snap ring pliers.
i) 15-11/16 IN external snap ring pliers.
j) Retaining ring pliers set, internal and external pliers with assorted tips.
k) Snap ring pliers set-internal and external pliers with assorted tips.
l) 7 IN vise grip pliers.
m) 10 IN vise grip pliers.
n) 11 IN vise grip pliers.
o) 5 IN vise grip with wire cutter.

2) Hammers:
a) 24 OZ compothane.
b) 32 OZ compothane.
c) 48 OZ compothane.
d) 7-1/2 LB compothane sledge.
e) 8 OZ compothane ball peen.
f) 16 OZ compothane ball peen.
g) 32 OZ compothane ball peen.
h) 40 OZ compothane ball peen.
i) 20 OZ claw.
j) 8 LB sledge.

3) Metal working tools:
a) Punch and chisel set: 23 punches and chisels, chisel gage, holder and kit bag.

b) Half round file set, four files: 6, 8, 10, and 12 IN long in kit bag.
c) Mill file set, six files: 6, 8, 10, 12, 14, and 16 IN long in kit bag.
d) Round file set, four files: 6, 8, 10 and 12 IN long in kit bag.
e) File handle, six each.
f) Hacksaw frame.
g) Hacksaw blades: 24 tooth x 12 IN long.
h) Straight cut shears: 10 IN OA length.
i) Tinners snips: 12 IN OA length.
j) Drill bit set - 29 bits 1/16 to 1/2 IN.
k) 10 IN bench grinder 1 HP, 115/230 V, 50/60 HZ.

4) Threading tools: Tap and die set-NF/NC taps and dies 1/4 to 1 IN, die stocks, tap handles and plastic boxes; external rethreading tool.
5) Tubing tools:
   a) Tube cutting and double flaring set.
   b) Single flaring tool.
   c) Tube cutter.
6) Measuring tools:
   a) Micrometer set, 4 micrometers, 0-1 IN, 1-2 IN, 2-3 IN, 3-4 IN and 3 test gages.
   b) Dial caliper, 0-6 IN capacity in 0.001 grad.
   c) Feeler gage, 19 1/2 x 12 IN gages in sizes 0.0025 IN, 0.003 through 0.020 IN in 0.001 IN grad.
   d) Tape measure: 12 FT long.
   e) Torqometer 600 LB-FT 3/4 IN SW DR.
7) Screwdrivers:
   a) Standard screwdriver set:
      (1) 3-1/4 IN long.
      (2) 6-1/8 IN long.
      (3) 7-15/16 IN long.
      (4) 10-3/4 IN long.
      (5) 12-3/4 IN long.
   b) Heavy-duty standard screwdriver: 23-13/16 IN long.
   c) Short standard screwdriver: 4-3/4 IN long.
   d) Magnetic tip screwdriver.
   e) Miniature screwdriver set.
   f) Phillips screwdriver set:
      (1) #2 tip 3-1/4 IN long.
      (2) #1 tip, 6-1/4 IN long.
      (3) #2 tip, 7-15/16 IN long.
      (4) #3 tip, 10-3/8 IN long.
      (5) #4 tip, 10-11/16 IN long.
   g) Ratchet and bit set.
   h) Screw starter, 5 IN aluminum handle.
   i) Screw starter set:
      (1) 2-5/8 IN long.
      (2) 7-5/8 IN long.
      (3) 8-7/8 IN long.
8) Prybars: 16 IN prybar, 22 IN pinchbar, 42 IN pinchbar, 60 IN slatbar.
9) Pullers:
   a) Light-duty puller set, two and three jaw pullers to 2-1/2 tons capacity.
   b) Medium-duty puller set, two and three jaw pullers to 12-1/2 tons capacity with puller storage board.
   c) Industrial puller set.
   d) Bearing separator:
      (1) 1/4 to 1-1/8 IN.

(2) 3/8 to 2-3/8 IN.
(3) 5/8 to 4-1/2 IN.
(4) 1-1/2 to 6-1/8 IN.
(5) 1-1/4 to 8-3/4 IN.

10) Miscellaneous wrenches:
    a) Strap wrench:
        (1) 1 to 5 IN capacity.
        (2) 1 to 6 IN capacity.
    b) Chain wrench 24 IN handle, 6 IN capacity.
    c) Hexhead wrench set, 20 wrenches 0.028 to 3/4 IN in a kit bag.
    d) Adjustable wrench set:
        (1) 4 IN long 1/2 IN jaw capacity.
        (2) 6 IN long 3/4 IN jaw capacity.
        (3) 8 IN long 15/16 IN jaw capacity.
        (4) 10 IN long 1-1/8 IN jaw capacity.
        (5) 12 IN long 1-5/8 IN jaw capacity.
        (6) 15 IN long 1-11/16 IN jaw capacity.
    e) Pipe wrench:
        (1) 10 IN.
        (2) 14 IN.
        (3) 18 IN.
        (4) 24 IN.
        (5) 36 IN.
    f) Internal pipe wrench set:
        (1) 3/8 IN capacity.
        (2) 3/4 IN capacity.
        (3) 1/2 IN capacity.
        (4) 1 IN capacity.
    g) Hook spanner set:
        (1) 3/4 IN to 2 IN capacity.
        (2) 1-1/4 to 3 IN capacity.
        (3) 2 to 4-3/4 IN capacity.
        (4) 4-1/2 to 6-1/2 IN capacity, kit bag.
    h) Adjustable pin spanner wrench set:
        (1) 3/4 to 2 IN capacity.
        (2) 1-1/4 to 3 IN capacity.
        (3) 2 to 4-3/4 IN capacity.
        (4) 4-1/2 to 6-1/4 IN capacity, kit bag.
    i) Valve persuader wrench.

11) Open end wrenches:
    a) Open end wrench set:
        (1) 1/4 x 5/16 IN.
        (2) 3/8 x 7/16 IN.
        (3) 1/2 x 9/16 IN.
        (4) 5/8 x 11/16 IN.
        (5) 3/4 x 13/16 IN.
        (6) 7/8 x 15/16 IN.
        (7) 1 x 1-1/16 IN.
        (8) 1-1/8 x 1-3/16 IN.
        (9) 1-1/4 x 1-5/16 IN, kit bag.
    b) Angle head open end wrench set:
        (1) 1/4 IN.
        (2) 5/16 IN.
        (3) 3/8 IN.
        (4) 7/16 IN.

(5) 1/2 IN.
(6) 9/16 IN.
(7) 5/8 IN.
(8) 11/16 IN.
(9) 3/4 IN.
(10) 13/16 IN.
(11) 7/8 IN.
(12) 15/16 IN.
(13) 1 IN.
(14) 1-1/16 IN.
(15) 1-1/8 IN.
(16) 1-3/16 IN.
(17) 1-1/4 IN.
(18) 1-5/16 IN.
(19) 1-3/8 IN.
(20) 1-7/16 IN.
(21) 1-1/2 IN.
(22) 1-5/8 IN.
(23) 1-11/16 IN.
(24) 1-3/4 IN.
(25) 1-13/16 IN.
(26) 1-7/8 IN.
(27) 2 IN.

c) Short open end wrench set:
(1) 3/16 x 7/32 IN.
(2) 3/8 x 7/16 IN.
(3) 1/4 x 9/32 IN.
(4) 1/2 x 9/16 IN.
(5) 5/16 x 11/32 IN, kit bag.

12) Combination wrenches:
a) Short standard combination wrench set:
(1) 5/16 IN.
(2) 11/32 IN.
(3) 3/8 IN.
(4) 7/16 IN.
(5) 1/2 IN.
(6) 9/16 IN.
(7) 5/8 IN.
(8) 11/16 IN.
(9) 3/8 IN, kit bag.

b) Long handle combination wrench set:
(1) 5/16 IN.
(2) 3/8 IN.
(3) 7/16 IN.
(4) 1/2 IN.
(5) 9/16 IN.
(6) 5/8 IN.
(7) 11/16 IN.
(8) 3/4 IN.
(9) 13/16 IN.
(10) 7/8 IN.
(11) 15/16 IN.
(12) 1 IN.
(13) 1-1/16 IN.
(14) 1-1/8 IN.

(15) 1-3/16 IN.
(16) 1-1/4 IN.
(17) 1-5/16 IN.
(18) 1-3/8 IN.
(19) 1-7/8 IN.
(20) 1-1/2 IN.
(21) 1-9/16 IN.
(22) 1-5/8 IN.

c) Combination wrench:
(1) 1-3/4 IN.
(2) 1-13/16 IN.
(3) 1-7/8 IN.
(4) 2 IN.

13) 1/4 IN drive tools:
a) 1/4 IN drive tool set with standard and deep 6 point.
b) Sockets:
(1) 3/16 IN.
(2) 7/32 IN.
(3) 1/4 IN.
(4) 9/32 IN.
(5) 5/16 IN.
(6) 11/32 IN.
(7) 3/8 IN.
(8) 7/16 IN.
(9) 1/2 IN.
(10) 9/16 IN.
c) Long shank driver.
d) Breaker bar.
e) Flextension 6 IN.
f) Ratchet adductor.
g) Ratchet.
h) Socket screwdriver.
i) 1/4 IN double square socket.
j) 5/16 IN double square socket.
k) 3/8 IN double square socket.
l) Ratchet spinner.
m) Extension:
(1) 2 IN.
(2) 4 IN.
(3) 6 IN.
n) Metal box.

14) 3/8 IN drive tools:
a) Standard 12 point sockets:
(1) 1/4 IN.
(2) 5/16 IN.
(3) 11/32 IN.
(4) 3/8 IN.
(5) 7/16 IN.
(6) 1/2 IN.
(7) 9/16 IN.
(8) 5/8 IN.
(9) 11/16 IN.
(10) 3/4 IN.
(11) 13/16 IN.
(12) 7/8 IN.

(13) 15/16 IN.

b) Deep 12 point sockets:
   (1) 1/4 IN.
   (2) 5/16 IN.
   (3) 3/8 IN.
   (4) 7/16 IN.
   (5) 1/2 IN.
   (6) 9/16 IN.
   (7) 5/8 IN.
   (8) 11/16 IN.
   (9) 3/4 IN.
   (10) 13/16 IN.
   (11) 7/8 IN.

c) Flex 12 point sockets 5/16 IN.
   (1) 3/8 IN.
   (2) 7/16 IN.
   (3) 1/2 IN.
   (4) 9/16 IN.
   (5) 5/8 IN.
   (6) 11/16 IN.
   (7) 3/4 IN.
   (8) 13/16 IN.
   (9) 7/8 IN.
   (10) 15/16 IN.

d) Speeder.

e) Sliding T-handle.

f) Breaker bar.

g) Short shank driver.

h) Ratchet adductor.

i) Ratchet.

j) Ratchet spinner.

k) Universal joint.

l) Extension:
   (1) 2 IN.
   (2) 4 IN.
   (3) 6 IN.
   (4) 12 IN.

m) Flextension:
   (1) 8 IN.
   (2) 5/16 IN.

n) Power socket, 6 point:
   (1) 11/32 IN.
   (2) 3/8 IN.
   (3) 7/16 IN.
   (4) 1/2 IN.
   (5) 9/16 IN.
   (6) 5/8 IN.

o) Weatherhead socket:
   (1) 7/16 IN.
   (2) 1/2 IN.
   (3) 9/16 IN.
   (4) 11/16 IN.
   (5) 3/4 IN.

p) Impact driver set:
   (1) Heavy-duty screwdriver: 11/16 IN.

(2) Clutch driver:
    (a) 3/8 IN.
    (b) 19/64 IN.
(3) Screwdriver:
    (a) 1/4 IN.
    (b) 5/16 IN.
    (c) 3/8 IN.
(4) Hex driver:
    (a) 3/16 IN.
    (b) 7/32 IN.
    (c) 1/4 IN.
    (d) 5/16 IN.
    (e) 3/8 IN.
(5) Phillips driver:
    (a) #2.
    (b) #3.
    (c) #4.
    (d) #4.
(6) Pozi-drive driver:
    (a) 3/8 IN impact socket 6 point.
    (b) 7/16 IN impact socket 6 point.
    (c) 1/2 IN impact socket 6 point.
    (d) 9/16 IN impact socket 6 point.
    (e) 5/8 IN impact socket 6 point.
    (f) 11/16 IN impact socket 6 point.
    (g) 3/4 IN impact socket 6 point.
(7) Extra roll pins.
(8) Impact driver, metal box.

15) 1/2 IN drive tools:
a) 1/2 IN drive tool set with standard 12 point sockets:
    (1) 3/8 IN.
    (2) 7/16 IN.
    (3) 1/2 IN.
    (4) 9/16 IN.
    (5) 5/8 IN.
    (6) 11/16 IN.
    (7) 3/4 IN.
    (8) 13/16 IN.
    (9) 7/8 IN.
    (10) 15/16 IN.
    (11) 1 IN.
    (12) 1-1/16 IN.
    (13) 1-1/8 IN.
    (14) 1-3/16 IN.
    (15) 1-1/4 IN.
    (16) 1-5/16 IN.
b) Deep 12 point sockets:
    (1) 1/2 IN.
    (2) 9/16 IN.
    (3) 5/8 IN.
    (4) 11/16 IN.
    (5) 3/4 IN.
    (6) 13/16 IN.
    (7) 7/8 IN.
    (8) 15/16 IN.

(9) 1 IN.
(10) 1-1/16 IN.
(11) 1-1/8 IN.

c) Flex 6 point sockets:
(1) 9/16 IN.
(2) 5/8 IN.
(3) 11/16 IN.
(4) 3/4 IN.
(5) 13/16 IN.
(6) 7/8 IN.
(7) 15/16 IN.

d) Ratchet spinner.
e) Speeder: 19-1/2 IN long.
f) Universal joint.
g) Sliding T-handle.
h) Ratchet adductor.
i) Ratchet 10 IN long.
j) Breaker bar.
k) Extensions:
(1) 2 IN.
(2) 5 IN.
(3) 10 IN.

16) 3/4 IN drive tools:
a) 3/4 IN drive heavy duty tool set with 12 point sockets:
(1) 3/4 IN.
(2) 16 IN.
(3) 7/8 IN.
(4) 15/16 IN.
(5) 31/32 IN.
(6) 1 IN.
(7) 1-1/16 IN.
(8) 1-1/8 IN.
(9) 1-3/16 IN.
(10) 1-1/4 IN.
(11) 1-5/16 IN.
(12) 1-3/8 IN.
(13) 1-7/16 IN.
(14) 1-1/2 IN.
(15) 1-9/16 IN.
(16) 1-5/8 IN.
(17) 1-11/16 IN.
(18) 1-3/4 IN.
(19) 1-13/16 IN.
(20) 1-7/8 IN.
(21) 2 IN.
(22) 2-1/16 IN.
(23) 2-1/8 IN.
(24) 2-3/16 IN.
(25) 2-1/4 IN.
(26) 2-3/8 IN.

b) Extensions:
(1) 3 IN.
(2) 8 IN.
(3) 16 IN.

c) Sliding head.

d) Breaker bar head.
e) Ratchet head.
f) 20 IN handle for heads.
g) Universal joint.
h) Ratchet adductor.
i) Metal box.
j) Impact socket set 6 point:
(1) 9/16 IN.
(2) 5/8 IN.
(3) 11/16 IN.
(4) 3/4 IN.
(5) 13/16 IN.
(6) 7/8 IN.
(7) 15/16 IN.
(8) 1 IN.
(9) 1-1/16 IN.
(10) 1-1/8 IN.
(11) 1-3/16 IN.
(12) 1-1/4 IN.
(13) 1-5/16 IN.
(14) 1-3/8 IN.
(15) 1-7/16 IN.
(16) 1-1/2 IN.
(17) 1-9/16 IN.
(18) 1-5/8 IN.
(19) 1-11/16 IN.
(20) 1-3/4 IN.
(21) 1-13/16 IN.
(22) 1-7/8 IN.
(23) 2 IN.
(24) 2-1/16 IN.
(25) 2-3/16 IN.
(26) 2-1/4 IN.
(27) 2-3/8 IN.
k) Impact extensions:
(1) 7 IN.
(2) 10 IN.
(3) 13 IN.

17) Pneumatic tools:
a) Pneumatic gasket scraper.
b) 3/8 IN pneumatic drill.
c) 1/2 IN pneumatic drill.
d) 1/2 IN drive impact wrench set with 6 point sockets:
(1) 3/8 IN.
(2) 7/16 IN.
(3) 1/2 IN.
(4) 9/16 IN.
(5) 5/8 IN.
(6) 11/16 IN.
(7) 3/4 IN.
(8) 13/16 IN.
(9) 7/8 IN.
(10) 15/16 IN.
(11) 1 IN.
e) 1/2 IN drive impact wrench.

f) Plastic box.
g) 3/4 IN drive impact wrench.
h) Air hammer set:
(1) Air hammer.
(2) Panel cutter.
(3) Ripper bit.
(4) Muffler cutter.
(5) Flat chisel.
(6) Plastic case.
(7) 5 FT whip hose (5 each).
(8) 50 FT air hose (3 each).

18) Miscellaneous shop tools and equipment:
a) Awl.
b) Standard wire brush.
c) 20-ton hydraulic press.
d) Extension light.
e) 50 FT extension cord.
f) Inspection mirror.
g) Mechanics stethoscope.
h) Barlow knife.
i) Mechanical pick-up tool.
j) Inspection light.
k) Parts washer.
l) Extractor set.
m) Flashlight.
n) Safety goggles.
o) Mechanics creeper.
p) Nut splitter.
q) Oiler set.
r) Putty knife.
s) Chisel edge scraper.
t) Magnetic pick-up tool.
u) Gasket punch set.
v) Soldering gun set.
w) Wet/dry vacuum.
x) Tote tray.
y) Heavy-duty roll cab/bench.

C. Safety Tools; Non-Sparking, Non-Magnetic:
1. General:
a. Provide only tools produced from non-ferrous alloys approved for non-sparking use by the United States Government and FM.
2. Provide one tool kit, Ampco M-50 Tool Kit; consisting of the following items:
a. One hexagon wrecking bar 36 IN OA x 7/8 IN.
b. Adjustable wrench, one each:
1) 10 IN.
2) 12 IN.
3) 15 IN.
c. Ball peen hammer, one each:
1) 1 LB.
2) 2 LB.
d. Three scaling hammers: 1 LB.
e. One sledge hammer: 5 LB.
f. Three deck scrapers: 12 IN overall.
g. Three scraper blades: 4 IN wide.

h. Three ship scrapers: 4 IN triangular blade.
i. Standard screwdriver, one each:
   1) 8 IN blade.
   2) 12 IN blade.
j. Two scoop shovels: "D" handle.
k. Cold chisel, one each:
   1) 5/8 x 6-1/2 x 3/4 IN.
   2) 7/8 x 8 x 1 IN.
l. Pipe wrench, one each:
   1) 10 IN.
   2) 14 IN.
   3) 18 IN.
m. One wood case.

3. Provide one tool kit Ampco M-49 Tool kit; consisting of the following items:
   a. 5/16 x 3/8 IN 12 point box wrench.
   b. 7/16 x 1/2 IN 12 point box wrench.
   c. 9/16 x 5/8 IN 12 point box wrench.
   d. 3/4 x 7/8 IN 12 point box wrench.
   e. 7 1/2 IN Phillips screwdriver.
   f. 9 3/4 IN screwdriver.
   g. 10 IN adjustable wrench.
   h. 6 1/2 combination pliers.
   i. 8 IN combination pliers.
   j. 9 1/2 IN groove joint pliers.
   k. Knife 3 1/8 IN blade.
   l. 7-1/2 IN putty knife.
   m. #2 claw hammer.
   n. 14 IN pipe wrench.
   o. 3 x 8 IN shoe handle brush.
   p. 12 IN deck scraper, 1-7/8 IN blade.
   q. 6 x 6 x 18 IN metal box.

D. Power Tools (Pneumatic, Electric, Hydraulic):
   1. Snap-On 1M-5123, air wrench set, 1/2 drive; one each.
   2. Snap-On FAR7012C, air ratchet set, 3/8 IN drive; one each.
   3. Snap-On CG-473-HY, hydraulic press set, 20-ton cap; one each.
   4. Snap-On YA226, hydraulic hand jack, 3-ton cap; one each.
   5. Snap-On YA228, hydraulic hand jack, 8 ton cap; one each.
   6. Snap-On YA657, hydraulic service jack, 8,000 LB capacity; one each.
   7. Wilton 15 IN vari-speed.
      a. Drill press, 1/2 IN chuck, industrial type with minimum 1/2 HP drive motor, instant speed selection from 400 to 5000 RPM; one each.
   8. Sioux #8040, drill; heavy duty reversible, 3/8 IN chuck; one each.
   9. Sioux #8100, drill; heavy duty, reversible 1/2 IN chuck; one each.
   10. Wellsaw Model 600, metal cutting band saw, 6 IN round stock capacity, heavy duty cast iron frame and I-beam construction, 1/2 HP drive; one each.
      a. Provide unit complete with motor, pulleys, and two each 8, 10, and 14 tooth/IN blades.

E. Calibration and Testing Equipment:
   1. Jensen J317B860 Digital Multimeter; fluke 8060A with J317B090 case; one each.
   2. Jensen J137B893 Digital Photo Tachometer; one (1) each.
   3. Jensen J50B171 Simpson 260(-7) Heavy-Duty Multimeter with overload protection and J50B818 case; one each.
   4. Jensen J56B240 Ammeter Set; one each.
   5. Jensen J310B225 Tektronix 2225 50 MHz Oscilloscope; one each.

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

# SECTION 11 52 13
## PROJECTION SCREENS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Projection Screens in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Experienced and qualified technicians to install projection screens.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Indicate location, size, mounting, and operation of each screen; elevation of each kind of screen; location and extent of additional support; and other pertinent data.
   2. Indicate relation to ceiling where applicable.
   3. Indicate location and requirements for electrical connections where applicable.

B. Product Data:
   1. Provide manufacturer's technical data for each type of screen including functional description and construction of specified components.

C. Contract Closeout Information:
   1. Operation and Maintenance Data.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Projection screens:
   1. Base:
      a. Da-Lite Screen.
   2. Optional :
      a. Draper Shade and Screen.

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 MATERIALS

A. Components of each type of screen by same manufacturer.

B. Projection screen, manual:
   1. Unit for wall or ceiling surface mounting as indicated.
   2. White powder coated metal case, with mounting brackets.
   3. Mount top of screen fabric on roller with permanent roller lock or other pull-down limit. Form bottom of fabric into pocket enclosing tubular steel bar.
   4. Screen: Flame and mildew resistant, Matte White surface with black border.
   5. Controlled Screen Return feature.
   6. Da-Lite, Model B.
   7. Size: TBD inches by TBD inches.

C. Projection screen, manual:
   1. Unit for recessed ceiling mounting housed in extruded aluminum case, with mounting brackets.
   2. Mount top of screen fabric on roller with permanent roller lock or other pull-down limit. Form bottom of fabric into pocket enclosing tubular steel bar.
   3. Screen: Flame and mildew resistant, Matte White surface with black border.
   4. Da-Lite, Advantage Manual.
   5. Size: TBD.

D. Projection screens, motor operated:
   1. Unit for surface wall or ceiling mounting as indicated.
   2. Mount top of screen fabric to metal roller supported on brackets with self-aligning bearings.
   3. Screen case: White powder coated metal case, with mounting brackets.
   4. Screen Operation: Electrically operated, retractable, heavy duty, with rigid metal roller.
   5. Motor: Size and capacity recommended by manufacturer.
   6. UL listed.
   7. Instant reversing, gear drive motor with permanently lubricated ball bearings, automatic thermal overload protection.
   8. Controls: Limit switches to automatically stop screen in up and down position. 3-button control switch (up, down, and stop) in box with cover plate for flush wall-mounting.
   9. Screen: Flame and mildew resistant, Matte White surface with black border.
   10. Da-Lite, Cosmopolitan Electrol.
   11. Size: TBD.

E. Projection screens, motor operated, recessed:
   1. Unit for recessed ceiling mounting.
   2. Mount top of screen fabric to metal roller supported on brackets with self-aligning bearings.
   3. Screen case: White extruded aluminum case, with mounting brackets.
   4. Bottom of case fitted with aluminum door on concealed hinges to open and close automatically with lowering and raising of screen.
   5. Screen Operation: Electrically operated, retractable, heavy duty, with rigid metal roller.
   6. Motor: Size and capacity recommended by manufacturer.
   7. UL listed.
   8. Instant reversing, gear drive motor with permanently lubricated ball bearings, automatic thermal overload protection.
   9. Controls: Limit switches to automatically stop screen in up and down position. 3-button control switch (up, down, and stop) in box with cover plate for flush wall-mounting.
   10. Screen: Flame and mildew resistant, Matte White surface with black border.
   11. Da-Lite, Advantage Deluxe Electrol.
   12. Size: TBD.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions under which units are to be installed.

B. Proceed with installation only after unacceptable conditions have been remedied.

C. Installation constitutes acceptance of responsibility for performance.

### 3.2 INSTALLATION

A. Install projection screens in accordance with reviewed shop drawings at locations and heights indicated in the drawings.

B. Provide manufacturer's brackets , hanging devices, or both as required by installation indicated.

C. Install screen housing in conjunction with ceiling system.

D. Securely install screens plumb and level to supporting substrate.

## 3.3 FIELD QUALITY CONTROL

A. Inspection and Testing: Operate each screen three (3) times to ensure viewing surfaces extend and retract through full range of motion and operate as intended.

## 3.4 PROTECTION

A. Protect manually operated projection screens from damage during construction.

B. Repair damage to adjacent materials caused by manually operated projection screen work.

## 3.5 CONTRACT CLOSEOUT

A. Perform demonstration and instruction for Owner's representative.

**END OF SECTION**

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# SECTION 11 53 11
## LABORATORY GLASSWARE, EQUIPMENT AND REFERENCES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Laboratory glassware, equipment, and references.
      a. Purchase, delivery, and inventory of general laboratory glassware.
      b. Purchase, delivery, and installation of laboratory equipment.
      c. Purchase, delivery, and inventory of laboratory references.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Catalog and/or model numbers are provided to establish the minimum quality and functional requirements.

### 1.3 SYSTEM DESCRIPTION

A. Items identified in this Section shall be provided by a single source.
   1. Provide single source coordination responsibility for all glassware, equipment and references.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Submit all laboratory glassware, equipment and reference information in a single coordinated transmittal.
   1. Partial submittals will not be accepted.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of glassware and installation of laboratory equipment with laboratory casework installation.
   1. Laboratory casework to be complete prior to delivery of glassware, equipment and reference materials to facility laboratory.

B. Notify the Engineer at least 30 days prior to intended date of delivery of glassware, equipment and reference materials to the facility laboratory.
   1. Upon delivery, provide and pay for the services of the laboratory Equipment Supplier to work with the Owner's Designated Representative to inventory the delivered material.
   2. Remove from the Project site any items found to be damaged, broken or not in conformance with this Specification Section, and replace at no cost to the Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Glassware:
      a. Corning Glass Works.
      b. Kimble Glass.
   2. Porcelain ware:
      a. Coors.
   3. Plasticware:
      a. Nalge Co.
   4. Balances and scales:
      a. Mettler Instrument Corp.
      b. Ohaus Scale Corp.
   5. Filtration equipment:
      a. Gelman Instrument Corp.
      b. Millipore Corp.
   6. Gas testing and safety:
      a. Mine Safety Appliance Co.
   7. Heating equipment:
      a. Precision Scientific.
      b. Thermolyne Corp.
   8. Incubators and refrigerators:
      a. Precision Scientific Co.
      b. Lab-Line Instruments Inc.
   9. Instrumentation:
      a. Orion Research Inc.
      b. Yellow Springs Instrument.
      c. Cole Parmer Instrument Co.
      d. Hach Chemical Co.
   10. Distillation and water purification:
      a. Barnstead.
      b. Millipore.
      c. Calgon.

### 2.2 MATERIALS

A. All glassware shall be Pyrex or Kimax.

### 2.3 LABORATORY GLASSWARE AND APPARATUS

A. General:
   1. Catalog numbers are listed for convenience and to establish functional and quality requirements.
   2. Supplier catalogs numbers are identified by the following prefixes:
      a. CGW - Corning Glass Works.
      b. CMS - Curtin Matheson Scientific.
      c. CPR - Cole Parmer Instrument Co.
      d. FIS - Fisher Scientific Co.; www.fishersci.com.
      e. GEL - Gelman Instrument Co.
      f. HAC - HACH Chemical Co; www.hach.com.
      g. TML - Thermolyne Corp.
      h. VWR - VWR Scientific Inc.
      i. REP - Raven Environmental Products, www.ravenep.com
   3. Quantities are listed after the catalog number and description of the item(s).

B. Chemical Conditioning and Flocculation Tests:

| | | |
|---|---|---|
| FIS-15-433-721 | Phipps & Bird PB-900, Programmable Jar Tester, 6 Place, Square Acrylic Jars | 1 |

C. pH Measurement:

| | | |
|---|---|---|
| HAC-8508600 | HQ440d Benchtop Meter Package with PHC281 pH Ultra Electrode | 1 |

D. Suspended Solids Analysis:

| | | |
|---|---|---|
| FIS-14-557-400 | Analytical Balance, Electronic: Sartorius, SECURA-124-1S | 1 |
| HAC- 1352900 | Magnetic Filter Funnel, 47 MM | 3 |
| HAC-2486150 | Filter Funnel Vacuum Manifold | 1 |
| HAC-2551456 | Glass Fiber Filters, AE Grade, 47 MM, package of 100 | 10 |
| FIS-10-180E | Filtering Flask, 500 mL | 4 |
| FIS-10-180F | Filtering Flask, 1,000 mL | 4 |
| FIS-S-02123A | Desiccator Cabinet | 1 |
| FIS-02-214B | Reference Weight Set | 1 |

E. Total Solids Analysis:

| | | |
|---|---|---|
| FIS-FB--968D | Evaporating Dish, 120 mL, pack of 6 | 1 |
| FIS- 968E | Evaporating Dish, 150 mL, pack of 6 | 1 |
| FIS-968F | Evaporating Dish, 250 mL, pack of 6 | 1 |
| FIS-01-920-230 | Moisture Determination Balance, Ohaus MB23 | 1 |
| FIS-01-910-362 | Electronic Top Loading Balance, | 1 |

F. Turbidity Analysis:

| | | |
|---|---|---|
| HAC-18900-00 | HACH 18900 Ratio Turbidimeter | 1 |

G. Laboratory Glassware and Supplies:

| | | |
|---|---|---|
| FIS-01-351 | Apron, Student | 2 |
| CMS-094-441 | Aspirator, Filter Pump (Nalgene 6140) | 2 |
| CGW-1000-50 | Beaker, 50 mL, Pyrex,package of 6 | 1 |
| CGW-1000-100 | Beaker, 100 mL, Pyrex, package of 6 | 1 |
| CGW-1003-150 | Beaker 150 mL, Heavy Duty Pyrex, package of 6 | 1 |
| CGW-1003-250 | Beaker, 250 mL, Heavy Duty Pyrex, package of 6 | 1 |

| | | |
|---|---|---|
| CGW-1003-400 | Beaker, 400 mL, Heavy Duty Pyrex, package of 6 | 1 |
| CGW-1003-600 | Beaker, 600 mL, Heavy Duty Pyrex, package of 6 | 1 |
| CGW-1003-1L | Beaker, 1000 mL, Heavy Duty Pyrex, package of 6 | 6 |
| CGW-1595-5 | Bottle, Solution, 19 L | 2 |
| FIS-925-138 | Bottle, Polypropylene, 125 mL, case of 72 | 1 |
| FIS-925-139D | Bottle, Polypropylene, 250 mL, case of 72 | 1 |
| FIS-925-140 | Bottle, Polypropylene, 500 mL, case of 48 | 1 |
| FIS-925-141 | Bottle, Polypropylene, 1000 mL, case of 24 | 1 |
| FIS-02-926-976 | Bottle, Wheaton, 250 mL, case of 12 | 1 |
| FIS-02-926-978 | Bottle, Wheaton, 500 mL, case of 12 | 1 |
| FIS-02-923-5E | Bottle, Amber Polyethylene, 500 mL, pack of 12 | 1 |
| FIS-02-923-5F | Bottle, Amber Polyethylene, 1000 mL,pack of 6 | 1 |
| FIS-02-926979 | Bottle, Wheaton, 1000 mL, case of 12 | 1 |
| FIS-03-311-1A | Bottle, Polyethylene, Heavy Duty, 125 mL, pack of 6 | 1 |
| FIS-03-311-1B | Bottle, Polyethylene, Heavy Duty, 250mL, pack of 6 | 1 |
| FIS-03-311-1C | Bottle Polyethylene, Heavy Duty, 500 mL, pack of 4 | 1 |
| FIS-03-309-1G | Bottle, Polyethylene, Heavy Duty, 2000 mL, pack of 6 | 1 |
| FIS-03-409-22C | Bottle, Wash, 500 mL, pack of 6 | 1 |
| FIS-02-963-10A | Bottle, Polyethylene Spigot, 2 GAL | 2 |
| FIS-02-963-10C | Bottle, Polyethylene Spigot, 5 GAL | 2 |
| HAC-591-00 | Bottle, Pipette, HACH | 4 |
| FIS-03-536 | Brush, White Nylon Bristle | 1 |
| FIS-03-545 | Brush, Beaker | 1 |
| FIS-03-560 | Brush, Funnel/Graduate | 1 |
| FIS-03-565 | Brush, Flask | 1 |
| FIS-03-570A | Brush, Flask | 1 |
| FIS-03-608 | Brush, Centrifuge Tube | 1 |
| FIS-03-614 | Brush, Buret | 1 |
| FIS-03-625 | Brush, Pipette | 2 |
| FIS-03-636 | Brush, Tube | 1 |
| FIS-03-680 | Brush, Table | 1 |
| FIS-03-687-30 | Bucket, Graduated Polyethylene | 2 |
| FIS-03-700-22A | Buret, 10 mL | 2 |
| FIS-03-700-22B | Buret, 25 mL | 2 |
| FIS-03-700-22C | Buret, 50 mL | 2 |
| FIS-03-700-22D | Buret, 100 mL | 2 |
| FIS-843-1B | Buret, Automatic, Pinchcock 25 mL | 2 |

| | | |
|---|---|---|
| FIS-03-834B | Buret, Automatic w/reservoir, nalgene, 25 mL | 2 |
| FIS-03-843C | Buret, Automatic w/reservoir, nalgene, 50 mL | 1 |
| FIS-834D | Buret, Automatic w/reservoir, nalgene, 100 ml | 1 |
| FIS-03-865 | Buret Funnel | 2 |
| FIS-03-902Q | Burner, Natural Gas | 2 |
| FIS-12-002 | Burner Lighter | 2 |
| FIS-15-252-400 | Cart, lab 2 shelves | 1 |
| REP-F-10300 | Centrifuge, 6 polycarbonate conical bottom tubes, 19 MM x 120 MM, 0-100 PCT graduations | 1 |
| FIS-S47351 | Chart, Toxic-Hazard Chart | |
| FIS-S01743 | Chart, Laboratory Safety | 1 |
| FIS-S45514 | Chart, Periodic Table | 1 |
| FIS-S45527 | Chart, English/Metric Systems | 1 |
| FIS-03-405-40 | Container, Sample, w/snap closure, 4 OZ | 50 |
| FIS-7-905-2 | Counter | 1 |
| FIS-15-251 | Carrier, Utility, Polycarbonate | 2 |
| FIS-04-680 | Carboy Caddy | 1 |
| FIS-5-850A | Clamp, Flatjaw Pinchcock | 4 |
| FIS-5-850B | Clamp, Flatjaw Pinchcock | 4 |
| FIS-5-870A | Clamp, Hoffman Pinchcock | 4 |
| FIS-5-875A | Clamp, Hoffman, Open Side | 4 |
| FIS-5-869 | Clamp, Polycarbonate | 2 |
| FIS-5-779 | Clamp, Double Buret | 2 |
| FIS-5-772 | Clamp, Single Buret, Vinyl | 2 |
| FIS-5-777 | Clamp, Single Buret, Vinyl | 2 |
| CGW-3024-25 | Cylinder, Graduated, 25 mL | 6 |
| CGW-3024-50 | Cylinder, Graduated, 50 mL | 6 |
| CGW-3024-100 | Cylinder, Graduated, 100 mL | 6 |
| CGW-3024-250 | Cylinder, Graduated, 250 mL | 6 |
| CGW-3024-500 | Cylinder, Graduated, 500 mL | 4 |
| CGW-3024-1L | Cylinder, Graduated, 1000 mL | 4 |
| FIS-08-572-6C | Cylinder, Graduated, Nalgene, 50 mL | 2 |
| FIS-08-572-6D | Cylinder, Graduated, Nalgene, 100 mL | 2 |
| FIS-08-572-6E | Cylinder, Graduated, Nalgene, 250 mL | 2 |
| FIS-08-572-6F | Cylinder, Graduated, Nalgene, 500 mL | 2 |
| FIS-08-572-6G | Cylinder, Graduated, Nalgene,1000 mL | 2 |
| FIS-08-607-053 | Drawer/ganizer, Stopper, Large | |
| FIS-08-607-054 | Drawer/ganizer, Stopper, Small | 2 |

| | | |
|---|---|---|
| FIS-08-607-051 | Drawer/ganizer, Pipet, Large | 4 |
| FIS-08-607-052 | Drawer/ganizer, Pipet, Small | 4 |
| FIS-08-607-061 | Drawer/ganizer, Utility, Large | 6 |
| FIS-08-607-062 | Drawer/ganizer, Utility, Small | 6 |
| FIS-08-607-053 | Drawer/ganizer, Cylinder, Small | 4 |
| CGW-4980-25 | Flask, Erlenmeyer, 25 mL, Pyrex | 4 |
| CGW-4980-50 | Flask, Erlenmeyer, 50 mL, Pyrex | 4 |
| CGW-5100-125 | Flask, Erlenmeyer, 125 mL, Pyrex | 4 |
| CGW-5100-250 | Flask, Erlenmeyer, 250 mL, Pyrex | 4 |
| CGW-5100-500 | Flask, Erlenmeyer, 500 mL, Pyrex | 4 |
| CGW-5100-1L | Flask, Erlenmeyer, 1000 mL, Pyrex | 4 |
| CGW-5020-25 | Flask, w/stopper, 25 mL, Pyrex | 2 |
| CGW-5020-50 | Flask w/stopper, 50 mL, Pyrex | 2 |
| CGW-5020-125 | Flask w/stopper, 125 mL, Pyrex | 2 |
| CGW-5020-250 | Flask w/stopper, 250 mL, Pyrex | 2 |
| CGW-5020-500 | Flask w/stopper, 500 mL, Pyrex | 2 |
| CGW-4985-500 | Flask w/screw cap, 500 mL, Pyrex | 2 |
| CGW-4985-1L | Flask w/screw cap, 1000 mL, Pyrex | 2 |
| CGW-5580-10 | Flask, volumetric w/snap cap, 10 mL | 2 |
| CGW-5580-25 | Flask, volumetric w/snap cap, 25 mL | 2 |
| CGW-5580-50 | Flask, volumetric w/snap cap, 50 mL | 2 |
| CGW-5580-100 | Flask, volumetric w/snap cap, 100 mL | 2 |
| CGW-5580-200 | Flask, volumetric w/snap cap, 200 mL | 2 |
| CGW-5880-500 | Flask, volumetric w/snap cap, 500 mL | 2 |
| CGW-5580-1L | Flask, volumetric w/snap cap, 1000 mL | 2 |
| FIS-9-805-C | Filter Paper, Whatman No. 1, 7 CM | 1 box |
| FIS-9-805-D | Filter Paper, Whatman No. 1, 9 CM | 1 box |
| FIS-9-805-E | Filter Paper, Whatman No. 1, 11 CM | 1 box |
| FIS-9-845-B | Filter Paper, Whatman No. 40, 7 CM | 1 box |
| FIS-9-845-C | Filter Paper, Whatman No. 40, 9 CM | 1 box |
| FIS-9-845-D | Filter Paper, Whatman No. 40, 11 CM | 1 box |
| FIS-9-873F | Filter Paper, Glass Filter, 7 CM | 1 box |
| FIS-9-873G | Filter Paper, Glass Filter, 9 CM | 1 box |
| FIS-9-873H | Filter Paper, Glass Filter, 11 CM | 1 box |
| FIS-9-832C | Filter Paper, Whatman No. 12, 18.5 CM | 1 box |
| FIS-10-184 | Filter Adapter Set | 2 |
| FIS-8-887 | Forceps, Curved | 2 |

| | | |
|---|---|---|
| FIS-8-890 | Forceps, Straight | 2 |
| FIS-10-309 | Forceps, Polypropylene | 2 |
| FIS-8-907 | Forceps, Hemostatic | 2 |
| FIS-10-362C | Funnel, Buchner, 70 MM, Nalgene | 2 |
| FIS-10-362D | Funnel, Buchner, 90 MM, Nalgene | 2 |
| FIS-10-362E | Funnel, Buchner, 110 MM, Nalgene | 2 |
| FIS-10-356C | Funnel, Buchner, 75 MM, Plate, Coors | 2 |
| FIS-10-356D | Funnel, Buchner, 91 MM, Plate, Coors | 2 |
| FIS-10-356E | Funnel, Buchner, 111 MM, Plate, Coors | 2 |
| FIS-10-346-5A | Funnel, Powder, 60 MM, Kimax | 2 |
| FIS-10-346-5C | Funnel, Powder, 100 MM, Kimax | 2 |
| FIS-10-322B | Funnel, Filtering, 45 MM | 2 |
| FIS-FB6015875 | Funnel, General Purpose, 75 MM | 2 |
| FIS--FB60158100 | Funnel, General Purpose, 100 MM | 2 |
| FIS-10-348B | Funnel, Heavy Duty Polypropylene, 76 MM | 2 |
| FIS-10-371D | Funnel, Heavy Duty Polypropylene, 152 MM | 2 |
| FIS-10-371-1C | Funnel, Filtration, 210 MM | 2 |
| FIS-11-312-10A | Glass Beads, Pyrex, 3 MM | |
| FIS-11-394-1A | Gloves, Disposable Nitrile | 1 box |
| FIS-11-394-1B | Gloves, Disposable Nitrile | 1 box |
| FIS-06-712-153 | Gauge, Combination 30 IN HG-0-30 PSIG Mod 125 | 2 |
| TML-SP-18425Q | Hotplate/Stirrer, Type 11700 | 2 |
| FIS-11-734 | Ink, Ceramic Marking | 2 |
| FIS-15924 | Labels, Polycoated, 3/4 x 3 IN | 2 |
| FIS-15922 | Labels, Polycoated, 1-15/16 x 3 IN | 2 |
| CGW-7085-1C | Pipet, Serological, Color Coded Pyrex, 1 mL | 6 |
| CGW-7085-2 | Pipet, Serological, Color Coded Pyrex, 2 mL | 6 |
| CGW-7085-5 | Pipet, Serological, Color Coded Pyrex, 5 mL | 6 |
| CGW-7085-10 | Pipet, Serological, Color Coded Pyrex, 10 mL | 6 |
| CGW-7087-5 | Pipet, Serological, Large Tip, 5 mL | 6 |
| CGW-7087-10 | Pipet, Serological, Large Tip, 10 mL | 6 |
| CGW-7087-25 | Pipet, Serological, Large Tip, 25 mL | 6 |
| CGW-7100-1 | Pipet, Volumetric Transfer, 1 mL | 3 |
| CGW-7100-2 | Pipet, Volumetric Transfer, 2 mL | 3 |
| CGW-7100-3 | Pipet, Volumetric Transfer, 3 mL | 3 |
| CGW-7100-4 | Pipet, Volumetric Transfer, 4 mL | 3 |
| CGW-7100-5 | Pipet, Volumetric Transfer, 5 mL | 3 |

| | | |
|---|---|---|
| CGW-7100-10 | Pipet, Volumetric Transfer, 10 mL | 3 |
| CGW-7100-15 | Pipet, Volumetric Transfer, 15 mL | 3 |
| CGW-7100-20 | Pipet, Volumetric Transfer, 20 mL | 3 |
| CGW-7100-25 | Pipet, Volumetric Transfer, 25 mL | 3 |
| CGW-7100-50 | Pipet, Volumetric Transfer, 50 mL | 3 |
| CGW-7100-100 | Pipet, Volumetric Transfer, 100 mL | 3 |
| CGW-7101-5 | Pipet, Volumetric Large Tip, 5 mL | 3 |
| CGW-7101-10 | Pipet, Volumetric, Large Tip, 10 mL | 3 |
| CGW-7101-25 | Pipet, Volumetric, Large Tip, 25 mL | 3 |
| CGW-7101-50 | Pipet, Volumetric, Large Tip, 50 mL | 3 |
| FIS-13-675-10F | Pipet, Sterile Polystyrene, 10 mL | 1 case/500 |
| FIS-15-350-15 | Pipet Washer/Dryer | 2 |
| FIS-15-350-10 | Pipet Rack | 2 |
| FIS-15-350-110A | Pipet Jar, Nalgene 5242, 17 X 51 CM | 2 |
| FIS-15-350-105AA | Pipet Basket, Nalgene 5241, 60 CM | 2 |
| FIS-13-683B | Pipet Filler, Pi-Pump, 2 mL | 2 |
| FIS-13-683C | Pipet Filler, Pi-Pump, 10 mL | 2 |
| FIS-13-683D | Pipet Filler, Pi-Pump, 25 mL | 2 |
| FIS-13-681-51 | Pipet Filler, Red | 2 |
| FIS-13-683-27B | Single Volume Dispenser, 2 mL | 3 |
| FIS-13-683-55 | Variable Volume Dispenser | 2 |
| FIS-03-475 | Pipet Sterilizing Box, Square | 1 |
| FIS-13-712-10 | Pipet Rack, Polypropylene | 4 |
| HAC-19700-01 | Pipet, Micromatic, HACH | 1 |
| FIS-1-002 | Dispenser, Acid/Reagent, Polyethylene | 4 |
| FIS-14-070-10AA | Rubber Bulb, 10 mL | 4 |
| FIS-22-235-325 | Rubber Bulb, Pressure | 4 |
| FIS-14-285 | Shears, Heavy Weight | 1 |
| FIS-14-275B | Shears, Medium Weight, 20 CM | 1 |
| CPR-WU-99152-50 | Sampler, Grab | 1 |
| FIS-14-356-8 | Spatula, Semi Micro | 2 |
| FIS-14-373 | Spatula, Round/Square Blade | 2 |
| FIS-14-375-10 | Spatula, Spoonula | 1 |
| FIS-14-371B | Spatula, Weighing, 10 CM | 1 |
| FIS-14-371C | Spatula, Weighing, 13 CM | 1 |
| FIS-14-430A | Spatula w/Porcelain Spoon, 123 MM | 1 |
| FIS-14-430B | Spatula w/Porcelain Spoon, 165 MM | 1 |

| | | |
|---|---|---|
| FIS-1-360 | Sleeves, Rubberized | 2 |
| TML-SL-7225 | Stirrer, Illuminated Stirlight | 1 |
| FIS-14-511-59 | Stirring Bar Kit, Magnetic | 1 |
| FIS-14-511-86 | Stir Bar Retriever | 2 |
| FIS-11-931 | Stool, Kik-Step | 2 |
| FIS-14-132 | Stoppers, Rubber, Assorted | 1 bag |
| FIS-S3508 | Stopper, Rubber, Twistit size 3 | 1 bag |
| FIS-S3508F | Stopper, Rubber, Twistit size 9 | 1 bag |
| FIS-S3508G | Stopper, Rubber, Twistit size 10 | 1 bag |
| FIS-11-284 | Stopper Gage | 1 |
| FIS-06-662-80 | Timer, 24 HR | 2 |
| FIS-6-656 | Timer, 60 min, eElectric, DimcoGray 171 | 1 |
| CPR-8678 | Timer, Digital Stopwatch w/Case | 1 |
| FIS-13-201-402 | Thermometer, Double Scale | 2 |
| FIS-NC0304107 | Thermometer, Double Scale | 2 |
| FIS-13-201-764 | Thermometer, Double Scale | 2 |
| FIS-13-201-696 | Thermometer, Pocket | 4 |
| FIS-2-620 | Tongs, Beaker, 33 CM | 2 |
| FIS-8-725 | Tongs, Safety Dish | 2 |
| FIS-10-062 | Tongs, Flask | 2 |
| FIS-15-193 | Tongs, Crucible | 2 |
| FIS-15-207 | Tongs, Muffle Furnace | 2 |
| FIS-15-202-5 | Tongs, Pickup, PTFE coated | 2 |
| FIS-6-666A | Kimwipes Tissues, 13 x 21 CM | 1 case |
| FIS-6-666-11 | Kimwipes, 37 x 42 CM | 1 case |
| FIS-14-171-211 | Tubing, Tygon, 3/16 IN ID | 50 FT |
| FIS-14-171-103 | Tubing, Tygon, 1/4 IN ID | 50 FT |
| FIS-14-171-228 | Tubing, Tygon, 3/8 IN ID | 50 FT |
| FIS-14-178-2BB | Tubing, Heavy Latex, 3/16 IN ID | 24 FT |
| FIS-14-178-2CC | Tubing, Heavy Latex, 1/4 IN ID | 24 FT |
| FIS-1-093-5 | Vacuum/Pressure Pump, Portable | 1 |
| FIS-22-237552 | Valve, Check | 1 |
| FIS-2-610-5A | Watch Glass, 2 IN | 6 |
| FIS-2-610-5C | Watch Glass, 2 IN | 6 |
| FIS-2-610-5E | Watch Glass, 4 IN | 6 |
| FIS-2-610-5G | Watch Glass, 5 IN | 6 |
| FIS-8-732-101 | Weighing Dishes, Disposable, Aluminum, 60 MM, 144/pk | 5 pk |

| | | |
|---|---|---|
| FIS-08-732-116 | Weighing Boats, Plastic, 250/pk | 1 pk |

H. Laboratory Safety Equipment:

| | | |
|---|---|---|
| FIS-10-029-280 | Eyewash Station, Emergency, | 1 |
| FIS-10-029-29 | Eyewash Solution | 4 |
| FIS-11-409-5 | Face Shield Headgear | 1 |
| FIS-19-027-286 | First Aid Cabinet | 1 |
| FIS-19-181-504 | Goggles, Chemical | 2 |

I. Laboratory General Equipment:

| DESCRIPTION | QUANTITY |
|---|---|
| Refrigerator FIS-11-670-232 | 1 |
| Muffle Furnace - FIS- 10-505-13 or FIS-505-10 Provide electrical connections to furnace/controller consisting of properly sized flexible cord, attachment cap and receptacle. | 1 |
| Drying Oven, Mechanical Convection FIS-475-154 | 1 |
| Autoclave, FIS-STE-2422005 | 1 |

J. Laboratory Reference Publications:
1. All references to be hard cover where available and of latest edition.
2. Quantity: Provide one copy of the references listed.
3. The following publications are available from the Water Environment Federation (WEF), www.wef.org:
   a. Standard Methods for the Examination of Water and Wastewater.
   b. Simplified Laboratory Procedures.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Service Connections: Where major laboratory equipment items are supplied without power cord, Provide and install properly sized power cord and twist-lock type attachment cap and receptacle.

B. Comply with Specification Section 10 14 00 for identification and tagging and for warning or caution signs.

**END OF SECTION**

# SECTION 11 53 12
LABORATORY CHEMICALS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Laboratory chemicals.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. All chemicals shall meet or exceed ACS standards.
   2. Supplier catalog numbers are listed to establish the minimum quality requirement.

### 1.3 SYSTEM DESCRIPTION

A. Provide single source responsibility through the supplier for the Laboratory Chemicals.

B. Contract Closeout Information:

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 50.

B. In order to insure a fresh supply of chemicals and prevent deterioration of same, delivery shall be coordinated such that chemicals do not arrive at project site more than 30 days prior to occupancy of laboratory by Owner.
   1. Store chemicals at an ambient temperature of 68 DEGF +10 DEGF unless otherwise specified by the manufacturer.
   2. Any materials showing evidence of deterioration due to improper storage shall be removed from site and replaced immediately at no cost to Owner.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Laboratory chemicals:
      a. Fisher Scientific Company (FIS).
      b. HACH Chemical Company (HAC).
      c. Sargent Welch (SW).
      d. VWR Scientific (VWR).
      e. Curtin Matheson Scientific (CMS).
      f. Aldrich Chemical Company, Inc. (ALD).

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Catalog numbers used to establish minimum product quality are as follows:
   1. Laboratory chemicals:
      a. Fisher Scientific Company (FIS) - Fisher/88.
      b. HACH Chemical Company (HAC) - Products for Analysis 1986-87.
      c. Aldrich Chemical Company (ALD) - Catalog 88/89.

## 2.2 LABORATORY CHEMICALS

A. Biochemical Oxygen Demand and Dissolved Oxygen Tests:
   1. HAC-14160-66, Nutrient Buffer Pillow for 300 ml bottle, 100 each.
   2. HAC-14861-98, Nutrient Buffer Pillows for 3 liters dilution water, 25 each.
   3. HAC-14862-98, Nutrient Buffer Pillows for 6 liters dilution water, 25 each.
   4. HAC-14863-97, Nutrient Buffer Pillows for 10 liters dilution water, 30 each.
   5. FIS-SO-M-109, Magnesium Sulfate Solution, 2.25 PCT, 1 L.
   6. FIS-SO-F-97, Ferric Chloride Solution, 0.25 PCT, 1 L.
   7. FIS-SO-P-341, Phosphate Buffer Solution, 1 L.
   8. FIS-SO-C-10, Calcium Chloride Solution 2.75 PCT, 1 L.
   9. FIS-D-16, Dextrose (D-Glucose), Anhydrous, Cert. ACS 500 g.
   10. FIS-A-125, Glutamic Acid, Crystal, Reagent Grade, 600 g.
   11. FIS-SO-A-435, Alkaline Iodide-Sodium Azide Solution, 1 L.
   12. FIS-SO-P-340, Potassium Bi-Iodate Solution, 0.025N, 1 L.
   13. FIS-SO-M-20, Manganese Sulfate Solution, 1 L.
   14. FIS-S-516, Starch, Soluble, 200 g.
   15. HAC-1070-16, Phenylarsine Oxide Titrant, 0.025N, 1 qt.
   16. HAC-2533-35, Nitrification Inhibitor 2-35 g.
   17. HAC-459-01, Dispenser Cap, Nit. Inhibitor, 2.
   18. HAC-357-11, Copper sulfate-Sulfamic Acid Solution, 1 pt.

B. Acidity/Alkalinity Tests:
   1. FIS-P-243, Potassium hydrogen Phthalate, Primary Standard, 100 g.
   2. FIS-H-325, Hydrogen Peroxide Solution, 30 PCT, 100 g.
   3. FIS-M-216, Methyl Orange (indicator), 25 g.
   4. FIS-6116, Phenolphthalein Disodium Salt, 25 g.
   5. FIS-M-301, Methyl Red, Sodium Salt, 10 g.
   6. FIS-B-90, Bromocresol Green, Sodium Salt, 5 g.
   7. FIS-S-281, Sodium Carbonate, Alkalimetric Standard, 500 g.
   8. HAC-14287-10, "Voluette" Standard Ampule For Alkalinity, 32 each.
   9. HAC-14330-10, "Voluette" Standard Ampule For Acidity, 32 each.

C. Chemical Oxygen Demand Test (Full-Scale Dichromate Reflux Method):
   1. FIS-P-188, Potassium Dichromate, Crystal, Cert. ACS, 500 g.
   2. FIS-S-190, Silver Sulfate, Powder, Cert. ACS, 100 g.
   3. FIS-I-77, Ferrous Ammonium Sulfate, Crystal, 500 g.
   4. FIS-P-69, Ferroin Indicator Solution, 100 g.
   5. FIS-M-190I, Mercuric Sulfate, 100 g.
   6. FIS-A-295, Sulfamic Acid, 100 g.

D. Chemicals Oxygen Demand Test (HACH Reactor Method):
   1. HAC-21259-15, High Range (0-1500 MG/l) COD Vials, 150 each.
   2. HAC-21258-15, Low Range (0-150 MG/l) COD Vials, 150 each.

E. Grease and Oil Tests:
   1. FIS-11300, 1,1,2-Trichloro-1,2,2-Trifluoroethane, 2-3 kg.
   2. FIS-S-421, Sodium Sulfate, Anhydrous Granular, 500 g.

F. Hardness Test:
   1. HAC-424-37, Buffer Solution, Hardness 1(4 OZ MDB), 2 each.
   2. HAC-851-99, ManVer II Hardness Indicator Powder Pillows, 200 each.
   3. HAC-205-16, TitraVer Hardness Titrant, 0.020N, 1 qt.
   4. HAC-14080-99, CDTA Magnesium Salt Powder Pillows, 100 each.
   5. HAC-2187-10, "Voluette" Ampule Standard For Hardness, 16 each.

G. Metals and Toxic Materials:
   1. Chromium - Hexavalent:

a. HAC-12066-66, Chroma Ver III Chromium Reagent Powder Pillows, 100 each.
b. HAC-14256-10, Voluette Standard Ampule for Hexavalent Chromium, 16.
c. HAC-810-14, Chromium, Hexavalent, Standard Solution, 50 MG/l, 8 OZ.

2. Chromium - total:
   a. HAC-2043-99, Chromium 1 Reagent Powder Pillows, 100 each.
   b. HAC-2044-99, Chromium 2 Reagent Powder Pillows, 100 each.
   c. HAC-2126-99, Acid Reagent Powder Pillows, 100 each.
   d. HAC-14151-14, Chromium Standard Solution, 50 MG/l, 8 OZ.
   e. HAC-14257-10, Voluette Standard Ampule - Total Chromium, 16 each.
3. Cadmium:
   a. HAC-14458-11, Chloroform, ACS, 1 pt.
   b. HAC-767-14, Potassium Cyanide, ACS, 4 OZ.
   c. HAC-2180-11, Sodium Hydroxide Solution, 50 PCT, 1 pt.
   d. HAC-14202-99, Buffer Powder Pillows, Citrate, 100.
   e. HAC-12616-68, DithiVer Metals Reagent Powder Pillows, 100.
   f. HAC-14024-14, Cadmium Standard Sol., 100 MG/l, 4 OZ.
   g. HAC-14261-10, Voluette Standard Ampule for Cd, 16 each.
4. Copper:
   a. HAC-14188-66, CuVer I copper Reagent Powder Pillows, 100.
   b. HAC-2011-11, Copper 1 Reagent, 1 pt.
   c. HAC-2012-11, Copper 2 Reagent, 1 pt.
   d. HAC-128-14, Copper Standard Solution, 100 MG/l, 8 OZ.
   e. HAC-14247-10, Voluette Standard for Copper, 16.
5. Cyanide:
   a. HAC-14039-99, CyaniVer 3 Cyanide Reagent Powder Pillows, 100 each.
   b. HAC-14040-99, CyaniVer 4 Cyanide Reagent Powder Pillows, 100 each.
   c. HAC-14041-99, CyaniVer 5 Cyanide Reagent Powder Pillows, 100 each.
   d. HAC-184-20, Sodium Cyanide ACS, 4 OZ.
   e. HAC-2476-37, Nitrophenol Indicator Solution, 10 g/l.
   f. HAC-243-99, Hexa Ver Chelating Reagent Powder Pillows, 100 each.
6. Iron-ferrous:
   a. HAC-1037-99, Ferrous Iron Reagent Powder Pillows, 100 each.
   b. HAC-11256-14, Ferrous Ammonium Sulfate Hexahydrate, ACS, 4 OZ.
7. Iron - total:
   a. HAC-854-99, FerroVer Iron Reagent Powder Pillows, 100 each.
   b. HAC-300-22, RoVer Rust Remover, 22 OZ.
   c. HAC-14175-14, Iron Standard Solution, 100 MG/l as FE, 4 OZ.
   d. HAC-14253-10, Voluette Standard Ampule For Iron, 16 each.
8. Nickel:
   a. HAC-14458-11, Chloroform, ACS, 1 pt.
   b. HAC-2123-99, Nickel 1 Reagent Powder Pillows, 100 each.
   c. HAC 2124-99, Nickel 2 Reagent Powder Pillows, 100 each.
   d. HAC-14176-14, Nickel Standard Solution, 100 MG/l, 4 OZ.
   e. HAC-14266-10, Voluette Standard Ampule For Nickel, 16 each.
9. Phenols:
   a. HAC-424-11, Buffer Solution, Hardness 1, 1 pt.
   b. HAC-724-11, Chloroform, ACS, 1 pt.
   c. HAC-872-99, Phenol Reagent Powder Pillows, 100 each.
   d. HAC-1836-99, Phenol 2 Reagent Powder Pillows, 100 each.
10. Zinc.
11. HAC-14032-99, ZincoVer V Zinc Reagent Powder Pillows, 100.
12. HAC-14033-37, Cyclo Hexanone, 4 OZ.
13. HAC-2378-14, Zinc Standard Solution, 100 MG/l Zn, 8 OZ.
14. HAC-14246-10, Voluette Standard Ampule for Zinc, 16 each.

H. Nitrogen Tests:
   1. Total kjeldahl nitrogen and ammonia nitrogen:
      a. FIS-S-249, Sodium Tetraborate, 500 g.
      b. FIS-A-74, Boric Acid, Powder ACS, 500 g.
      c. FIS-M-296, Methyl Red, Indicator, 20 g.
      d. FIS-M-225, Methylene Blue, Lab Grade, 100 g.
      e. FIS-P-304, Potassium Sulfate, Crystal, ACS, 500 g.
      f. FIS-M-174, Mercuric Oxide, Red Powder, ACS, 25 g.
      g. HAC-21196-49, Hydrogen Peroxide, 50 PCT, 500 ml, 2 each.
      h. HAC-21194-49, Nessler Reagent, 500 ml, 1 each.
      i. HAC-21100-14, Polyvinyl Alcohol Sol., 20g/L, 118 ml, 2 each.

I. pH Test:
   1. FIS-SO-B-101, Buffer Solution, pH4, Red, 1 case (6 x 500 ml).
   2. FIS-SO-B107, Buffer Solution, pH7, Yellow, 1 case (6 x 500 ml).
   3. FIS-SO-B-115, Buffer Solution, pH10, Blue, 1 case (6 x 500 ml).

J. Volatile Acids Test:
   1. ALD-30636-3, Silicic Acid, Chromatography Grade, 0-60 mesh, 1 kg.
   2. FIS-C605-4, Chloroform, Regent Grade, 4 L.
   3. FIS-A383-4, N-Butanol, 4 L.
   4. FIS-T416-5, Tuymol Blue Indicator, 2-5 g.
   5. FIS-A183-500, Ascarite, 8-20 mesh, 2-500 g.

K. General Chemicals:
   1. FIS-A-300 S, Sulfuric Acid, Conc., 2-1/2 L Safe Cote Bottle, 1 each.
   2. FIS-SO-A-200, Sulfuric Acid Solution, 1ON, 1 L.
   3. FIS-SO-A-226, Sulfuric Acid Solution, 0.02N, 1 L.
   4. FIS-A-144-S, Hydrochloric Acid, Conc., 2-1/2 L Safe Cote Bottle, 1 each.
   5. FIS-A-200-S, Nitric Acid, Conc., 2-1/2 L Safe Cote bottle, 1 each.
   6. FIS-A-38-S, Acetic Acid, glacial, 2-1/2 L Safe Cote Bottle, 1 each.
   7. FIS-S-318, Sodium Hydroxide, Pellets, Cert. ACS, 500 g.
   8. FIS-SO-S-255, Sodium Hydroxide Solution 1ON, 1 L.
   9. FIS-SO-S-282, Sodium Hydroxide Solution, 0.02N, 1 L.
   10. FIS-S-430, Sodium Sulfite, Anhydrous Crystal, Cert. ACS 500 g.
   11. FIS-S-446, Sodium Thiosulfate, Anhydrous Powder, 500 g.
   12. FIS-S-233, Sodium Bicarbonate, Powder, 1 kg.
   13. FIS-C-96, Calcium Tydroxide, Lab Grade, 1 kg.
   14. FIS-C-117, Calcium Oxide, Fisher Cert., 1 kg.
   15. FIS-C-99, Calcium Hypochlorite, Technical, 3 kg.
   16. FIS-P-251, Potassium Hydroxide, NF/FCC, 3 kg.
   17. FIS-P-188, Potassium Dichromate, Crystal, Cert. ACS, 500 g.
   18. FIS-P-190, Potassium Bi-Iodate, Purified, 100 g.
   19. FIS-I-88, Ferric chloride, Lump, Cert., ACS, 500 g.
   20. FIS-6116, Phenolphthalein, Disodium Salt, 25 g.
   21. FIS-P-79, Phenolphthalein, 25 g.
   22. FIS-C-493, Copper Sulfate, 500 g.
   23. HAC-14222-11, Cobalt Chloride Solution (Spectrophotometer Calibration), 1 each.
   24. HAC-14210-14, Neodymium Chloride Solution (Spectrophotometer Calibration), 1 each.
   25. FIS-A-412, Methanol, Absolute, 1 L.
   26. FIS-A-416, 2-Propanol (Iso-Propyl Alcohol), 1 L.
   27. FIS-A-407-S, Ethyl Alcohol, Safe-Tin, 1-4 liter.
   28. FIS-G-33, Glycerin, ACS, 500 ml.
   29. FIS-A-611, Aluminum Sulfate, Tech., 3 kg.
   30. FIS-7-578-3B, Drierite, Indicating, 10 LB.
   31. FIS-C-211, CELITE, Analytical Filter Aid, 300 g.

32. HAC-451-37, Brom Cresol Green - Methyl Red Indicator 4 OZ DB, 2 each.
33. HAC-162-37, Phenolphthalen Indicator Sol., 4 OZ DB, 2 each.
34. HAC-1114-24, Phenylarsine Oxide, 25 g.

L. Cleaning Compounds and Solvents:
1. FIS-SO-C-88, Chromic-Sulfuric Acid Cleaning Compound, 2-1/2 L.
2. FIS-SO-F-105, Detergent, Biodegradable (FL-70), 1 L.
3. FIS-F-7, Fisher Washing Powder, (auto-dishwasher), 3 kg.
4. FIS-4-320, SPARKLEEN, All-Purpose det., 3-1/4 LB Carton, 1 each.
5. FIS-S-333, Sodium Metaphosphate, 500 g.
6. FIS-S-377, Sodium Phosphate, Tribasic, 1 kg.
7. FIS-S-529, Sodium Lauryl Sulfate NF/FCC Grade, 500 g.
8. FIS-A-1B, Acetone, 1 L.

## PART 3 - EXECUTION - (NOT USED)

## END OF SECTION

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# DIVISION 12

## FURNISHINGS

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# SECTION 12 24 13
## ROLLER WINDOW SHADES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Roller Shades, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Obtain roller shades through one source from a single manufacturer.
   2. Minimum twenty (20) years' experience in manufacturing products comparable to those specified in this section.

B. Installer Qualifications:
   1. Installer trained and certified by manufacturer with a minimum of ten (10) years' experience installing products comparable to those specified in this section.

C. ASTM International (ASTM):
   1. ASTM G21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
   2. No growth for fungi ATCC9642, ATCC 9644, ATCC9645.

D. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code.
   2. NFPA 701-2015, Standard methods for Fire Tests for Flame Propagation of Textiles and Films.
      a. Passes flame propagation performance criteria for Test Method.
   3. NFPA Article 100 Electrical components listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system.

### 1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's data sheets on each product to be used, including:
      a. Preparation instructions and recommendations.
      b. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
      c. Storage and handling requirements and recommendations.
      d. Mounting details and installation methods.
      e. Window treatment schedule:
         1) Use same room designations as indicated on Drawings and include opening sizes and key to typical mounting details.

B. Samples:
   1. Provide for each finish product specified,
      a. One set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
      b. One set of shade components, unassembled, demonstrating compliance with specified requirements.
         1) Mark face of material to indicate interior faces.

C. Contract Closeout Information:
   1. Warranty.
   2. Maintenance Data:
      a. See Section 01 33 04.

### 1.4 WARRANTY

A. Roller Shade Hardware: Manufacturer's standard non-depreciating 10 year limited warranty.

B. Shadecloth: Manufacturer's standard non-depreciating 10 year limited warranty.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Roller Shades:
   1. Base:
      a. MechoShade Systems.
   2. Optional:
      a. Draper.
      b. Hunter Douglas Contract.
      c. Lutron,Vimco.

B. Other manufacturers desiring approval comply with Section 01 25 13.

### 2.2 MATERIALS

A. Transparent Single-Fabric Shadecloth:
   1. Translucent, twill-weave pattern:
   2. ThermoVeil Reversible Sati/Diamond Weave by MechoShade Systems, Inc.
      a. 3000 and 3200 Satin Weave: 1-2 PCT open.
      b. 3300 Diamond Weave: 1-2 PCT open.
   3. Color: As selected from manufacturer's standard colors.

### 2.3 COMPONENTS

A. Manual Operated Chain Drive Hardware and Brackets:
   1. Adjustable universal, regular and offset drive capacity.
   2. Removable fascia with concealed fasteners.
   3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
   4. Provide multiple shade operation by a single chain operator.
   5. Minimum 1/8 IN thick plated steel.
   6. Drive Bracket and Brake Assembly:
      a. Model M5:
         1) SnapLoc fascia, room darkening side / sill channels, center supports and connectors for multi-banded shades.
      b. M5 drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 IN steel pin.

B. Drive Chain:
   1. No.10 stainless steel chain
   2. Rating: 90 LBS, minimum.

### 2.4 ACCESSORIES

A. Fascia for Shade Type _:
   1. Continuous extruded aluminum.
   2. Conceal brackets, shade roller and fabric.
   3. Provide bracket / fascia end caps.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 IN to interior face of glass.

B. Allow clearances for window operation hardware.

C. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

D. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

E. Train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

### 3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.5 SCHEDULE

A. Shade Type 1:
   1. Manual operating, chain drive.
   2. Sunscreen roller shades.
   3. Provide at windows of rooms and spaces shown on Drawings.

**END OF SECTION**

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# SECTION 12 35 54
## LABORATORY CASEWORK (WOOD)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Laboratory casework (wood).
2. Laboratory counter tops (epoxy resin).
3. Laboratory sinks (epoxy resin).
4. Laboratory service fittings.
5. Resilient base molding for application to casework.
6. Selected laboratory equipment as listed.

B. Related Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 06 10 00 - Rough Carpentry.
4. Section 09 22 16 - Non-Load-Bearing Wall Framing Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. Americans with Disabilities Act (ADA):
   a. Accessibility Guidelines (ADAAG).
2. ASTM International (ASTM):
   a. C1036, Standard Specification for Flat Glass.
   b. C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
   c. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
   d. D570, Standard Test Method for Water Absorption of Plastics.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D785, Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
   g. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   h. F1861, Standard Specification for Resilient Wall Base.
3. Hardwood Plywood and Veneer Association (HPVA):
   a. HP-1, American National Standard for Hardwood and Decorative Plywood.
4. National Fire Protection Association (NFPA):
   a. 30, Flammable and Combustible Liquids Code.
   b. 45, Standard on Fire Protection for Laboratories Using Chemicals.
5. Scientific Apparatus Makers Association (SAMA):
   a. LF 8, Performance Requirements for Laboratory Furniture.
6. Scientific Equipment and Furniture Association (SEFA):
   a. 2.3, Installation of Scientific Laboratory Furniture and Equipment.
   b. 3, Work Surfaces.
   c. 4.1, Glossary of Terms.
   d. 7, Laboratory and Hospital Fixtures.
   e. 8, Laboratory Furniture, Casework, Shelving and Tables.

B. Qualifications:
1. Manufacturer qualifications:
   a. Minimum 10 years' experience in manufacturing of units specified.
   b. Five similar installations in past two years.

2. Installer qualifications:
    a. Employed or approved in writing by manufacturer.
    b. Minimum five years' experience installing wood casework and epoxy resin tops.
    c. Five installations of wood casework and epoxy resin tops in past two years of similar scope.

C. Miscellaneous:
1. Furnish all wood casework, service fittings, accessories, sinks, drains, and epoxy resin tops from one manufacturer unless noted otherwise.

## 1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Terms referred to in Performance Test Results (PART 2):
1. "A" (Excellent):
    a. Indicated excellent to superior integrity of finish film.
    b. Includes no effect to slight allowable change in gloss (dulling or increase in gloss) and slight discoloration.
2. "B"(Good):
    a. Indicated good to very good integrity of finish film.
    b. Allows change of gloss or discoloration.
    c. Any effect can be removed from the tested area by abrading with 325-mesh silica powder and water, indicating that the discoloration is only superficial and that the finish film is good below the surface.

C. Exposed: Surfaces normally exposed to view, including but not limited to cabinet exteriors, doors and drawer fronts, interiors of and shelving in open or glazed cases, tops of cases less than 84 IN above finished floor and bottoms of wall cases 48 IN or more above finished floor.

D. Semi-exposed: Surfaces not normally exposed to view, including but not limited to interiors of and shelving in cases with solid doors and/or drawers, tops of cases 84 IN or more above finished floor and bottoms of wall cases less than 48 IN above finished floor.

E. Concealed: Surfaces not exposed to view after installation, including but not limited to cabinet end panels, tops and backs not exposed to view after installation.

F. Additional terminology common to the laboratory furniture and equipment industry as defined in SEFA 4.1.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Product technical data sheets on all components.
3. Scaled drawing showing layout, controlling dimensions, elevations, etc.
    a. Minimum plan scale: 1/8 IN = 1 FT-0 IN.
    b. Minimum elevation scale: 1/2 IN = 1 FT-0 IN.
    c. Minimum detail scale: 1-1/2 IN = 1 FT-0 IN.

B. Samples:
1. Available casework, work top and base molding colors for Engineer's color selection.
2. Base molding minimum 6 IN long.

3. Minimum 4 x 4 IN work top sample showing raised edge in color specified.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. Certification of manufacturer qualifications.
   2. Certification of installer qualifications.
   3. Listing of five installations in past two years of similar scope.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Area to receive casework to be enclosed with temperature and humidity controlled prior to delivery of casework.
   1. Temperature range: 65 - 80 DEGF.
   2. Humidity range: 30 - 50 PCT RH.

B. Building finish and environmental conditions: In accordance with SEFA 2.3.

C. Prior to delivery to jobsite, hold stored material in a conditioned environment.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Product numbers listed on the Drawings are based on Kewaunee Scientific Corporation.

B. Epoxy Resin Laboratory Countertops, Cup Sinks, Drain Troughs, Curbs and Service Ledges:
   1. Kewaunee Scientific Corporation.
   2. Wilsonart.
   3. Durcon Company.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Wood:
   1. Kiln dry in humidity controlled kilns to a moisture content of 4-1/2 PCT.
      a. Then temper all kiln-dried lumber to a moisture content of 6 PCT before use.
   2. Solid wood components:
      a. Provide clear solid woods with color and graining in conformance with standards required of the Scientific Laboratory Equipment Industry.
   3. Hardwood plywood:
      a. HPVA HP-1 1994 - 3.13; 3.15.
      b. Book-matched, A-1 plain sliced, select grade 1 face.
         1) Veneer core: 7- ply, with type II interior plies.
         2) Lumber core: 5-ply, solid core.
      c. Hardwood plywood for drawer box construction:
         1) Veneer core: 9-ply.
      d. Softwoods and particleboard are not acceptable.

B. Glass:
   1. Framed swinging and sliding doors:
      a. 1/8 IN thick.
      b. ASTM C1036.
      c. Clear glass: Type I, Class I, Quality q3.

C. Sink and Countertop: Molded Epoxy Resin.

## 2.3 ACCESSORIES

A. Hardware and Trim:
   1. Door and drawer pulls:
      a. Meet requirements of ADA.
      b. Satin finished extruded aluminum with clear lacquer coating.
   2. Hinges:
      a. Institutional, five knuckle.
      b. Stainless steel with brushed satin finish.
      c. Minimum 2-1/2 IN high.
   3. Friction catches: Adjustable nylon roller-type with strike.
   4. Locks:
      a. Heavy-duty cylindrical-type.
      b. 5-disc tumbler removable core.
      c. Minimum 200 primary key changes.
      d. Master key.
      e. Satin nickel plated and stamped with identifying number.
   5. Shelf support system.
      a. Twin pin-type for mounting in interior of cabinet.
      b. Corrosion-resistant material.
      c. Secure shelves from accidental removal.
      d. Shelves adjustable on 1.25 IN centers.
      e. Surface-mounted metal supports and clips are not acceptable.
   6. Elbow catches:
      a. Bronze-finished cast aluminum.
   7. Label Holders: Satin finished aluminum, self-adhesive type.
      a. Sized to hold maximum 2-1/2 x 1-1/8 IN cards.
      b. For all doors and drawers.

B. Molded Epoxy Resin Sinks, Countertops and Curbs:
   1. One-piece modified epoxy resin sinks (drop-in style):
      a. Modified epoxy resin unit with coved corners and bottom sloped to drain.
      b. Color: White.
      c. Minimum 1/4 IN thick lip.
      d. Complete with polyethylene trap and sink outlet assembly.
         1) Adjustable tail piece.
         2) Plug strainers, gasket and locknut.
         3) 1-1/2 IN I.P.S. male straight thread outlet.
         4) Outlet color to match sink.
   2. Countertops:
      a. Modified epoxy resin having the following minimum physical properties:
         1) Density: 140 PCF.
         2) Modulus of rupture: 3,500 PSI.
         3) Modulus of elasticity: 4.46 x 106 PSI.
         4) Compressive strength: 15,900 PSI; ASTM D695.
         5) Shear strength: 5,400 PSI.
      b. Chemical and corrosion resistant.
      c. Minimum 1 IN thick.
      d. Radius or bevel all exposed edges to a 1/8 IN radius.
      e. All sink cut-outs and holes for services shall be factory drilled and cut.
         1) Provide rabbeted cut-out in work top to accept lip of drop-in type sink.
         2) Sink cut outs shall be provided with 3/4 IN radius (minimum) corners.
      f. Color: White.
      g. Backsplash curbs:
         1) 4 IN high x 1 IN thick.
         2) Top set, sealed to work surface with epoxy adhesive.

3) Same construction and color as work surface.
4) Provide at back and exposed ends of countertops unless noted otherwise.

C. Resilient Base:
1. Top set, coved toe.
2. ASTM F1861.
3. 1/8 IN x 4 IN.
4. Mitered inside corners and wrapped outside corners.
5. Color: Black.

D. Miscellaneous Support Struts:
1. Pair of nominal 1 IN x 1-1/2 IN vertical channels with adjustable U-shaped connectors top and bottom.
2. Minimum 16 GA steel coated with corrosion resistant paint coating.
3. Size as required for pipe chase and to support items as shown on Drawings.
4. Compatible with commercially available pipe clamps and accessories.

E. Laboratory Service Fittings:
1. Laboratory grade.
2. Manual operation.
3. Finish:
   a. Chrome plated.
4. Service indexes:
   a. Identify services with tamperproof color coded plastic index buttons as follows:

| SERVICE | COLOR | CODE | COLOR OF LETTERS |
|---|---|---|---|
| Cold Water | Dark Green | CW | White |
| Hot Water | Red | HW | White |
| Steam | Black | STM | White |
| Air | Orange | Air | Black |
| Gas | Dark Blue | Air | White |
| Vacuum | Yellow | Vac | Black |
| Dist. Water | White | DW | Black |
| R.O. Water | White | RO | Black |
| Oxygen | Light Green | OXY | White |
| Hydrogen | Pink | H | Black |
| Nitrogen | Brown | N | White |
| All other rare gases | Light Blue | Chem Symbol | Black |

5. Water fittings:
   a. Cast red brass or bronze.
   b. Provide with renewable unit containing all operating parts subject to wear.
   c. Integral volume control device.
   d. All units capable of converting from compression to self-closing without altering faucet body.
   e. Four arm forged brass handles with service index buttons as required.
6. Steam fittings:
   a. Heat resistant handle.
   b. Removable stainless steel seat with flat Teflon seat disc.

c. Teflon impregnated packing.
    1) Constructed such that unit may be repacked while under pressure.
7. Reverse osmosis water fittings:
    a. Cast bronze with interior tin lining.
        1) Chrome plated.
        2) Self-closing.
    b. Wrist blade handle.
8. Ground key valve hose cocks:
    a. Heavy duty with tapered body and integral tapered, serrated hose connection.
    b. Forged body.
    c. Wrist blade type handle with colored service index button.
    d. One quarter turn ON and OFF.
    e. 40 PSI pressure rating without leakage.
9. Needle valve hose cocks:
    a. Laboratory type with ultra-sensitive flow control.
    b. Replaceable stainless steel floating cone.
    c. Stainless steel seat.
    d. Valve shall have "Teflon" impregnated packing.
    e. Unit shall be capable of being repacked while under pressure.
    f. 65 PSI pressure rating without leakage.
10. Turrets:
    a. Tapered design.
    b. Complete with 3/8 IN I.P.S. tank nipple, locknut and washer.
    c. Multiple service turrets: Allow for up to 4 different services in any combination.
11. Goosenecks:
    a. 3/8 IN I.P.S. spout.
    b. Removable serrated hose connection.
    c. Minimum 7-1/2 IN clearance between outlet and top with two 90 degree bends.
    d. Capable of conversion from fixed to swinging type.
12. Vacuum breaker:
    a. Integral with fixture assembly.
    b. Provide where indicated or where required by code.

F. Electrical Fittings: To be furnished in the Electrical Design.

G. Emergency Eyewash/Shower: See Section 22 20 00.

H. Support Rods:
1. Upright rods, cross rods and ring support rods, where specified: Anodized Duralumin 1/2 IN or 3/4 IN DIA, as required.
2. Rod sockets: Chrome plated brass, secured through table tops with lock nut and spring washer.
3. Rod clamps: Heavy-duty, designed to securely hold rod assembly in any position.
4. Use of wood rod assemblies is not acceptable.

## 2.4 FABRICATION

A. General:
1. Exposed wood species: White Maple.
2. Semi-exposed wood to be poplar, birch or similar clear hardwood.
3. Each individual unit shall be complete such that any unit may be relocated at any time without requiring field modification, other than field application of finished end panels.
4. Flush case interiors.
5. No exposed fasteners allowed.
    a. Use fluted hardwood dowels not less than 3/8 IN DIA to join frames and panels.
6. Integrally joined parts shall result in a totally enclosed cabinet.

B. Cases-General:

1. End panels:
   a. Minimum 3/4 IN thick hardwood plywood with minimum 1/8 IN thick solid hardwood facing on exposed edges.
   b. Fasten end panels to top frame members, intermediate rails and bottoms with multiple dowels, glue and/or screws.
2. Backs:
   a. 1/4 IN thick.
   b. Exposed: Hardwood plywood.
   c. Semi-exposed: Tempered hardboard.
   d. Dado back into end panels and bottom and fasten securely.
      1) Provide removable back where required for access to utilities, service chases or as otherwise indicated.
3. Bottoms: Minimum 3/4 IN thick hardwood plywood with minimum 1/8 IN solid hardwood facing on front edge.
4. Top:
   a. Base cabinets: horizontal frame.
   b. Wall cases, counter-mounted cases and full-height cases: Solid top, minimum 3/4 IN thick hardwood plywood with minimum 1/8 IN solid hardwood facing on front edge.
5. Doors:
   a. General:
      1) Solid doors: Solid core plywood with minimum 1/32 IN thick face veneer to match casework.
         a) Under 48 IN high: Minimum 3/4 IN thick.
         b) 48 IN high and greater: Minimum 1 IN thick.
      2) Glazed doors: Hardwood frame, mortised, tenoned and glued.
         a) Under 48 IN high: Minimum 3/4 IN thick.
         b) 48 IN high and greater: Minimum 1 IN thick.
         c) Set glass into door and secure with a plastic retainer.
   b. Hinged doors:
      1) Rabbeted edge to overlap case opening all four sides.
      2) Hinges:
         a) Drilled for screw attachment to door and case.
         b) Doors less than 48 IN high: 1 pair.
         c) Doors 48 IN high up to 84 IN high: 1-1/2 pair.
      3) Provide hardwood astragal applied to left-hand door of double-door cases.
      4) Provide elbow catches on left-hand door of double-door cases specified to receive locks.
   c. Adjustable shelves:
      1) Minimum 3/4 IN thick hardwood plywood with minimum 1/8 IN hardwood facing on front edge.
      2) Adjustable and fixed shelving up to 48 IN long to support an evenly distributed load of 40 PSF up to a maximum of 200 LBS.

C. Base Cabinets:
1. Base cabinets to support a minimum of 400 LBS/SF of cabinet top area including work surface without distortion resulting in interference with door and drawer operation.
2. Top horizontal frame:
   a. Front top rail:
      1) Two pieces of hardwood, grooved and glued together.
         a) Exposed member: Minimum 1-1/2 IN x 7/16 IN hardwood to match hardwood plywood.
         b) Concealed member: Minimum 2-1/2 IN x 3/4 IN hardwood.
   b. Side members: Minimum 1-3/4 IN x 3/4 IN hardwood, mortised and glued into front and rear rails and blind screwed into cabinet end panels.
   c. Rear member: Minimum 2-1/2 IN x 3/4 IN hardwood.

3. Intermediate rails:
    a. Minimum 3 IN x 3/4 IN plywood with 3/4 IN x minimum 1/8 IN solid hardwood facing on exposed edge to match casework.
    b. Mount intermediate rails at the front between the drawers and between all drawers and doors.
        1) Attach with multiple dowels and glue.
4. Security panels:
    a. Provide minimum 1/4 IN tempered hardboard security panels above locked compartments where access to locked compartment is possible by removal of drawer above.
        1) Security panels to be full depth and width of cabinet.
        2) Securely fasten to provide a tamper-resistant installation.
        3) Design panels so as not to interfere with operation of doors and/or drawers.
5. Toe space:
    a. Minimum 3/4 IN x 4 IN hardwood plywood toe space rail to form a 2-1/2 IN deep x 4 IN high, totally enclosed toe space.
6. Drawers:
    a. Sides: Minimum 1/2 IN thick, 9-ply hardwood plywood.
    b. Fronts: Minimum 3/4 IN thick, 5-ply solid core plywood.
        1) Attach using dovetail joints and glue for drawers over 3 IN deep.
        2) Attach using mortise and tenon joints for all drawers 3 IN deep or less.
    c. Back : Minimum 1/2 IN thick 9-ply hardwood plywood.
        1) Dadoed, glued and nailed to the sides.
    d. Bottom: Minimum 1/4 IN thick tempered hardboard, set and glued into 1/4 IN grooves, all sides.
    e. Drawer suspension:
        1) Provide drawer suspension assemblies rated for 100 LBS minimum.
        2) Construction:
            a) Two epoxy-coated steel sections providing quiet, smooth operation on nylon rollers.
            b) Case channels to maintain drawer alignment.
            c) Drawers to be removable without tools.
            d) Slides to wrap under and support drawer sides.

D. Full-height Cases:
1. Fasten center shelf to end panels with multiple dowels and glue to assure a completely rigid case.
    a. All other shelves to be adjustable on 1-1/4 IN centers using support system specified.
2. Toe space/base rail:
    a. 22 IN deep cases: Minimum 3/4 IN x 4 IN hardwood plywood toe space rail to form a 2-1/2 IN deep x 4 IN high, totally enclosed toe space.
    b. 12 IN and 15 IN deep cases: Minimum 1 IN x 4-3/4 IN solid hardwood (to match case) base rail mounted flush with the face of the cabinet.

E. Apron Frames:
1. Minimum 3/4 IN thick hardwood veneer plywood.
    a. Groove top edge for securing top fasteners.
2. Drawers: Materials and construction same as drawers specified above.

F. Open-Leg Tables:
1. Construct to guarantee equal tension in wood and metal parts.
2. Apron frames: Materials and construction per this Specification Section.
3. Table legs:
    a. 2-1/2 IN square solid hardwood with all corners radiused 1/4 IN.
    b. Secure to apron frame with heavy-duty corner bolt and 14 GA metal corner brace.
    c. Lock corner braces into apron rails in vertical groves and securely fasten with screws.

d. Leg stretchers (where required):
    1) 1-5/16 IN x 2-1/2 IN solid hardwood.
    2) Secure to legs with mortise and tenon joints and 4 IN long through-bolt.

G. Kneespace Panels and Miscellaneous Fillers:
1. 1/4 IN minimum thick hardwood plywood to match casework.
2. Attach to blind cleats with stainless steel screws and finish washers where concealed fastening is not possible or access to utilities is required.

H. Wood Finish:
1. Surface preparation:
    a. Sand all surfaces to remove loose fibers, scratch marks and abrasions prior to application of wood finish.
    b. Thoroughly remove all sanding dust with compressed air and tack cloth.
2. Wood finish application:
    a. Apply finishes under controlled atmospheric conditions.
    b. Cure finish after application in a humidified oven at 140 DEGF and 30 PCT relative humidity.
3. Wood casework finish:
    a. Finished surface shall meet the performance requirements as set forth by SAMA LF 8.
    b. Concealed and semi-exposed surfaces:
        1) Double-pass coat of resinous wood sealer
    c. Exposed surfaces, including interiors of and shelving in open or glazed cases:
        1) Provide finish resistant to acid, alkali, solvent, water and abrasion.
        2) Double-coat surfaces with a non-fiber-lifting stain or toner to secure specified color.
        3) Thoroughly dry color coat.
        4) Apply, thoroughly dry, sand and dust first sealer coat.
        5) Apply and thoroughly dry second sealer coat.
        6) Apply and thoroughly dry double-pass coat of chemical resistant synthetic varnish, providing semi-gloss finish.

## 2.5 SOURCE QUALITY CONTROL

A. Casework Finish:
1. Performance Test Results (Chemical Spot Tests):
    a. Make chemical spot tests by applying 5 drops of each reagent to the surface to be tested.
    b. Cover each reagent (except those marked **) with a 1-1/4 IN DIA watch glass, convex side down, to confine the reagent.
    c. Spot test volatile solvents marked ** as follows:
        1) Saturate a 1 IN ball of cotton with solvent and place on the surface to be tested.
        2) Then cover cotton ball by an inverted 2 OZ wide mouth bottle to retard evaporation.
    d. Conduct all spot tests in such a manner that the test surface is kept wet throughout the entire test period and at a temperature of 77 DEGF +3 DEGF.
    e. At the end of the test period, flush reagents from the surface with water and scrub the surface with a soft bristle brush under water.
        1) Rinse and dry.
    f. Clean volatile solvent test areas with a cotton swab soaked in the solvent used on the test area.
    g. Immediately prior to evaluation, 16 to 24 HRS after the reagents are removed, scrub the test surface with a damp paper towel and dry with paper towels.

| REAGENTS | TIME IN MINUTES | TEST RATINGS |
|---|---|---|
| Acetone** | 60 | A |
| Ammonium Hydroxide, 28 PCT | 60 | A |
| Benzene** | 60 | A |
| Carbon Tetrachloride** | 60 | A |
| Ethyl Acetate** | 60 | A |
| Ethyl Alcohol** | 60 | A |
| Ethyl Ether** | 60 | A |
| Glacial Acetic Acid, 99 PCT | 60 | A |
| Hydrochloric Acid, 37 PCT | 60 | A |
| Methanol** | 60 | A |
| Methyl Ethyl Ketone** | 60 | A |
| Naphtha** | 60 | A |
| Nitric Acid, 30 PCT | 60 | A |
| Phosphoric Acid, 75 PCT | 60 | A |
| Potassium Hydroxide, 40 PCT | 60 | A |
| Sodium Hydroxide, 40 PCT | 60 | A |
| Sodium Hydroxide, 10 PCT | 60 | A |
| Sulfuric Acid, 70 PCT | 60 | A |
| Toluene** | 60 | A |

2. Performance test results (heat resistance):
   a. Allow hot water (190 DEGF - 205 DEGF) to trickle on the finished surface, setting at an angle of 45 degrees from horizontal, for a period of 5 minutes.
   b. Finish must show no visible effect from the hot water treatment after cooling and wiping dry.
3. Performance test results (moisture resistance):
   a. Soak a 2 IN x 3 IN x 1 IN cellulose sponge with water and place on the finished surface for a period of 100 HRS.
   b. Maintain sponge in wet condition throughout the entire test period.
   c. Finish will show no visible effect after drying.
4. Performance test results (impact resistance):
   a. Drop a 1 LB ball (approximately 2 IN DIA) from a distance of 1 FT onto the finished surface of a 3/4 IN thick plywood panel supported underneath by a solid surface.
   b. Finish will show no evidence of cracks or checks in the finish due to impact upon close examination.

B. Work surface:
1. Performance test results:
   a. Black molded epoxy resin:
      1) Physical properties:
         a) Flexural strength (ASTM D790): 15,000 PSI.
         b) Compressive strength (ASTM D695): 30,000 PSI.
         c) Hardness, Rockwell E (ASTM D785): 100.
         d) Water absorption (ASTM D570) percent by weight:

(1) 24 HRS: 0.04.
(2) Percent by weight, seven days: 0.05.
(3) Percent by weight, 2 HR boil: 0.04.

e) Specific gravity: 1.97.
f) Tensile strength: 8,500 PSI.

2) Performance test results (heat resistance):
   a) Heat a size 0, 15 ml capacity, high form crucible over a Bunsen burner until the bottom attains an incipient red heat.
   b) Immediately transfer the hot crucible to the top surface and allow to cool to room temperature.
   c) Upon removal of the cooled crucible, the top surface shall show no blisters, crack or any breakdown whatsoever.
3) Performance tests results (chemical resistance):
   a) Tops shall resist chemical attacks from normally used laboratory reagents.
   b) Less than 0.1 PCT weight change for top samples submerged in reagents for a period of seven days.
      (1) Tests performed in accordance with ASTM D543 at 77 DEGF.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Preparation:
   1. Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.

## 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Follow manufacturer's printed instructions and Drawings in all cases where items or details are not indicated.

C. Casework:
   1. Set casework components plumb, square, and straight with no distortion.
      a. Securely anchor to building structure.
      b. Shim as required using concealed shims.
   2. Screw continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16 IN tolerance.
   3. Secure wall cabinets to solid supporting material.
      a. Do not secure to plaster or gypsum board.
   4. Abut top edge surfaces in one true plane.
      a. Provide flush joints not to exceed 1/8 IN between top units.
   5. Provide all trim, fillers, closures, stands, supports, sleeves, collars, escutcheons, ferrules, brackets, braces or other miscellaneous items required for complete installation.
   6. Install base molding after installation of base cabinets is complete.

D. Work surfaces:
   1. Scribe to abutting surfaces as required.
   2. Only factory-prepared field joints, located per approved shop drawings, are permitted.
      a. Secure joints in the field, where practical, in the same manner as in the factory.
   3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.
   4. If field cutting or drilling of epoxy resin countertop, backsplash curb or service ledge assembly is required, make holes using saw blades or drill bits as recommended by countertop manufacturers.
   5. Seal all joints in epoxy resin countertops, backsplash curbs and service ledges using materials and methods as recommended by manufacturer.

6. Seal joints in tops, backsplashes, etc., with sealant as specified by countertop manufacturer.
   a. Seal rabbeted cut-out around all drop-in sinks

E. Furnish and set in place all service and plumbing fixtures as indicated.
   1. Except for final mechanical and electrical connections, complete installation of each item in every respect, including all necessary items required for proper operation and appearance.
   2. Where an item of equipment is furnished without a cord and plug, bring electrical wiring in or on equipment to an equipment junction box located on and part of the equipment such that flexible connection no longer than 3 FT is needed to make final connection between items and rough-in junction box.

## 3.3 ADJUSTING AND CLEANING

A. Repair all damage to surrounding area as result of this installation.
   1. Remove all debris and leave area broom clean.

B. Test and adjust all items of equipment for satisfactory operation.

C. Patch all damaged areas of casework in accordance with manufacturer's recommendations.

## 3.4 PROTECTION

A. Cover work surfaces as recommended by manufacturer.
   1. Protect all installed casework and accessories per manufacturer instructions.

B. Remove protection upon acceptance of Project by Owner.

## 3.5 SCHEDULE

A. Keying Schedule.

**END OF SECTION**

# SECTION 12 48 13
## ENTRANCE FLOORING SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

B. Related Sections include but are not necessarily limited to:

### 1.2 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Product data sheet on each component included in the system.

B. Samples:
   1. Manufacturer's full range of grid insert and exposed aluminum colors, textures, finishes, and patterns available.
   2. Minimum 6 IN long sample of each color and type selected.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Arden.
   2. Balco.
   3. Construction Specialties, Inc.
   4. J. L. Industries.
   5. K. N. Crowder.
   6. Pawling.
   7. Reese Enterprises, Inc.

### 2.2 MANUFACTURED UNITS

A. Drainable Recessed Foot Grid System:
   1. Framing members shall be straight frame or ledged frame style.
      a. Aluminum, minimum 16 GA, 6063-T5 alloy.
      b. Maximum depth: 4-1/4 IN.
   2. Grids:
      a. Tread rails shall be aluminum 6063-T5.
      b. Lock bars shall be aluminum 6061-T6.
         1) Maximum 10 IN OC spacing.
      c. Grid inserts shall be vinyl abrasive.
         1) Color of vinyl abrasive grid insert shall be __Black___.
      d. Tread spacing shall be between 1-1/4 and 1-3/4 IN OC.
   3. Finish:
      a. All exposed aluminum surfaces shall receive anodized black finish.
      b. Concealed aluminum surfaces shall have mill finish.
   4. Structural loading: All grid and framing sections, when completely installed, shall be capable of supporting a minimum of 200 LB/SQFT uniform loading.

5. All aluminum members which will come in contact with concrete or masonry shall receive dissimilar materials protection.
6. Unit shall be completely prefabricated and preassembled at the factory.
   a. Provide watertight, minimum 16 GA aluminum pan complete with 2 IN IPS drain and stainless steel strainer.
   b. Pan shall be attached to bottom surface of the frame.
7. See the Plumbing design for drain piping, traps and connections.
8. Unit: C/S Group PEDIGRID Series.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Verify substrate and correct all unsatisfactory conditions.
   1. Installation of unit indicates acceptance of substrate.

### 3.2 INSTALLATION

A. Follow manufacturer's printed instruction for installation.

B. Set units flush with surrounding floor finish level if unit is recessed.
   1. Refer to Room Finish Schedule for floor finish.

C. Provide all trim, fillers, inserts, anchors or other miscellaneous items required for complete installation.

D. Provide temporary wood filler in recess and cover frames with minimum 1/2 IN plywood or fiberglass.

E. Protect installed unit from damage until acceptance by Owner.

**END OF SECTION**

# SECTION 12 51 00
## OFFICE FURNITURE AND FURNISHINGS (OF)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Office furniture and furnishings.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

   a. HFS100, Human Factors Engineering of Visual Display Terminal Workstations.
2. Catalog and/or model numbers are provided to establish minimum quality and functional requirements.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Samples:
   1. Color samples of all available fabric, vinyl, painted steel colors.
   2. Plastic laminate patterns, colors and finishes.

C. Schedule listing room where item is to be located.

D. Submit all system components in a single coordinated transmittal.
   1. Partial submittals will not be accepted.

E. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Desks, file cabinets, tables and chairs:
      a. Steelcase, Inc.
      b. All Steel Company.
      c. Haworth.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 FABRICATED UNITS

A. General:
   1. Baked enamel painted finish on all exposed steel surfaces.
   2. Full height modesty panel.

3. Steel panel leg design on all desks.
4. All pedestals shall be suspended.
5. Desk tops shall have two wire grommets.
6. Provide plastic laminate top with square edge design.
7. Chair shall have fabric upholstery.
    a. All chairs shall meet ANSI HFS100.

B. Furniture Units:
1. OF-3 Desk:
    a. Number: Eight (8)
    b. Location: As shown on Drawings
    c. Single left or right hand pedestal; per plans; with 26 IN high L-return.
        1) L-return to have single pedestal with one box and one file drawer.
    d. 60 x 30 In top.
    e. Two box and one file drawer.
2. OF-3 Executive Chair:
    a. Number: 21
    b. Location: As shown on Drawings
    c. Allsteel "Tolleson Seating."
    d. High back.
    e. Open arm, field replaceable.
    f. Knee tilt, full swivel.
    g. Pneumatic seat height adjustment.
    h. Pleated upholstery with fully upholstered outer back shell.
    i. Soft, dual wheel, five caster base.
3. OF-7 Operational Stool:
    a. Number: One (1)
    b. Location: Water Quality Testing Area
    c. Allsteel "Buhk 1000 Series Stools."
    d. Swivel only with mechanical seat height adjustment.
    e. Footrest.
    f. Soft dual wheel, five caster base.
    g. Molded cushions.
    h. Arms which allow chair to pull up directly to work surface.
    i. Epoxy paint coating on all surfaces not upholstered.
4. OF-10 Vertical Legal File Cabinet:
    a. Number: One (1)
    b. Location: As directed by Owner
    c. 3 drawer
    d. Lockable.
    e. Integral pull.
    f. 18 IN wide x 28 IN deep.
    g. Hanging frames.
    h. Anti-rebound feature.
5. OF-13 Conference Table:
    a. Number: One (1)
    b. Location: Meeting Room
    c. Steelcase "8600 Series."
    d. 150 IN long.
    e. 39 IN wide.
    f. "T" base, minimum of two (2) bases on tables up to 96 IN and minimum of three bases on tables over 96 IN long.
    g. Wood top with wood bullnose edge.
    h. Painted column and scuff resistant base.
6. OF-14 Waste Paper Basket:

a. Number: 15
b. Location: Provide to Owner
c. Rectangular steel 15 x 8 x 17 IN.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Follow manufacturer's printed instructions for installation.

B. Provide all trim, fillers, closures, supports, brackets, braces or other miscellaneous items required for complete installation.

C. Refer to Contract Documents for location of all office furniture and furnishings.

D. Repair all scratches or other damage as a result of shipping and installation.
1. Use patching materials provided by manufacturer.

**END OF SECTION**

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# DIVISION 13

## SPECIAL CONSTRUCTION

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# SECTION 13 31 23
## TENSIONED FABRIC STRUCTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Tensioned Fabric Structures (TFS), as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 REFERENCES

A. ASTM International (ASTM):
   1. ASTM A36 Standard Specification for Carbon Structural Steel
   2. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength
   3. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
   4. ASTM A603 Standard Specification for Zinc-Coated Steel Structural Wire Rope
   5. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
   6. ASTM E108 Standard Test Methods for Fire Tests of Roof Coverings
   7. ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C
   8. ASTM F3125 Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

B. American Society of Civil Engineers (ASCE):
   1. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and other structures.

C. National Fire Protection Association (NFPA):
   1. NFPA 701 National Fire Protection Association Fire Test for Flame Propagation of Textiles and Films.

D. American Welding Society (AWS):
   1. AWS D1.1 American Welding Society Structural Welding Code.
   2. AWS D1.2 American Welding Society Structural Welding Code, Aluminum.

### 1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer product data, including specifications and installation instructions for each component of TFS.
   2. Include laboratory test reports and other data, where applicable.
   3. Structural Calculations: Signed and sealed by engineer licensed to practice Structural Engineering in State project is located and specializing in TFS design and engineering.

B. Shop Drawings:
   1. Dimensioned drawings signed and sealed by engineer licensed to practice Structural Engineering in State project is located.
   2. Include plan view, elevations, details, sections, connections, anchorage, foundations, and footings.
   3. Full and comprehensive assembly procedure guide installation.

C. Samples:
   1. Provide three, 12-inch square fabric swatches in color selected.

### 1.4 QUALITY ASSURANCE

A. Manufacturer Responsibilities:
   1. Design, engineer, fabricate, supply, and install Tension Fabric Structure.
   2. Have been in continuous operation as a professional Tensioned Fabric Structure manufacturer for minimum of 10 years.
   3. Provide full time on site Quality Assurance Manager.

B. Provide Tensioned Fabric Structures engineered to support dead, live, and lateral (wind or seismic) loads indicated.
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.
   2. Include frames, reinforcing members connections and fabric.
   3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

### 1.5 WARRANTY

A. Warrant frame, fabric materials, finish, and workmanship against defects for a period of five (5) years from date of substantial completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Tensioned Fabric Structures:
   1. Base:
      a. Eide Industries, Inc.

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 DESIGN CRITERIA

A. Fabric structure shall be cable supported tensioned membrane.

B. Structural Design:
   1. Comply with applicable codes, regulations and requirements of authorities having jurisdiction.
   2. Design Wind Speed: 90 mph minimum.

C. Engineering:
   1. Prepare structural design drawings defining complete structure, precise interface geometry determination, reaction loads imposed on foundations, anchoring loads, connection details, interfaces, and seam layouts.
   2. Structural calculations:
      a. Large deflection numerical shape generation: Insure stable, uniformly stressed, three dimensionally curved shape in static equilibrium with internal prestress forces and resisting applied loads.
      b. Large deflection finite element method structural analysis of membrane system under applicable wind, seismic and snow loads.
      c. Finite element method structural analysis of support frame system.
      d. Member sizing calculations of primary structural members.
      e. Connection design including bolt, weld, and ancillary member sizing.
      f. Biaxial Fabric test specification, interpretation, and fabric compensation determination.
      g. Accurate generation of two dimensional compensated fabric templates required to generate three dimensional equilibrium shapes.

### 2.3 MATERIALS

A. Fabric Membrane:
   1. Low Elongation PVC/PVDF Coated Polyester
   2. Tensile Strength: To meet design requirements.

3. Light Transmission: 8 - 14 percent.
4. Color: White.
5. Flame retardant per NFPA 701.
6. Composure: Solid and water repellent.
7. Seams: RF Sealed.

B. Steel Framing:
1. Fabricate structural steel frame using standard shapes. Minimum A36 for standard profiles and A500 Grade B for structural tubes.
2. Fabricate in accordance with guidelines set forth by AISC steel design manual and AWS.
3. Fabricate structural members in as large segments possible to minimize field joints.
4. Grind smooth all welds, corners, and sharp edges.
5. Abrasive blast and prime steel prior to application of polyester powder coat finish.
6. Finish: Polyester powder coat. Minimum 3 mil coverage.

C. Membrane Plates and Clamps:
1. Aluminum: 6061-T6.
2. Finish: Polyester powder coat. Minimum 3 mil coverage.

D. Cables and Fittings:
1. Wire rope:
a. Conform to AISI Steel Cable Manual.
b. Class A galvanized coating. IWRC improved plow steel.
c. Hot dipped galvanized cable terminations and connectors.
2. Pre-stretch cables per ASTM A603.
3. Design fittings and attach to develop full breaking strength of cable.
4. Thimble end fittings: Minimum of 110 percent cable breaking strength.
5. Electro-galvanize swaged end fittings, pins, nuts, and washers.
6. Hot dip galvanize end fittings.
7. Tension cable to double design load before length is cut.

E. Fasteners:
1. Provide fasteners and hardware accessories of types and sizes suited for application:
a. Hot dipped galvanized high strength bolts, nuts, and washers.
b. Conform to ASTM F3125.
c. All other fasteners shall be adequately sized and treated for corrosion protection.
2. Concrete Anchor Bolts:
a. Hot dipped galvanized.
b. Conform to ASTM A307.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine conditions under which work is to be performed.

B. Correct unsatisfactory conditions before proceeding with installation.

### 3.2 ERECTION

A. Comply with Manufacturer recommendations, approved shop drawings and applicable Code requirements.

B. After installation, repair or replace marred or abraded surfaces to original condition using same paint or coating as factory-applied finishes.

## END OF SECTION

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# SECTION 13 34 19
## METAL BUILDING SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Complete metal building frame system including but not limited to:
      a. Design.
      b. Materials.
      c. Fabrication.
      d. Shipment.
      e. Erection.
      f. Components as specified.
   2. Building envelope – wall, roof, and fenestration are excluded from this specification.
      a. Providing structural and miscellaneous framing for new penetrations being cut into roof and wall systems.
      b. Providing structural and miscellaneous framing to support new equipment being installed on roof and wall systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 07 41 13 Insulated Metal Roof Panels
   5. Section 07 42 14 Preformed Factory-Insulated Wall Panels
   6. Section 07 92 00 - Joint Sealants.
   7. Section 08 11 00 - Hollow Metal Doors and Frames.
   8. Division 08 - Openings
   9. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American Architectural Manufacturers Association (AAMA):
      a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
   3. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      d. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      e. A792/A792M, Standard Specification for Steel Sheet, 55 PCT Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
      f. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      g. C653, Standard Guide for Determination of the Thermal Resistance of Low-Density Blanket-Type Mineral Fiber Insulation.

h. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
i. C991, Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
j. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
k. D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
l. D4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
m. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
n. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
o. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
p. F436, Standard Specification for Hardened Steel Washers.
q. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
r. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
s. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

4. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.3/D1.3M, Structural Welding Code - Sheet Steel.
5. FM Global (FM).
   a. FMRC Standard 4471, Approval Standard for Class 1 Roofs for Hail Damage Resistance, Combustibility, and Wind Uplift Resistance.
6. International Accreditation Service (IAS):
   a. AC472, Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems.
7. Metal Building Manufacturer's Association (MBMA):
   a. Low Rise Building Systems Manual.
8. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.
9. The Society for Protective Coatings/NACE International (SSPC/NACE).
   a. SP 6/NACE No. 3, Commercial Blast Cleaning.
10. Underwriters Laboratories, Inc. (UL):
    a. Building Materials Directory.

B. Qualifications:
1. Manufacturer's qualifications:
   a. Manufacturer must be member in good standing of the MBMA.
   b. Manufacturer must be currently approved by IAS Accreditation Committed under the Inspection Programs for Manufacturers of Metal Buildings Systems IAS AC472 to assure compliance with fabrication Special Inspections as required by the building code.
2. Erector qualifications:
   a. Erector (installer) must be approved in writing by metal building manufacturer.
   b. Erector must have minimum of 10 years current experience in erection of similar structures.
3. Manufacturer's Structural Engineer: Registered in the State of Oregon.

## 1.3 DEFINITIONS

A. Code: The word "code" refers to the building code.

B. Installer, Erector or Applicator:

1. Installer, erector or applicator is the person actually installing, erecting or applying the product in the field at the Project site.
2. Installer, erector and applicator are synonymous.

C. PVDF: Polyvinylidene fluoride.
1. Nomenclature as listed in Bibliography of the MBMA Low Rise Building Systems Manual.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's technical reference manual containing all of the manufacturer's standard construction details and specifications.
1) Manufacturer's erection manual containing all details and methods for installation of building frame, roof system, wall system, and accessories.
2) Edit to mark out items not used for this installation.
3. Design and fabrication drawings:
a. Erection drawings minimum scale: 1/8 IN = 1 FT-0 IN.
b. Details and sections minimum scale: 1-1/2 IN = 1 FT-0 IN.
c. List of all design loads and combination of loads.
d. Size and location of each component of the building.
1) Include clearance under structural framing members, both horizontal and vertical.
2) Include cross-section of components.
e. Fasteners and details of fasteners connecting each component of the building.
f. Size, location and details of anchor bolts, base plates, and all other components fastened to the foundation.
1) Size anchor bolts and base plates assuming 3000 PSI concrete.
g. Details of wall panels, roof panels, finishes, flashings, closures, closure strips, trim, gutters, downspouts, sealant, and all other miscellaneous components.
4. Letter stating product name or formulation and DFT of manufacturer's standard shop applied primer paint coating.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Manufacturer's and Erector's Qualifications.
2. Manufacturer's approval of erector.
3. Manufacturer's Certificate of Accreditation per IAS AC472.
4. Structural calculations stamped and signed by a professional Structural Engineer licensed in the State where Project is located.
a. Include list of design loads and loads transmitted to foundation through columns or walls and location where loads occur.
b. Submit calculations for information only.
5. Certificate of compliance by fabricator that steel was fabricated in accordance with the approved construction documents.

## 1.5 WARRANTY

A. Manufacturer's standard warranty.

B. Provide written notice of any exceptions taken to warranties.
1. Any exceptions may be grounds for not accepting the manufacturer, at the discretion of the Owner or Engineer.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Metal building systems:
      a. Butler Manufacturing.
      b. NCI Building Systems.
      c. Nucor Building Systems.
      d. Star Building Systems.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 SYSTEM DESCRIPTION

A. Buildings shall be insulated (under separate specifications), clear span rigid frame, or beam and column or truss frame single slope self-framing type with vertical walls and single slope roof.
   1. Provide cross bracing in the side walls perpendicular to the rigid frame.
   2. Buildings with flush girts must have cast-in-place anchor bolts, due to minimum edge distance requirements for alternate anchor types.

B. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.

### 2.3 BUILDING DESIGN CRITERIA

A. Critical Dimensions:
   1. Building Size:
      a. As indicated on the Drawings.
   2. Roof slope:
      a. As indicated on the Drawings.
   3. Provide minimum clear inside dimensions as noted on the Drawings.
   4. Horizontal Plan Dimensions:
      a. Measure to exterior face of girts.
      b. Measure to interior face of girts / outside face of rigid frame.
   5. Eave Height:
      a. Measure from top of finished floor to intersection of insides of roof and sidewall sheets.
   6. Clear height between finished floor and bottom of roof steel: indicated on the drawings.

B. Building Foundation:
   1. All footings, foundations, and piers have been designed based on assumed loadings and reactions.
      a. Member sizes and geometry may vary depending on the building being supplied.
      b. Do not construct these members until Engineer has verified design with approved Shop Drawings of metal building being supplied.
      c. Design all column base plates as pinned connections. Fixed base plates are not permitted.

C. Roof Live Loads:
   1. Roof framing members:
      a. Per building code.
      b. 20 PSF uniformly distributed live load.
      c. 2000 LB concentrated (point live load) at panel point of lower chord of trusses or at any point along primary structural members.
      d. Roof live loads as shown on Drawings.
   2. The above loads are in addition to other applicable equipment loads and shall be applied to the horizontal projection of the roof.

D. Snow Loads:
   1. Design structure for snow loading as set forth in the building code.
      a. Project site conditions are as follows:
         1) Basic ground snow: 37 PSF.
         2) Importance factor: 1.2.
         3) Snow exposure coefficient: 0.9.
   2. Design roof panels, secondary support members and primary framing where appropriate for a snow load drifting accumulation as specified in the building code.

E. Wind Loads:
   1. Design structure for wind loading as set forth in the building code.
      a. Project site conditions are as follows:
         1) Basic wind speed: 106 MPH.
         2) Site exposure: Class C.
         3) Importance factor: 1.0.
         4) Enclosure type: Enclosed or .

F. Seismic (Earthquake) Loads: Refer to Structural Drawings

G. Auxiliary Loads: Refer to Structural Drawings

H. Combination of Loads:
   1. The combining of dead, live, snow, wind, seismic and auxiliary loads for design purposes as set forth in the building code, unless otherwise specified.
   2. Horizontal sway deflection of building due to combination of required design loads:
      a. H/60.
   3. Deflection of purlins and secondary members not to exceed L/180 of its span when supporting applicable vertical live, dead, and auxiliary loads.

## 2.4 MATERIALS

A. Steel:
   1. Structural Shapes and Plate:
      a. All W-shapes and WT-shapes: ASTM A992/A992M.
      b. HSS-shapes: ASTM A500 Gr C.
      c. All other plates, bars and rolled shapes: ASTM A36/A36M.
      d. Unless noted otherwise on Drawings.
   2. Miscellaneous Metals:
      a. Insulation support: Structural Steel Grade 50 per ASTM C653.

B. Bolts, Nuts and Washers, High Strength:
   1. Bolts: ASTM F3125, Grade A325.
   2. Nuts: ASTM A563.
   3. Washers (hardened): ASTM F436.
   4. Galvanized, ASTM A153/A153M.
   5. Provide two washers with all bolts.

C. Bolts and Nuts:
   1. ASTM A307, Grade A.
   2. Galvanized, ASTM A153/A153M.

D. Anchor Bolts:
   1. ASTM A307, ASTM A36/A36M, galvanized steel.
   2. Embedment details to be provided by building manufacturer.

E. Fasteners:
   1. Roof and wall panels: 300 series stainless steel, ASTM F593.
   2. Miscellaneous fasteners: Corrosion resistant.

F. Any structural member to be hot-dipped galvanized shall be minimum 12 GA thickness.

G. Roof and Fascia Panels:
   1. See Specification 07 41 13.

H. Wall Panels:
   1. See Specification 07 42 14.

I. Gutters and Downspouts:
   1. Same material and factory applied finish to match roof panels.

J. Grout: See Division 03.

K. Closures: Neoprene.

L. Calking and Sealants:
   1. See Specification Section 07 92 00.

## 2.5 FABRICATION

A. General:
   1. Fabricate building structure, roof and wall panels, accessories and trim in accordance with requirements of AISC and MBMA.
   2. Provide all necessary clips, flashing angles, caps, channels, closures, bases and any other miscellaneous trim required for complete water and airtight installation.
      a. Provide an inside closure at the base of all corrugated panels and an outside closure at the top of all corrugated panels in addition to all other closure strips required.
         1) Form closure strips to fit the corrugation of the metal panels and securely support in place.
         2) Closure strips shall fit between corrugated panels and trim or flashing as required to completely separate the interior of the building from the exterior.
      b. Provide flashing at all intersections of wall panels and roof panels, and above all openings in wall and roof panels, in addition to all other flashing required.
         1) Form flashing:
            a) To completely contain water on the outside of the building.
            b) To be watertight and securely fastened in place.
      c. Provide sealant at all edges where metal panel trim or flashing is adjacent to the foundation of the building in addition to all other sealant required.
   3. At door, window and louver openings, provide additional framing and fasteners as required to structurally replace the wall panel and/or framing displaced.
   4. Fabricate and prepare material for shipment knocked down.
   5. Factory punch frame to receive all fasteners.
   6. Finishes:
      a. Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances.
         1) Clean all primary and secondary structural steel members, not noted as being galvanized, in accordance with SSPC SP 6/NACE No. 3.
      b. All structural components shall have primer paint coats applied in the shop and finish coats applied in the field.
         1) Shop paint, prime and finish coats, all surfaces which will be inaccessible after erection.
         2) Paint in accordance with Specification Section 09 96 00.
         3) Paint surfaces of all components not exposed to view.
         4) Manufacturer's standard shop applied primer is not acceptable as substitute for primer specified.

B. Primary Framing:
   1. Coating:
      a. 300B area: Galvanized Steel
      b. All other buildings: Painted Steel.
   2. Rigid Frames:

a. Frames: Welded-up plate section columns and roof beams, complete with necessary splice plates for bolted field assembly.
b. Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes factory fabricated.
c. Columns and Roof Beams: Fabricated complete with holes in webs and flanges for attachment of secondary structural members and bracing.
d. Bolts for Field Assembly of Frame Members: High-strength bolts.

3. Endwall Structural Members:
   a. Welded-up plate sections or rolled shapes designed in accordance with AISC Specification for Structural Steel Buildings.
   b. Endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.
   c. Splice Plates and Base Clips: Shop fabricated complete with bolt connection holes.
   d. Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes shop fabricated.
   e. Beams and Posts: Factory fabricated complete with holes for attachment of secondary structural members.
4. Intermediate Frames:
   a. Substituted for end-wall roof beams, when specified.
   b. Factory fabricate necessary endwall posts and holes for connection to intermediate frame used in endwall.

C. Secondary Structural Members:
1. Coating: match primary framing coating
2. Wall Purlins (Girts):
   a. In-set column purlins.
3. Purlins:
   a. Purlins:
      1) Zee-shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
      2) Zee sections to be design by manufacturer.
   b. Eave Members:
      1) Eave Struts:
         a) Cee-shapped precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
         b) Factory punched cee sections to be design by manufacturer.
      2) Girts:
         a) Zee or Cee shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
         b) Zee or cee sections to be design by manufacturer.
      3) Outer Flange of Girts: Factory-punched holes for panel connections.
   c. Bracing:
      1) Locate bracing as indicated on the Drawings.
      2) Diagonal Bracing:
         a) Hot-rolled rods or rolled angle sections to be design by manufacturer.
         b) Attach to columns and roof beams.
      3) Flange Braces and Purlin Braces: Cold formed and installed as indicated on the Drawings.

D. Welding:
1. Welding Procedures, Operator Qualifications, and Welding Quality Standards:
   a. AWS D1.1.
   b. AWS D1.3.
2. Welding inspection, other than visual inspection as defined by AWS D1.1, paragraph 6.9, shall be identified and negotiated before bidding.
3. Certification of Welder Qualification: Supply when requested.

E. Framed Openings:
   1. Walls:
      a. Provide all necessary subframing, including connections, to support wall openings for doors, windows, louvers, pipe or duct penetrations, etc.
         1) Material gage to be determined by metal building manufacturer for size of opening.
      b. Size and location of opening as shown on the Drawings.
      c. Jamb, lintel and girts:
         1) Steel:
            a) Match primary framing coating.
         2) Metal building manufacturer responsible for providing correct size opening for penetration scheduled, shown or specified.
      d. Provide trim to cover all exposed areas of opening frames to match with the wall panels.
   2. Roofs:
      a. Provide all necessary roof subframing to support roof mounted equipment and to frame roof penetrations.
         1) Material gage to be determined by metal building manufacturer for size of equipment or opening.
      b. Location of roof mounted equipment and/or roof or wall opening as shown on the Drawings.
      c. Purlins, angles, clips:
         1) Steel:
            a) Factory applied prime coat per Section 09 96 00.
         2) Metal building manufacturer responsible for providing correct size of opening for penetration scheduled, shown or specified.

F. Painting of Structural Steel Framing System:
   1. General:
      a. Structural Steel: Prime paint as temporary protection against ordinary atmospheric conditions.
      b. Perform subsequent finish painting, if required, in field as specified in the painting section.
      c. Before painting, clean steel of loose rust, loose mill scale, dirt, and other foreign materials.
   2. Primary Frames:
      a. Clean steel in accordance with SSPC SP 2.
      b. Factory cover steel with 1 coat of gray water-reducible alkyd primer paint formulated to equal or exceed performance requirements SSPC-Paint 15.
      c. Minimum Coating Thickness: 1.0 MIL.
   3. Secondary Structural Members – Roll-Formed:
      a. Hot-dipped zinc coating, ASTM A653, G30; followed by 1 coat of clear acrylic finish.
      b. Acrylic-Coated G30 Galvanized Steel: Equal or exceed performance requirements of SSPC Paint-15.

G. Louvers:
   1. See Specification Section 08 90 00.

H. Snow Retention Systems:
   1. Provided by the Metal Building System manufacturer.
      a. To be covered by the warranty provided by the Metal Building System manufacturer.
   2. Mechanical non-penetrating system for sloped metal roof systems to prevent ice and snow from sliding off roof.
   3. Components:
      a. Clamps (non-penetrating attachment):
         1) 6061-T6 aluminum extrusions conforming to ASTM B221.
         2) Fasteners: 300 Series stainless steel.

b. Cross Members:
   1) 6061-T6 aluminum extrusions conforming to ASTM B221.
   2) Receptacle in face to receive color-matched metal strips.
   3) Provide splice connectors ensuring alignment and structural continuity at end joints.
c. Color Strips:
   1) Same material and finish as roof panels; obtained from roof panel manufacturer.
d. Snow and Ice Clips:
   1) Aluminum, with rubber foot, minimum 3 IN wide.
   2) Height as required for roof profile.
e. Finish:
   1) Mill.

4. Performance Requirements:
   a. Provide snow guards to withstand exposure to the weather and environmental elements, and resist design forces without failure due to defective manufacture.
   b. Utilize a factor of safety greater than 2 to determine allowable loads from ultimate tested clamp tensile load values.
5. Installation:
   a. Provide clamps or brackets at 32 IN maximum spacing.
   b. Install snow guards starting 2 FT from the eave edge of the roof and extending uniformly upward and laterally over the entire roof area spaced at not more than 16 IN OC in each direction.
   c. Fasten to roof surface as recommended by manufacturer.
      1) Fasteners shall be compatible with roof panel system and shall not void any roof warranties.
      2) Fasteners shall not damage panel finish.
6. Refer to Drawings for roof areas to receive snow guards.
7. Basis of Design: S-5! Metal Roof Innovations; Colorgard series or equal.

I. Roof Penetration Flashing (Maximum 13 IN DIA):
   1. Flashing material: EPDM rubber with an aluminum sealing ring base.
   2. Minimum projection above the weather surface of the roof: 8 IN.
   3. Configuration of the flanges to match the roof panel.

J. Specification Section for manufacturer's internal quality control requirements.

K. Testing:
   1. Owner may employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
   2. Independent testing agency shall have a minimum of five (5) years performing similar work and shall be subject to Owner's approval.

### 2.6 MAINTENANCE MATERIALS

A. Provide one gallon of touch up paint for each color provided on the building.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
   1. Install tolerances in accordance with AISC 303, Code of Standard Practice.
      a. Install products straight without bowing, sagging, or warping.
   2. Install all fasteners.
   3. Install base plates on grout bed.
      a. Grout bed to be 1 IN thick unless noted otherwise on the Drawings.

## 3.2 INSTALLATION – OTHER ITEMS

A. Separate the roof support member from the roof panel, except at each concealed structural fastener, with a spacer of material having a density of not less than 2 PCF and, if of a combustible material, having a flame spread rating no greater than 25.

B. Fasten roof panels to purlins or secondary support members in accordance with manufacturer's recommendations.

C. Provide all closures, angles and gasketing required for complete weather tight installation at locations where new penetrations are being cut into roof or wall system.
   1. Tape or seal insulation and vapor barrier, using tape recommended by vapor barrier manufacturers, to maintain integrity of vapor barrier.

D. Install wall panels to supporting structure with concealed fasteners.
   1. Finish of fasteners to match panel finish.

E. Install door frames, window frames, louvers, trim and other miscellaneous items in accordance with manufacturer's instructions and details.

## 3.3 FIELD QUALITY CONTROL

A. All inspections and tests are to be performed at the Project site by a third party independent testing agency.

B. Inspect field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
   1. Visually inspect all welds.
   2. Test 50 PCT of full penetration welds and 10 PCT of fillet welds with liquid dye penetrant.
   3. Test 20 PCT of full penetration welds with ultrasonic or radiographic testing.

C. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints, Section 9.
   1. Inspect while work is in progress.

D. Inspect structural steel which has been erected.

E. Prepare and submit test reports to Engineer.

## 3.4 ADJUSTING AND CLEANING

A. See Specification Section 01 75 00 for Adjusting requirements.

B. See Specification Section 01 74 00 for Cleaning requirements.

C. Touch up paint any scratched factory finished surfaces or remove and replace as directed by Engineer.

D. Remove and replace any damaged wall or roof panels, frames, etc., as directed by Engineer.

**END OF SECTION**

# SECTION 13 44 00
FABRIC BAFFLE WALL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Design, fabrication, and erection of tension-fabric baffle systems composed of NSF 61 compliant material for the reservoir as shown on the drawings and specified herein.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 – Metal Fabrications.
   4. Section 33 16 25 – Welded Steel Water Storage Tank.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D413, Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate.
      b. D471, Standard Test Methods for Rubber Property – Effect of Liquids.
      c. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 deg C and 30 deg C.
      d. D751, Standard Test Method for Coated Fabrics
      e. D1204, Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature.
      f. D2136, Standard Test Method for Coated Fabrics – Low Temperature Bend Test.
      g. D3389, Standard Test Method for Coated Fabrics Abrasion Resistance.
      h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
      i. G153, Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
   2. NSF International (NSF):
      a. Standard 61-2019, Drinking Water System Components – Health Effects.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations on reinforcing field cut openings.
   3. Fabrication and/or layout drawings.
      a. Plan showing profile, location, section, and details of each item including anchorage or support system(s).
      b. Locations and type of expansion joints.
      c. Materials of construction including shop applied coatings.
      d. Listing of all accessory items being provided indicating material, finish, etc.

B. Baffle system installer experience including a list of all similar installation projects completed within the previous 5 years.

C. Warranty: Fabric manufacturer shall confirm in writing, that the material to be furnished will be free of defects in materials and workmanship at the time of the sale, and against deterioration due to effects of ozone, ultraviolet or other normal weathering on a pro-rated basis for up to 10 years from the date of completed installation.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle materials to preclude damage.
Store all materials on skids above ground. Keep free of dirt and other foreign matter which will damage items or finish and protect from corrosion and UV exposure.

## PART 2 - PRODUCTS

### 2.1 DESIGN REQUIREMENTS

A. Baffles shall confirm to the specified dimensions shown on the drawings.

B. The baffles shall be erected and anchored as shown in the drawings.

### 2.2 FABRIC

A. Listed by NSF 61 as being acceptable for use in potable water.

B. Knitted polymer coated polyester fabric with a 6.5 oz. /sq. yd. minimum weight.

C. Free of all defects such as holes, tears, blisters and any other defects that may affect its serviceability.

D. Not be less than 30 mils thickness with a +10 percent allowable variation. Not less than 7 mils thickness of polymer coating over the base fabric.

E. Non-wicking.

F. The fabric shall meet or exceed the following minimum physical properties:

| Fabric Physical Properties | Requirement | |
|---|---|---|
| | USC Units | Metric Units |
| Base Fabric Type | Polyester | |
| Base Fabric Weight (nominal) | 6.5 oz/yd$^2$ | 220 g/m$^2$ |
| Thickness<br>ASTM D 751 | 30.0 mils min | 0.75 mm min |
| Weight<br>ASTM D 751 | 30.0 ± 2 oz/yd$^2$ | 1020 ± 70 g/m$^2$ |
| Tear Strength<br>ASTM D 751, Trapezoid Tear | 35/35 lb min | 155/155 N min |
| Breaking Yield Strength<br>ASTM D 751, Grab Tensile Procedure A | 550/550 lb min | 2450/2450 N min |
| Low Temperature<br>ASTM D 2136, 4 hr – 1/8-inch mandrel | Pass @ -30°F | Pass @ -35° C |
| Dimensional Stability<br>ASTM D 1204, 212°F - 1 hr | 1.5% max each direction | 1.5% max each direction |
| Adhesion Heat Sealed Seam<br>ASTM D 751, Dielectric Weld | 35 lb/2 in min | 150 N/5 cm min |
| Dead Load Seam Shear Strength<br>ASTM D 751, 4 hr test | 2 in seam, 1 in strip<br>210 lb @ 70°F<br>105 lb @ 160°F | 5 cm seam, 2.5 cm strip<br>935 N @ 21°C<br>465 N @ 70°C |
| Bursting Strength<br>ASTM D 751, Ball Tip | 650 lb min<br>800 lb typical | 2890 N min<br>3560 N typical |

| Fabric Physical Properties | Requirement | |
|---|---|---|
| | USC Units | Metric Units |
| Hydrostatic Resistance<br>ASTM D 751, Method A | 800 psi min | 540 N/sq cm min |
| Blocking Resistance<br>ASTM D 751, 180°F/82°C | #2 Rating max | |
| Adhesion - Ply<br>ASTM D 413, Type A | 15 lb/min<br>or Film Tearing Bond | 65 N/2.5 cm min<br>or Film Tearing Bond |
| Bonded Seam Strength<br>ASTM D 751, Grab Test Method, Procedure A | 550 lb min | 2450 N min |
| Abrasion Resistance<br>ASTM D 3389, H-18 Wheel<br>1000 g load | 2000 cycles (min) before fabric exposure<br>50 mg/100 cycles max weight loss | |
| Weathering Resistance<br>ASTM G 153 (Carbon-Arc) | 8000 hrs (min) - No appreciable changes or stiffening or cracking of coating | |
| Water Absorption<br>ASTM D 471, Section 12<br>7 Days | 0.025 $kg/m^2$ max @ 70°F/21°C<br>0.14 $kg/m^2$ max @ 212°F/100°C | |
| Wicking<br>ASTM D 751 | 1/8 in max | 0.3 cm max |
| Puncture Resistance<br>ASTM D 4833 | 250 lb min | 1110 N min |
| Coefficient Of Thermal Expansion/Contraction<br>ASTM D 696 | $8 \times 10^{-6}$ in/in/°F max | $1.4 \times 10^{-5}$ cm/cm/°C max |

### 2.3 ACCEPTABLE PRODUCTS

A. 8130 XR-3-PW as manufactured by the Seaman Corporation of Wooster, Ohio.

B. Or equal.

### 2.4 FASTENERS AND HARDWARE

A. Reference Specification 05 50 00.

B. All bolts, washers, nuts, and expansion anchors shall be type 316 stainless steel, minimum 3/8-inch diameter.

C. Batten connection shall be shall be type 316 stainless steel flat bar, minimum ¼-inch thickness by 2 inches wide.

D. Floor and Wall connection shall be type 316 stainless steel angle, minimum ¼-inch thickness by 2 inches wide by 2 inches wide.

E. Suspension and Tension for the top and open ends of the curtain(s) shall be type 316 stainless steel 3/16-inch-diameter cable with type 316 stainless steel 3/16-inch cable clamps and thimbles.

## PART 3 - EXECUTION

### 3.1 COORDINATION

A. The baffle system installer shall coordinate with the Engineer and the tank manufacturer concerning attachment details and the sequence of construction. The connection details are shown on the plans are provided as a guide for the contractor and baffle system installer.

## 3.2 INSPECTION

A. All sheets and seams shall be 100% visually inspected during fabrication. No defective seams or exposed scrim will be allowed. All exposed scrim edges shall be sealed with an approved polypropylene edge sealant or capped with a strip of unreinforced polypropylene. All indicated repairs shall be made by the baffle fabric fabricator before the panels are packaged for shipment.

B. In addition to visual inspection, a 48-inch (1.2m) weld sample shall be made with each factory seam welding unit used in this work at the beginning of every work shift and every four hours of production thereafter. Sample shall be taken from a seam specifically made for quality testing and not taken from the fabricated panel itself. Test specimens shall be cut at quarter points from each 48-inch seam sample (a total of three places) and tested for seam strength and peel adhesion. The shear seam strength shall be tested in accordance with ASTM D751 as modified in Annex A of ANSI/NSF 54. The peel adhesion shall be tested in accordance with ASTM D 4437 as modified in Annex A of ANSI/NSF 54.
   1. A log shall be maintained showing the date, time, panel number, and test results. Failure of the material and/or seams to meet all the requirements of these specifications may be cause for rejection of the material and/or seams as appropriate. The Fabricator shall provide the test results to the Owner or Engineer upon request.

C. Upon completion of baffle wall installation, contractor shall visually inspect the baffle walls for damage from ground level. Any repairs shall be made with newly manufactured material cut with rounded corners extending 4-inches in each direction from the damaged area. The entire repair shall be completely welded to the baffle wall.

## 3.3 INSTALLATION

A. Field verify dimensions in each reservoir tank and provide the field dimensions to the baffle system installer prior to fabrication of the baffle curtains.

B. All work shall be fabricated and erected in accordance with the approved submittal drawings. For those baffles requiring widths greater than the coated fabric available from the manufacturer, a thermal fusion heat seam nominal 2 inches wide shall be used at those locations to join multiple widths of fabric together. The strength of the seam shall be as great as or greater than the parent material in shear strength.

C. Baffle shall be secured to the floor and walls with type 316 Stainless Steel Angles with type 316 stainless steel expansion anchors. All baffle penetrations shall be punched. Provide 3/8-inch polypropylene rope in the 4-inch-wide, double hem on the perimeter of the baffle curtain(s). The 3/8-inch polypropylene rope inside the 4-inch-wide hem shall be behind the stainless steel plates at floor and wall locations.

D. Provide stainless steel pipe and stainless steel angle plates; or stainless steel flat plates sandwiching the baffle curtain on the top edge and open end of the baffle wall with 3/8-inch bolts for attaching the baffle to the top and the open end wall of the tank as shown on the drawings.

E. Provide stainless steel ¼-inch x 2-inch x 2-inch x 2-inch angle plates to be attached to the ceiling and the open end wall of the tank for securing the type 316 stainless steel 3/16-inch-diameter cable from the tank wall to the top edge or open end of the baffle curtain to tension or suspend the baffle curtain. The type 316 stainless steel 3/16-inch-diameter cable shall be secured using type 316 stainless steel 3/16-inch cable clamps.

**END OF SECTION**

# DIVISION 14

## CONVEYING EQUIPMENT

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# FSECTION 14 24 24
## HYDRAULIC ELEVATORS - MACHINE ROOMLESS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Hydraulic Elevators – Passenger, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Provide elevators manufactured by a firm with a minimum of 10 years experience in fabrication of elevators equivalent to those specified.

B. Optional items manufacturers are responsible for, at no additional cost to Owner:
   1. Costs for dimensional adjustments to fit their elevators to openings.
      a. Hoistway inside dimensions or floor to floor heights shall not be changed.
   2. Provide or arrange for additional electrical wiring, energy, panels, transformers etc., required to accommodate their elevators.

C. Installer Qualifications:
   1. Installed by the manufacturer.
   2. Provide licenses and permits and perform required inspections and tests.

D. Design elevator system maintainable by manufacturer approved, licensed elevator maintenance company:
   1. Manufacturer provided or approved diagnostic devices, special tools, or instructions.
   2. Provide onsite capability to diagnose faults to circuit boards and components for the elevator controller.
   3. Provide detachable device for fault diagnosis.
      a. Device and software shall remain property of manufacturer.
   4. Provide upgrades and/or revisions of software:
      a. During the progress of the work.
      b. Warranty period.
      c. Term of the ongoing maintenance agreement between the Owner and original provider.
   5. Diagnostic equipment complete with:
      a. Access codes.
      b. Adjusters and set-up manuals including:
         1) Adjustment.
         2) Diagnosis.
         3) Troubleshooting of elevator system.
         4) Performance of routine safety tests.

E. Reference Standards:
   1. ASME A17.1 / CSA B44 - Safety Code for Elevators and Escalators.
   2. ANSI A117.1 Accessible and Usable Buildings and Facilities.
   3. ADA Standards for Accessible Design.
   4. ANSI/NFPA 70, National Electrical Code.
   5. ANSI/NFPA 80, Fire Doors and Windows.
   6. ANSI/UL 10B, Fire Tests of Door Assemblies.

F. Seismic Design Parameters:
   1. Design and install equipment in compliance with Site Classification and Design Categories as defined in International Building Code.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Hoistway Plans and Machine Room Plans and Sections clearly showing the following:
      a. Structural Loads imposed on building superstructure.
      b. Clearances and travel of car.
      c. Hoistway and pit dimensions.
      d. Location and sizes of access doors, hoistway entrances and frames.
      e. Car, guide rails, buffers and other components in hoistway.
      f. Signal and operating fixtures, operating panels and indicators.
      g. Cab design, dimensions and layout.
      h. Hoistway-door and frame details.
      i. Electrical characteristics and connection requirements.
      j. Heat dissipation (BTU) of elevator equipment.

B. Product Data:
   1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
      a. Car enclosures and hoistway entrances.
      b. Operation, control, and signal systems.
   2. Bio-based hydraulic fluid.

C. Samples:
   1. Cab and entrance finishes.

D. Contract Closeout Information:
   1. Inspection and Acceptance Certificates and Operating Permits.
   2. Operation and Maintenance Data.
   3. Owner instruction report.
   4. Warranty.

### 1.4 WARRANTY

A. 1 year Service Contract.

B. Service Contract:
   1. Include examination, oiling, greasing, adjustment and repairs as required.
   2. Normal work hour service.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Hydraulic Elevators - Passenger:
   1. Base:
      a. ThyssenKrupp Elevator.
   2. Optional:
      a. Otis Elevator

B. Other manufacturers desiring approval comply with Section 01 61 00.

### 2.2 GENERAL PARAMETERS

A. Quantity of Elevators in this Group: 1.

B. Elevator Names / Mark Numbers: Elevator 1.

C. Elevator Operating Equipment:
   1. Oil Hydraulic power unit and cylinder.
   2. Machine Roomless
   3. Cylinder Configuration:

a. Twin, direct-acting cylinders without well hole.

D. Cab Minimum Dimensions, Inside Clear, and Capacity Rating:
1. 5 FT-8 IN Wide x 4 FT-3 IN Deep, 2,100 LBS.

E. Cab Height:
1. Standard height: 95 IN nominal.
a. Inside clear:
1) 88 IN nominal.

F. Speed:
1. 100 FPM.

G. Travel: 12 FT 0 IN.

H. Number of Stops: 2.

I. Hoistway Entrances:
1. Quantity, per elevator:
a. Front: 1.
2. Door Type:
a. Side opening.
3. Door Opening Width (clear):
a. 36 IN.
4. Door Height (clear):
a. 84 IN (@ Standard height Cars).
5. Model: Otis Hydrofit, 2100

## 2.3 ELEVATOR MACHINE EQUIPMENT

A. General:
1. Hydraulic system: Compact design suitable for operation under the required pressure.
2. Locate hydraulic tank and controller in hoistway.
3. Main Power Supply: 460 VAC, 3 Phase, with a separate equipment grounding conductor.
4. Secondary Power: 110 VAC, 1 Phase hydraulic power source to reposition elevator in the event of a system component failure.
5. Car Lighting Power Supply: 120 VAC, 1 Phase, 15 Amp, 60 Hz.
6. Speed: + 2 PCT of specified speed under any loading condition or direction of travel.
7. Stopping Accuracy: 1/4 IN under any loading condition or direction of travel.
8. Electrical work: Provide necessary wiring to connect parts of equipment.

B. Power Unit:
1. Mount in the elevator pit.
2. Control valve shall include an integral check valve.
3. Control section shall direct the main valve and control up and down starting, acceleration, transition from full speed to leveling speed, up and down stops, pressure relief and manual lowering.
4. Include: Muffler, low-pressure switch and a shut-off valve.
5. Mount motor and pump assembly on rubber isolated base.
6. Control valve assembly designed to reduce transmission of vibrations and noise to elevator car.
7. Metered bypass, check, relief, and manual lowering valves, and metered lowering and leveling devices.
8. Manual valve for lowering of car when power fails.

C. Controller:
1. Microprocessor-based control system to perform functions of safe elevator operation.
2. The system shall also perform car and group operational control.
3. Include necessary starting switches, relays, switches, solid-state components and hardware required for car and door operation.

4. Provide 3-phase overload device to protect the motor against overloading.

D. Miscellaneous options required:

E. Hydraulic fluid:
   1. Non-toxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.

## 2.4 HOISTWAY EQUIPMENT

A. Hoistway Operating Devices:
   1. Emergency stop switch in the pit.
   2. Terminal stopping switches.

B. Cylinder:
   1. Made of steel pipe of sufficient thickness and suitable for the operating pressure.
   2. High pressure seal as well as an internal guide ring and self-adjusting packing.

C. Plunger:
   1. Constructed of select steel tubing or pipe of proper diameter machined true and smooth with a fine polished finish.
   2. Stop ring: Welded to plunger to prevent over extension.

D. Guide Rails:
   1. Tee or Omega section steel rails with brackets and fasteners.
   2. Use heavy-weight rail sections as required to span between structural supports indicated, or include supplemental steel bracing/sub-frame as required.

E. Buffer:
   1. Polyurethane or helical coil spring.

F. Wiring:
   1. Wiring for hoistway electrical devices, hall panels, pit emergency stop switch, and traveling cable for elevator car.

G. Pit Ladders:
   1. Coordinate pit ladders per ANSI/ASME-A17.1.
   2. Ladders are specified in Section 05 50 00.

## 2.5 HOISTWAY ENTRANCES

A. General:
   1. Fire Label: 1-1/2 HR UL B label.

B. Frames:
   1. Bolted construction for complete one-piece unit assembly.
   2. Securely fastened to fixing angles mounted in the hoistway and shall be of 14 GA sheet steel.
   3. Material:
      a. Type 301 or 304 Stainless Steel (non-magnetic).
         1) Finish:
            a) #4, Brushed Satin.

C. Doors:
   1. Flush, 16 GA hollow metal construction with vertical internal channel reinforcements and sound deadening material.
   2. Material:
      a. Type 301 or 304 Stainless Steel.
         1) Finish:
            a) #4 Brushed Satin.

D. Sills:
   1. Extruded aluminum with slip resistant wearing surface.
   2. Supported on steel anchors secured to floor construction.
   3. Elevator contractor to provide sill angles as required.

E. Entrance Markings:
   1. Entrance jambs shall be marked with 4 x 4 IN plates having raised floor markings with Braille adjacent.
      a. Markings shall be provided on both sides of the entrance.

F. Sight Guards: Finish compatible or matching door frames.

G. Fascia:
   1. Galvanized sheet steel shall be provided at the front of the hoistway.
      a. Include similarly at rear of hoistway where rear openings are indicated.
   2. Include necessary supports, connections and filler pieces.

## 2.6 CAR - GENERAL

A. Car frame:
   1. Fabricated from formed or structural steel members and adequately braced to support the platform and car enclosures.
   2. Slide guides.
   3. Buffer striking plate on the underside of the car-frame platform must fully compress the spring buffer before the plunger reaches its lower limit of travel.

B. Elevator Car Platform:
   1. All-steel construction with welded steel frame reinforced as necessary.
   2. Floor: Minimum 12 GA sheet steel.
   3. Fasten floor securely to frame and reinforcing members.
   4. Threshold Material: Extruded Aluminum.

C. Load Weighing Device:
   1. Mounted under the platform.
   2. Platform load weighing device set to a predetermined maximum load in car.
   3. Car bypasses hall calls when device is actuated.

D. Exhaust Fan:
   1. Mounted on car top.

E. Emergency Car Lighting:
   1. Emergency power unit employing a 6 volt, sealed rechargeable battery.
   2. Purpose: To supply illumination of elevator car and alarm bell in the event of building power failure.

F. Emergency Pulsating Siren:
   1. Mounted on top of the car and activated by Alarm button in the car operating panel.
   2. Rated sound pressure level: 80 dba @ 3 M.

G. Provide 125 VAC, 20A, duplex receptacle with ground-fault interrupter protection connected to same circuit as car lights and fan.

H. Provide accessibility code items.

I. Exit Panel:
   1. Standard hinged type with lock.
   2. Coordinate location with ceiling and lighting.

## 2.7 CAB TYPE

A. Panel Cab:
1. Cab Frame:
   a. 16 GA sheet steel, powder coated, pre-perforated for hardware to mount removable panels.
   b. Finish:
      1) Black powder coat.
2. Panel Type:
   a. Vertical Panels.
   b. Finish:
      1) Plastic Laminate:
         a) To be chosen from the manufacturer's standard selection.
3. Car Top: Cold rolled steel with hinged exit.

## 2.8 CAR FRONT FINISHES

A. Car Front:
1. 14 GA stainless steel:
   a. Finish: #4 Satin Brushed.

B. Car Doors:
1. Match materials and finished indicated for Hoistway Doors (above).

C. Floor covering:
   a. As noted in Drawing I-001 Interior Notes and Finish Legend.

D. Dropped Ceiling:
1. Downlighting:
   a. Metal panels with factory installed LED downlights.
   b. Panel Finish:
      1) Powder coat, Color to be selected from manufacturer's standard color chart.
      2) Stainless Steel, #8 Mirror Polish.
      3) Stainless Steel, #4 Satin brushed.

E. Metal Handrails:
1. Locations: 3 walls, (Exception: Omit from rear wall where cars are rear-opening type).
2. Mounting Height: 32 IN above cab floor.
3. Material and finish:
   a. Stainless Steel, #4 Satin brushed.
4. Profile:
   a. Flat Solid Metal:
      1) Size: 1/4 IN x 6 IN.
   b. Cylindrical Tubular Metal:
   c. Curved end returns.

F. Protective Pads:
1. Quilted fire retardant protective pads.
2. Include hooks/buttons.

## 2.9 FIXTURES AND DEVICES - GENERAL

A. Car and Hall Fixtures – Design and Style:
1. Traditional Fixtures:
   a. Faceplates: Flush-mounted, with square corners.
      1) Material and Finish:
         a) #4 Satin Stainless Steel.
   b. Indicators: Red LED matrix for floor positions; lanterns for directional indication.
   c. Raised and Braille markings.
   d. White LED illuminated buttons with black halo.

## 2.10 FIXTURES AND DEVICES – HALLS

A. Hall Call Stations:
   1. Located adjacent to hoistway entrance, combining landing buttons and key switches required for elevator operation.
   2. Raised markings shall be provided for each push-button.
   3. Quantity per landing: 1 centrally located fixture.
   4. Configurations:
      a. Terminal Landings: Provide single button.
      b. Intermediate Landing: UP and DOWN button.
   5. At main lobby, include a keyswitch for Car to Lobby, integrated into Hall Call fixture.

B. Chime:
   1. When car stops and the doors are opening, chime will sound.

C. Standby Power Cabinet:
   1. Manual selection of each elevator in normal operation after automatic return in standby power operation has been initiated.
   2. This is achieved via a strip switch inside the standby-power cabinet.
   3. Location: TBD.

## 2.11 FIXTURES AND DEVICES - CAR OPERATING PANEL (COP)

A. Fully integrated unit containing phone, push buttons, key switches, and message indicators for elevator operation including:

B. Buttons:
   1. Individually mark with landings served, Emergency Call, Door Open, Door Close, and other accessories indicated or required.
   2. Emergency Stop Button.

C. Switches:
   1. Lights, Inspection, Fan, Independent Service, and other accessories indicated.

D. Car Position Indicator:
   1. Digital readout, displaying the current position of the car.

E. Landing Passing Signal:
   1. Chime which sounds in the car to notify passenger that the car is either stopping at or passing a floor served by the elevator.

F. Independent Service:
   1. When switch in car is actuated, car operates independently from car buttons only and hall calls are ignored.

G. Telephone:
   1. Hands-free design complying with ADAAG requirements.
   2. Include wiring connected to the car traveling cable.
   3. Wire to PBX or Lobby Panel (as directed).

## 2.12 DOOR OPERATION

A. Door Control Features:
   1. Electrically operated, quietly and smoothly operate car and hoistway doors.
      a. Doors manually operable in emergency.
   2. Door control opens doors automatically when car arrives at landings in response to a normal hall or car call.
   3. Re-opening Device/Safety:
      a. Purpose:
         1) To stop and reopen the car and hoistway doors automatically if the doorway becomes obstructed by an object or person.

b. Primary Device:
   1) 2-dimensional, multi-beam array projecting across the car door opening.
   2) Normal Operation:
      a) Detect object, 1-1/3 IN diameter or larger, between the car doors in the following detection zone; within 1 IN to 71 IN above the sill.
   3) Degraded Conditions (one or more blocked or failed beams):
      a) Detect object, 4 IN diameter or larger, in the same detection zone.
   4) If the system performance is degraded to the point that the 4 IN object cannot be detected; maintain the doors in open position, or permit closing only by nudging force conditions.

## 2.13 OPERATION AND LOGIC

A. General Operating Features:
   1. Independent Service: When switch in car is actuated, car operates independently from car buttons only and hall calls are ignored.
   2. Firefighters' Service Phase I and Phase II: Returns cars to designated floor by means of key operated switch located at a lobby designated by Fire Marshal.
   3. Top of Car Inspection: Disable car when inspection switch is activated.

B. Simplex Collective Operation (1 car):
   1. General Description:
      a. Microprocessor based controller.
      b. Operation: Automatic by means of the car and hall buttons.
      c. If calls in the system have been answered, the car shall park at the last landing served.
   2. Operating Logic:
      a. Momentary pressing of car or hall call buttons automatically starts car (assuming hoistway doors are shut).
      b. Car stops automatically at first stop for which car or corridor button has been pressed, corresponding to direction in which car is traveling.
      c. Car stops automatically, in order, at stops for which such stops have been registered.
      d. Car, when traveling in UP direction, answers UP calls, but passes stops where DOWN calls have been placed (unless DOWN call is at highest stop for which any button has been pressed).
      e. Pressing UP hall call button when car is traveling downward shall not intercept its travel, unless UP call is at floor for which lowest stop is registered.
      f. When car has responded to its highest or lowest stop, and calls are registered for opposite direction, travel reverses automatically and answers those calls.
      g. Should farthest stop in either direction be in response to corridor call, entering passenger at that floor may choose travel direction during predetermined period of time.
      h. Should both UP and DOWN calls be registered at intermediate floor when car is traveling to floor beyond, reset only call corresponding to direction opposite to that which car is traveling.
      i. Doors open only when stopping in response to calls.

## 2.14 EMERGENCY POWER OPERATION

A. Emergency Power Manual Operation:
   1. Provide automatic override switching to lower 1 car at a time to lobby on emergency power.
   2. After cars are lowered, select 1 car to operate on emergency power.
   3. Provide manual strip switch on lobby floor panel for individual selection of elevators.
   4. Contact on emergency switchgear to furnish signal through pair No. 12 wires to elevator controller that system is on emergency power.
   5. Manufacturer may attempt to rescue elevators at same time if power requirement in DOWN direction is small enough.

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed.

B. Verify acceptability of hoistway to accept elevator and equipment.

C. Do not proceed with work until unsatisfactory conditions are corrected.

D. Start of installation constitutes acceptance of conditions and responsibility for performance.

### 3.2 ERECTION

A. Erect sills, struts, hanger supports, hanger covers and unit frames, prior to erection of rough walls and set in proper relation to elevator car guides.

B. Provide protective covering for finished frame and door surfaces.

C. Projections into Hoistway exceeding 4 IN:
   1. Coordinate location of 75 degree bevels to meet elevator code requirements.
   2. GWB bevels: Specified in Section 09 29 00.

D. Coordinate the installation of pit ladders ensuring that running clearances are maintained, location of ladder is optimal for servicing equipment, and in conformance with locally adopted codes.

E. Grouting and Concrete Fill:
   1. Grout:
      a. Specified in Section 03 31 30.
   2. Fully grout the following:
      a. Sills and thresholds.

### 3.3 DEMONSTRATION

A. Assist Owner in inspection and certification of elevator.

B. Ensure that control systems and operating devices are functioning properly and conform to locally adopted codes.

C. Elevator manufacturer shall make a final check of each elevator operation with the Owner's representative prior to turning each elevator over for use.

D. Submit report to verify Owner has been instructed for inspection, certification, function and operation of each elevator.

**END OF SECTION**

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# DIVISION 21

## FIRE SUPPRESSION

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# SECTION 21 05 00
## FIRE PROTECTION SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Fire Protection Systems, as indicated, in accordance with provisions of Contract Documents.

B. Fire Protection Systems Included:
   1. Water based:
      a. Wet-pipe sprinkler system.

### 1.2 QUALITY ASSURANCE

A. Single Contractor Responsibility:
   1. The complete fire protection piping and sprinkler systems shall be the responsibility of one contractor. The contractor shall be responsible for the design, selection, installation, operation, and field testing of all materials, equipment, and components of each automatic sprinkler system provided as specified in this section.

B. Authorities Having Jurisdiction (AHJ):
   1. Code Enforcement Agencies.
   2. Fire Marshall's Office.
   3. Owner's Representative.
   4. Water Supply Authority.

C. Referenced Criteria:
   1. Building Code:
      a. Adopted Building Code including all amendments and associated standards enforced by the AHJ.
   2. Fire Code:
      a. Adopted Fire Code including all amendments and associated standards enforced by the AHJ.
   3. Latest edition of referenced criteria applies unless an earlier edition is specifically indicated by the AHJ.
   4. National Fire Protection Association (NFPA).
   5. National Institute for Certification in Engineering Technologies (NICET).
   6. Underwriter's Laboratories (UL).
   7. FM Approval Guide.

D. Designer qualifications:
   1. The fire protection system shall be designed by a NICET Certified Level III Sprinkler Designer.
      a. If required by state regulations, a Professional Fire Protection Engineer shall seal drawings submitted to the AHJ.
      b. Drawings, seismic calculations, and hydraulic calculations shall include certification NICET Certified Level III Designer and the signature and registration number of the Professional Fire Protection Engineer if require by state regulations.
      c. The designer shall be responsible for understanding the construction of the building which includes but not limited to: building construction type, ceiling heights, beam depths, obstructions, other disciplines layouts (e.g. mechanical, electrical, etc.), and other features of the building that are required in order to provide a fire protection system that is fully code compliant.

E. Installer qualifications:

1. Fire protection systems shall be installed by a minimum NICET Level II technician and under the direct supervision of the NICET Level III designer indicated above.
2. Fire Protection Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.
3. Use workmen skilled in this trade.
4. Provide documentation that welders, and welding operators are certified in accordance with American Welding Society Standard AWS D10.9.

F. Field Quality Control:
1. Manufacturer's field services: Provided service by a factory-authorized and certified service representative to supervise field assembly and connection of components and pre-testing, testing, and adjustment of system.
2. Pre-testing: Determine, through pre-testing, conformance of system to requirements of drawings and specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
3. Inspection:
   a. Inspect equipment installation, interconnection with system devices, hanging and bracing methods.
   b. Verify that pipes are properly installed, connected, labeled, and are identified.
4. Welded connections visual inspection and non-destructive weld testing shall be done for all welded connections.

G. Design Requirements:
1. Use only new, unused material, designed and guaranteed to perform service required and approved by NFPA. Material and equipment shall be UL Fire Protection Directory listed or FM Approval Guide approved for fire protection service.
2. Provide fully code complaint operational systems.
3. Installation of the following items/systems shall be done by authorized representatives of respective manufacturers:
   a. Fire system valves.
4. Provide seismic protection for the sprinkler system. Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes."
5. Copy of the most recent water supply fire flow test. Flow test used for hydraulic calculations shall be less than a year old from the time the shop drawings are submitted.

## 1.3 RELATED SECTIONS

A. Supplementary General Conditions, Division 0 and 1 sections, and Contract Drawings apply to this section.

## 1.4 SYSTEM DESCRIPTION

A. System Design requirements:
1. General:
   a. Provide a complete fire protection system as described in the Contract Documents and according to criteria of the Authority(ies) Having Jurisdiction (AHJ) and all applicable national and local codes such as NFPA, ADAAG, Building Code, etc.
      1) Where discrepancies exist among the AHJ requirements, NFPA, and Contract Documents, the most stringent requirements shall take precedence.
      2) Contractor shall perform a thorough examination of Contract Documents and shall coordinate with other disciplines and trades, e.g. verification of hazardous area locations requiring equipment rated for that type of environment.
      3) Contractor shall be responsible for providing a fully functional and code compliant fire protection system at no additional cost to the Owner.

4) Contractor shall be responsible for coordinating all work and equipment to be provided by others. Work and equipment designated to be provided by others shall be include as part of the Contract and shall not be incurred cost to the Owner.

2. Design of fire sprinkler and suppression systems:
   a. Contractor shall conduct a water supply fire flow test in accordance with the latest edit of NFPA 291 at no additional cost to the Owner prior to design of the fire sprinkler system.
   b. Compare flow test results to those on the Contract Drawings, and use lowest pressures and flow of the two to design system(s).
   c. Design systems using adjusted water supply curve:
      1) Adjust the flow test water supply curve to correspond with the low hydraulic grade line as provided by the water supplier.
   d. Hydraulically designed sprinkler systems shall be designed to include a minimum safety factor of 10% of the supply pressure or 5 psi below the supply curve.
   e. The sprinkler system shall be hydraulically designed to work without addition of a fire pump. Minimize the pressure loss of the sprinkler system by increasing pipe sizes, reducing head spacing, adjusting sprinkler head k-factors, and incorporating other design details as necessary to make the system work with the available water supply and avoid the need for a fire pump.
3. Design of fire sprinkler seismic bracing:
   a. Contractor shall submit seismic bracing design calculations for all portions of the sprinkler system. Indicate the seismic zone of influence for all seismic sway bracing calculations on the drawings.
   b. See Structural S001 for the spectral response acceleration that shall be used when determining the seismic coefficient for the seismic sway brace calculations.

## 1.5 SUBMITTALS

A. Shop Drawings:
   1. General:
      a. The fire protection design is a delegated design and the Engineer of Record shall review for project information and general conformance with contract documents. Contractor shall provide a code compliant sprinkler system that meets the requirements of all applicable local and national codes.
      b. Fire Protection submittals and shop drawings shall be made as a complete package which includes product data, drawings, and calculations. Incomplete/partial submittals will be returned without being reviewed.
      c. Complete layout drawings of sprinkler systems, hanger and seismic bracing locations, alarms, and signal devices.
      d. Submit Working Plans documentation after design has been approved by Authority Having Jurisdiction (AHJ).
   2. Product Data:
      a. Submit catalog data and Specifications for all manufactured components including fittings, couplings, pipe, fire valves, check valves, fire department connection, sprinkler heads, flow alarm, alarm bell, hangers, sway bracing, and other components and appurtenances required for a complete system supplied as part of the fire protection system.
   3. Project Information:
      a. Submit detailed data and complete layout of fire protection systems approved by authorities having jurisdiction and prepared in accordance with the requirements for Working Plans described in applicable NFPA standards.
         1) Include calculations prepared in accordance with the requirements for Hydraulic and Seismic Bracing Calculations described in applicable NFPA standards.
         2) Upon receipt of comments from AHJ, make resubmissions, if required, to make clarifications or revisions to obtain approval.

3) The AHJ shall witness final testing and inspection in order to obtain final approval for system.

b. Submit a copy of the most recent hydrant flow test and list information on the shop drawings. If information is more than a year old from the time shop drawings are submitted, a new test should be performed as part of the project.

4. Certifications:
   a. Certification that all plans and calculations, including sprinkler flow calculations have been approved by all agencies with jurisdiction.
   b. Certification that all required post installation tests and inspections have been completed and approved by all agencies with jurisdiction.

B. Contract Closeout Information:
   1. Letter, with Owner acceptance signature, stating spare parts and extra materials per NFPA requirements have been delivered.
   2. Operating and maintenance data.
   3. Owner instruction report.
   4. Test reports:
      a. Certification that tests as indicated in FIELD QUALITY CONTROL (Part 3) have been successfully completed and approved by authorities having jurisdiction.
   5. As-built drawings:
      a. As-built shop drawings, at no later than 14 days after completion of the Final Tests. The Sprinkler System Drawings shall be updated to reflect as-built conditions after all related work is completed. Provide electronic drawings in 'dwg' and 'pdf' format

### 1.6 JOB CONDITIONS

A. Arrange and pay for permits, fees and inspections required.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents.

### 2.2 MATERIALS

A. Use only new, unused material, designed and guaranteed to perform service required and UL Listed, FM Approved and allowed by NFPA.

B. Pipe and fittings - General:
   1. Meet or exceed applicable NFPA standards.
   2. Working pressure: Not less than 175 PSI.
   3. The following are not permitted:
      a. Lightwall and Schedule 5 or 7 pipe.
      b. Plain end, pressure fit type fittings.
      c. Hole cut mechanical tee fittings.
      d. Threaded fittings on piping less than schedule 40.
   4. Fittings: galvanized where galvanized piping is used.
   5. Corrosion Resistance Ratio (CRR) of all pipe used: greater than one.
   6. Paint sprinkler systems with the exception of the piping installed above suspended ceilings. Clean, prime, and paint new sprinkler system piping, valves, hangers, accessories, and miscellaneous metal work as describe herein. Clean surfaces prior to painting. Immediately after cleaning, prime metal surfaces with SSPC Paint 25 or SSPC Paint 25 metal primer applied to a minimum dry film thickness of 1.5 mils. Paint piping with CID A-A-2962 gloss red enamel applied to a minimum dry film thickness of 1.6 mils. Exercise care to avoid painting sprinkler heads and operating devices. Upon completion of painting, remove materials which were used to protect sprinkler heads and operating devices which have been

inadvertently painted and provide new clean sprinkler heads and operating devices of the proper type.

7. Optional pipe materials and joining methods approved by NFPA 13 and FM are allowed if in accordance with applicable agency approval.

C. Above ground pipe normally containing water:
   1. Examples: Wet-pipe fire protection systems.
   2. Sprinkler piping 4 IN and greater:
      a. Black steel, Schedule-10:
         1) Welded joints.
         2) Mechanical coupling joints:
            a) Rolled groove type (cut grooving not allowed).
            b) Mechanical locking (push-on) type, (Plain end not allowed).
   3. Sprinkler piping less than 4 IN:
      a. Black steel, Schedule-40:
         1) Threaded joints.
         2) Welded joints.
         3) Mechanical joints:
            a) Cut or rolled groove type.
            b) Mechanical locking (push-on) type.
   4. Seamless copper tubing.
      a. High temperature soldered joints.

D. Pipe, below ground:
   1. Fire protection piping shall be provided as specified in utilities specification Division 33 fire protection piping and in accordance with AHJ requirements.
   2. Fire protection piping shall be ductile iron and installed in accordance with AHJ requirements.
      a. Ductile iron:
         1) AWWA/ANSI C151/A21.51.
         2) Ductile iron, Class 51.
         3) Lining: Cement
         4) Coating: Bituminous
         5) Fittings:
            a) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
            b) AWWA/ANSI C15 1 3/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
         6) Joints: Push-on with mechanical (stuffing box type) joints at fittings and valves
   3. Fire protection piping shall be Polyvinyl Chloride PVC and installed in accordance with AHJ requirements.
      a. PVC:
         1) Class 150 DR 18 and shall conform to the "Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 IN through 12 IN, For Water" (AWWA C900).

E. Fittings:
   1. Threaded:
      a. Black cast iron, Class 150.
      b. Black malleable iron.
      c. Galvanized malleable iron.
   2. Flanged:
      a. Black cast iron, short body, Class 125.
      b. Galvanized malleable iron.
      c. Gaskets: Full face of 1/8 IN minimum red sheet rubber.
      d. Flange bolts: ANSI-B18.2.
         1) Hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated.

3. Welded:
   a. Black steel, standard weights.
4. Mechanical: ASTM-A47.
   a. Malleable iron, 500 PSI working pressure.
   b. Coupling gasket material: Butyl rubber.
   c. UL listed.
   d. Approved by FM and NFPA-13.
5. High temperature soldered:
   a. Wrought copper.
   b. Cast bronze.

F. Pipe hangers, supports and seismic bracing:
   1. All purpose type, UL listed and FM approved.
      a. Star Sprinkler Corp., "Stargard 100" or approved equal.
   2. Space in accord with requirements of NFPA.
   3. Hangers, hanger rods, inserts, clamps, supports, and seismic bracing shall be constructed as approved by NFPA.

## 2.3 ALARM AND SIGNAL DEVICES

A. Alarm and signal devices, general:
   1. UL listed and FM approved.
   2. Coordinate electrical requirements with electrical installer.

B. Alarm devices:
   1. Alarm pressure switch:
      a. Shall signal Fire Alarm System Control Panel upon sensing change of pressure in fire system valve.
         1) Switch shall automatically reset when pressure returns to normal.
      b. Service: Normal.
   2. Local alarm devices:
      a. General:
         1) Provide local alarm on systems of sufficient size as indicated in NFPA-13.
         2) Use alarm bell and visible light alarm on electrically operated supplemental fire detection (valve release) systems.
         3) Devices shall be weatherproof.
      b. Alarm bell, electric:
         1) Shall provide audible alarm signal upon activation of fire protection system.
         2) An electrically driven, 10 IN diameter round, red enamel finish, and weatherproof bell.
         3) Provide backer plate to prevent birds and insects from entering inside of bell housing.
      c. Visible light alarm:
         1) Semi-flush, 24 volt DC.
         2) Tamper-resistant white lexan lens, with "FIRE" imprinted in red.
         3) Light shall be mountable on either ceiling or wall.

C. Signal devices:
   1. General:
      a. Shall be UL listed or FM approved.
   2. Valve tamper switch:
      a. Shall signal Fire Alarm System Control Panel upon valve movement.
   3. Waterflow detector:
      a. Shall signal Fire Alarm System Control Panel when water flows in system.
      b. Vane type flow switch with retard mechanism or manual adjustment to prevent false alarm.
      c. 175 PSI rated.

d. Suitable for working pressure of 150 PSI with sensitivity adjusting screw.
e. Switches shall be snap action, tamper proof, and have adjustable time response from 0 to 90 seconds.
f. Provide a water flow switch which either opens or closes an electrical signal circuit upon constant flow of water through the system shall be provided.
g. Provide with contacts for remote signal wiring.

4. Pressure supervising switch:
   a. Shall signal Fire Alarm System Control Panel upon drop in air pressure.
      1) Adjustable low-pressure setting.

## 2.4 FIRE ALARM SYSTEM CONTROL PANEL

A. Fire alarm system control panel: Provided under Electrical Specification Divisions.

## 2.5 FIRE PROTECTION SYSTEMS, WATER-BASED

A. Wet-pipe fire protection sprinkler system:
   1. Description: Automatic system shall employ closed sprinklers attached to a piping system filled with pressurized water.
      a. Normal operation:
         1) Actuation of sprinkler allows water to flow through actuated sprinkler.
         2) Waterflow sends signal to Fire Alarm System Control Panel.
      b. Failure of sprinkler allows water to flow through sprinkler.
         1) Waterflow sends signal to Fire Alarm System Control Panel.

## 2.6 FIRE DEPARTMENT CONNECTIONS

A. Fire Department connections and hydrants:
   1. Components and assemblies UL listed and FM approved.
   2. Minimum 175 PSI non-shock cold-water working pressure.
   3. Inlet threads for connections to fit local fire department standards.
   4. Outlet threads for hydrants to fit local fire department standards.
   5. An approved fire department connection shall be provided on the system side of the alarm check valve and shall be sized per NFPA.
   6. The fire department connection shall be provided with an approved check valve and an automatic drip type drain valve in the piping between the hose connection and the system riser connection.
   7. Fire department connection shall be located not less than 36 in. or more than 48 in. above the level of the adjoining ground, sidewalk, or grade surface.

B. Fire department (siamese) connections.
   1. Outside type.
   2. Inlet:
      a. Quantity:
         1) Two.
      b. Size:
         1) 2-1/2 IN.
      c. Fittings:
         1) Brass snoots, brass pin-lug swivels, brass pin-lug plugs, chains, and gaskets.
   3. Outlet:
      a. Quantity:
         1) One.
      b. Size:
         1) 4 IN.
   4. Finish:
      a. Satin brass.
   5. Raised lettering:
      a. "AUTOSPKR".

6. Connection style:
    a. Flush, wall-mounted, and drop clappers.

## 2.7 FIRE DEPARTMENT VALVES

A. Fire department valves, general:
    1. Components and assemblies UL listed and FM approved.
    2. Valves: Minimum 175 PSI non-shock cold-water working pressure.
    3. Outlet threads shall match local fire department standards.

B. Fire department valves:
    1. General:
        a. 2-1/2 x 2-1/2 IN valve.
        b. Cap and chain.
        c. Pattern: Straight or angle.

## 2.8 FIRE SYSTEM VALVES

A. Fire system valves, General:
    1. UL listed and FM approved.
    2. Body: Ductile or cast iron.
    3. Pressure rating: 175 PSI non-shock cold-water working pressure.
    4. 2 IN and smaller: Threaded.
    5. 2-1/2 IN and larger: Flanged or grooved.
    6. Trim to meet NFPA requirements.
    7. Trim to meet performance as indicated in descriptions of fire protection systems.

## 2.9 MANUAL VALVES

A. Isolation Valves:
    1. Gate valves:
        a. 2 IN and smaller: Gate valve, UL-FM, 175 psi WWP, bronze body, union or screwed bonnet, solid wedge disc, OS&Y, threaded.
        b. 2-1/2 IN and larger: Gate valve, UL-FM, 175 psi WWP, cast iron body, bolted bonnet, resilient or solid wedge, OS&Y, flanged.
    2. Butterfly valves:
        a. 2 IN and smaller: Butterfly valve, UL listed, 175 psi WWP, bronze body, stainless steel stem and disc, Viton seal, threaded.
        b. 2-1/2 IN and larger: Butterfly valve, UL-FM, 175 psi WWP, ductile iron body, O-Ring seals, aluminum-bronze or ductile-iron disc, stainless steel stem, Buna-N seal, manual geared operator with visual position indicator, lugged.
    3. Butterfly valves with tamper switches:
        a. 2-1/2 IN and smaller: Butterfly valve, Butterfly valve, UL listed, 175 psi WWP, bronze body, stainless steel stem and disc, Viton seal, threaded with tamper switch.
        b. 3 IN and larger: Butterfly valve, UL-FM, 175 psi WWP, coated cast or ductile iron body, aluminum bronze or ductile iron disk with EPDM coating, manual geared operator with visual position indicator, grooved.

B. Check valves 2-1/2 IN and larger: Check valve, T-pattern, horizontal swing, UL-FM, 175 psi WWP, cast iron body, bolted bonnet, bronze trim, renewable bronze or cast-iron disc and seat, flanged. Example: Stockham G-939 or Check valve, in-line, spring-operated single or double door(s), UL-FM, 200 psi WWP, cast iron body, renewable bronze door and rubber or EPDM seat, stainless steel spring, wafer or grooved.

C. Alarm Check Valve:
    1. 175 pound, UL listed, FM approved water flow alarm check valve which lifts from its seat when water flows.

2. Complete with clapper, external bypass valve, alarm test bypass, pressure gage, main drain connections, mounting supports for the retarding chamber, neoprene O-ring seal, tapped bosses for and with water pressure gages, alarm test valve, and a drip funnel.
3. Retarding chamber for varying water pressure as conditions require.
4. Include angle valves, globe valves, alarm line strainer, orifice restriction, pipe nipples and fittings.

D. Inspector's Test Station:
1. Valve and drain system to test operation of alarm devices.
2. 1-IN pipe and the termination shall be with ½-IN orifice size nozzle.
3. A sight glass shall be provided so that a visual confirmation of active water flow through the system can be visually seen.
4. The test station shall drain to the outside of the building.

E. Grade-Type Post Indicator Valve Assembly:
1. Valve: Gate valve, UL-FM, AWWA C-509, 175 psi WWP, cast iron body, resilient wedge, non-rise stem, indicator post flange, MJ or flanged.
2. Post: UL listed and FM approved indicator post to fit valve.
3. Shall be provided with an open and closed position switch, which shall be monitored on the fire alarm panel unit.

F. Outside Valve Boxes:
1. 3 piece cast iron, extension type, 5-1/4 IN shaft, 5-1/4 IN drop lid, screw or slip type.
2. Screw type lid: Tyler 6860 with No.6 bell base.
3. Slip type lid: Tyler 6865 with No.8 bell base.
4. Mark lids with WATER cast in metal.

G. Automatic Ball Drip Valve:
1. 1/2 IN straight or angle cast-brass ball drip shall close against pressure.
   a. When pressure drops, valve shall open to drain pipe.
   b. Mont on the fire department connection on the Siamese side of the check valve.

## 2.10 SPRINKLERS

A. Sprinklers - general:
1. Provide UL listed or FM approved sprinklers of style and type required for service indicated.
2. Finish of exposed parts: As indicated.
3. Provide pendent sprinklers on return bends due to water source.
4. In no case use heads rated less than 50°F higher than anticipated ambient temperature. Intermediate or higher temperature classification sprinkler heads shall be provided for locations with higher-than-normal ambient temperatures in accordance with NFPA 13 requirements, such as in mechanical rooms, electrical rooms, equipment rooms, spaces with skylights, etc.
5. All sprinkler heads shall be provided with guards in mechanical rooms, electrical rooms, pump/motor/equipment rooms, under grating and similar spaces, were the sprinkler head are subject to damage.

B. Flexible Sprinkler Hose Fittings:
1. For use in connecting sprinkler heads: in suspended ceilings.
2. A label shall be provided on the anchoring component of the bracket to limit the relocation of the fire sprinkler.
3. When installed and supported by suspended ceilings, the ceiling shall meet ASTM C635/C635M, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings, and shall be installed in accordance with ASTM C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
4. Rough brass, polished brass, or chrome plated.

5. Bracket attaches to the suspended ceiling for support of the flexible hose.
6. Braided stainless steel, hose fittings and accessories shall be UL listed or FM approved.

C. Sprinkler types: Metallic fusible link or glass bulb.

D. Sprinkler styles:
   1. Upright:
      a. Finish: Standard bronze.
   2. Pendant:
      a. Finish: Standard bronze.
   3. Concealed pendant:
      a. Ceiling plate flush with finished ceiling.
      b. Housing: 1/2 IN adjustment.
      c. Finish: White.
   4. Horizontal sidewall:
      a. Finish: Brass.
   5. Horizontal sidewall, extended coverage:
      a. Finish: Chrome.

## 2.11 SYSTEM ACCESSORIES

A. Alarm-test device:
   1. Optional replacement for alarm test loop.
   2. Single device or unit that provides visual verification of waterflow in a fire sprinkler system and allows for draining of all or a portion of that system.
   3. Contains sight glass, inspector test valve, auxiliary drain valve and test orifice.
   4. UL listed and FM approved.

B. Pressure gauges:
   1. Size: Minimum 3-1/2 dial.
   2. Range: 0-200 PSI.
   3. Shall be UL listed or FM approved for fire protection.

C. Spare parts:
   1. Sprinkler cabinet, Wall mounted:
      a. Provide spare sprinklers of each type and sprinkler wrench for each type in quantities required by NFPA-13.

D. Sprinkler guards:
   1. UL listed.
   2. Heavy duty welded wire.
   3. Red baked enamel finish.
   4. Listed for use with sprinkler that they are installed on.
   5. Provided in the electrical rooms, elevator hoist-way and where subject to mechanical and physical damage.

E. Microbiological Monitoring Station.
   1. General:
      a. Provide a complete MIC monitoring station with a sacrificial coupon.
      b. Unit shall be UL listed or FM approved

F. Strainer.
   1. General:
      a. Provide strainer with valved bypass.
      b. UL listed or FM approved.
      c. Epoxy-coated, steel body with flanged

G. Signs:
   1. NFPA approved identification signs shall be provided for valves. Each valve identification sign shall indicate the portion of the system controlled by the particular valve.

2. Hydraulic placard sign shall be located at the base of each fire protection system riser and shall be provided with the minimum design characteristics requirements of the system as required by NFPA.
3. Sign must be made of weatherproof metal or rigid plastic and attached with corrosion-resistant wire or chain.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Coordinate with other trades to ensure adequate space for equipment and piping placement.

B. Review plans, specifications and shop drawings of other trades to coordinate work.

C. Do not begin installation until after Agency approvals have been submitted to Architect.

D. Test systems in accordance with System Standards, manufacturers' instructions, and applicable NFPA publications.

E. Install systems in accordance with System Description, manufacturers' instructions, and approved shop drawings.
   1. Modifications to system design or arrangement after approval of drawings may only be made after receiving written approval of Architect and Authority(ies) Having Jurisdiction (AHJ).
   2. Such modifications do not include minor relocations in piping or sprinkler placement.
   3. Make revisions in accordance with NFPA.

F. Maintain fire and smoke ratings where mechanical items penetrate fire and fire/smoke rated building elements.

G. Field quality control: Give advance notice and arrange for field tests and inspections by authority(ies) having jurisdiction.

## 3.2 PIPING, SPRINKLERS, SUPPORTS, AND BRACING

A. Piping - general:
   1. Install sprinkler piping within first 6 IN of space under floor construction.
      a. Where conditions of construction require piping installation at a lower elevation, route piping to avoid interference with work of other trades.
   2. Offset, crossover and otherwise route piping to install system in available space.
      a. Not every offset is indicated.
   3. Pitch branch lines, cross mains, feed mains and risers to drains.
   4. Paint fire sprinkler piping in accordance with Section 09 91 23.
   5. Flush outside fire-main piping prior to connecting to inside system.
   6. Provide and arrange the wet fire sprinkler systems for flushing.
   7. Sleeves and Escutcheons:
      a. Provide sleeves for all pipes passing through slabs, walls and partitions.
      b. Extend sleeves 3 IN above floor and flush the walls.
      c. Set sleeves in forms prior to concrete pour for new concrete walls.
      d. Install chromed escutcheons on finished-area sides of pipe penetrations.
         1) Secure escutcheons so they make contact with floor, wall, or ceiling.

B. Sprinklers - general:
   1. Install sprinklers to provide and maintain minimum 18 IN of clearance between bottom of deflector and top of storage, files, shelving, and cabinets.
   2. Standard-application temperature rating:
      a. Sprinkler type:
         1) Glass bulb: 155 degF.
         2) Fusible link: 165 degF.
      b. Where non-standard applications exist, use higher rating.

1) Use sprinklers rated at least 50 degF higher than anticipated ambient temperature.

3. Install pendent sprinklers on return bends in accordance with NFPA-13.
4. Install in accord with approved Shop Drawings.
   a. Modifications made to system design or arrangement after approval of drawings by local authority may only be made after receiving written approval of authority and Project Representative.
   b. Such modifications do not include minor relocations in piping or head placement.
   c. Make all revisions in accord with NFPA 13.
5. Do not install sprinkler heads through or with escutcheon plate covering in suspended ceiling grids. Install oversized escutcheon plates in all suspended ceilings unless flex sprinkler drops are used.

C. Supports and Bracing: Install in accordance with NFPA-13.

D. Testing - general:
   1. The AHJ shall witness all final testing and inspection in order to obtain final approval for system.
   2. Test complete alarm system including control and signal circuits.
   3. Give advance notice and arrange for field tests and inspections by local authority, including paying for inspection fees and securing permits for same.
   4. Test sprinkler piping, including outside supplies, under hydrostatic pressure of 200 PSI or 50 PSI above normal working pressure, whichever is greater, for 2 hours.
      a. Prove system tight to satisfaction of Architect.
      b. Inside piping shall indicate no leakage.
      c. Leakage in underground piping shall be in accordance with NFPA-24.
      d. Following completion of the test, fill out test certificates and obtain approval of the AHJ.

E. Piping and sprinkler applications by room types:
   1. Electrical rooms/closets:
      a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
      b. Provide sprinkler guards.
   2. Elevator hoistway:
      a. Provide shielding to protect electrical elevator equipment from sprinkler system discharge.
         1) Coordinate with elevator installer.
         2) Coordinate with authority(ies) having jurisdiction.
      b. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard coverage).
         1) Glass bulb temperature rating: 200°F.
         2) Fusible link temperature rating: 220°F.
      c. Provide sprinkler guards.
      d. Provide a dedicated isolation valve, located outside and adjacent to the elevator hoist-way, for each fire sprinkler that is located within the hoist-way.
   3. Finished rooms (rooms with ceilings):
      a. Sprinkler styles:
         1) Concealed pendant.
         2) Horizontal sidewall, standard or extended coverage.
      b. Where ceiling exists in area subject to freezing, comply with requirements for areas subject to freezing.
      c. Locate sprinklers to coordinate with ceiling layout.
         1) Locate sprinklers centered in ceiling tile and in center of metal strip in linear metal ceilings, if such location makes added sprinklers necessary, provide added sprinklers as required to meet code.
   4. Mechanical equipment rooms:

a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
   1) Glass bulb temperature rating: 200°F.
   2) Fusible link temperature rating: 220°F.
b. Provide sprinkler guards.

5. Telephone/Communication rooms/closets:
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).
   b. Provide sprinkler guards.
6. Unfinished rooms (rooms without ceilings):
   a. Sprinkler styles: Upright, pendant, or horizontal sidewall (standard or extended coverage).

F. Automatic air vents:
   1. Sprinkler system piping design shall provide provisions to vent trapped air at all high points (within the work area).
   2. The design shall incorporate automatic air vents.
   3. Vents shall be equipped with an isolation valve and be piped to a suitable drain location.

## 3.3 ALARM AND SIGNAL DEVICES

A. Install valve tamper switch on each isolation valve indicated below:
   1. Valves at fire system valves.
   2. Post indicator valves.

## 3.4 FIRE PROTECTION SYSTEMS

A. Factory trained Engineer shall supervise installation of fire protection systems.

B. Factory trained Engineer shall provide following services:
   1. Supervise installation of fire protection systems.
   2. Instruct Owner's personnel in systems operations.

C. Test completed alarm systems including control and signal circuits wired by Electrical installer.
   1. Coordinate with electrical.
   2. Complete testing prior to substantial completion.

## 3.5 FIRE DEPARTMENT CONNECTIONS AND FIRE DEPARTMENT VALVES

A. Install fire department connections and fire department valves at height required by authority having jurisdiction.
   1. Position valve to allow 12 IN spanner wrench clearance for connecting hoses.

## 3.6 MANUAL VALVES

A. Provide isolation valves at following locations:
   1. Fire system valves.
   2. Flow test system:
      a. Inlet to hose valve manifold.
      b. Inlet and outlet of flow meter.

B. Provide check valves at following locations:
   1. Fire department connection.

C. Install indicator posts approximately 3 FT above grade.

D. Provide automatic ball drip at low points.
   1. Piping between outside fire department connection and check valve.

E. Provide valve boxes at each underground valve (except PIV's).

## 3.7 SYSTEM ACCESSORIES

A. Alarm test loops:
   1. Provide after each waterflow detector.
   2. Alarm test loop consists of two parallel branches.
      a. First branch: Inspector's test branch shall contain a shutoff valve and a restricting orifice imitating the flow through the smallest sprinkler on the system. Provide means for inspector to observe water flow (e.g., drain water within sight of valve or provide sight glass).
      b. Second branch: Drain branch shall contain shutoff valve.
      c. Alarm test loop sizing criteria:
         1) Riser or Main is 2 IN or smaller: 3/4 to 2 IN.
         2) Riser or main is 2-1/2 to 3-1/2 IN: 1-1/4 to 2 IN.
         3) Riser or main is 4 IN or larger: 2 IN.
   3. Extend loops to nearest floor drain or mop sink.
      a. Loops may be terminated outside when approved by authority having jurisdiction.
   4. Label valves and outlets.

B. Drains:
   1. Permit complete draining of systems without disconnection of piping.
   2. Drain consists of dirt leg, valve, and piping.
   3. Extend drain piping to nearest floor drain or mop sink.
   4. Required locations:
      a. At low points of systems.
      b. At alarm test loops.
      c. At fire system valves.
      d. At bases of risers.
   5. Size drain valve and piping according to alarm test loop sizing criteria in this section.
   6. At offsets, plugs may be substituted for drains when approved by authority having jurisdiction.

C. Pressure gauges:
   1. Provide at following locations:
      a. At service entrance to building.
      b. Above and below the alarm check valve.
      c. At alarm test loops.
      d. At other indicated locations.
   2. Provide shutoff valve and drain for each gauge.
   3. Pressure gauges shall be UL listed and labeled for fire protection sprinkler service, minimum 3½-IN dial, phosphor bronze tube, brass socket, moisture proof and weather resistant, 0-300 psi scale, 5 psi increments.
   4. Each gauge shall be fitted with a three-way valve and a ¼-IN threaded test connection.

D. Sprinkler cabinets:
      a. Install near sprinkler riser.

## 3.8 ELECTRICAL WIRING

A. Provide following:
   1. Wiring diagrams for devices.
   2. Wiring not specified but required to provide an operating system.

B. Electrical Installer will provide the following:
   1. Alarm and signal device wiring:
      a. Tamper switches: Supervised wiring to Fire Alarm System Control Panel.
      b. Waterflow detectors: Supervised wiring to Fire Alarm System Control Panel.

c. Alarm pressure switches: Supervised wiring to Fire Alarm System Control Panel.
d. Pressure supervising switches: Supervised wiring to Fire Alarm System Control Panel.
e. Supervised wiring from waterflow detector to outside alarm bell.

**END OF SECTION**

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# DIVISION 22

**PLUMBING**

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# SECTION 22 05 48
## VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Inertia bases.
   2. Vibration isolators.

B. Related Sections:
   1. Section 07 92 00 - Joint Sealing: Product requirements for joint sealers specified for placement by this section.
   2. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: Requirements for sound and vibration measurements performed independent of this section.
   3. Section 01 81 10 - Wind and Seismic Design: All vibration and seismic component design and installation must comply with 01 81 10 unless otherwise dictated by a more stringent requirement in this section.

### 1.2 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4, Sound Level Meters.
   2. S1.8, Reference Quantities for Acoustical Levels.
   3. S12.36, Survey Methods for the Determination of Sound Power Levels of Noise Sources.

B. Air-Conditioning and Refrigeration Institute (ARI):
   1. 575, Method of Measuring Machinery Sound within Equipment Space.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   1. Handbook - HVAC Applications.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 HP, plus connected piping.

B. Provide minimum static deflection of isolators for equipment as follows:
   1. Basement, Under 20 HP
      a. Under 400 RPM: 1 IN
      b. 400 - 600 RPM: 1 IN
      c. 600 - 800 RPM: 0.5 IN
      d. 800 - 900 RPM: 0.2 IN
      e. 1100 - 1500 RPM: 0.14 IN
      f. Over 1500 RPM: 0.1 IN
   2. Basement, Over 20 HP
      a. Under 400 RPM: 2 IN
      b. 400 - 600 RPM: 2 IN
      c. 600 - 800 RPM: 1 IN
      d. 800 - 900 RPM: 0.5 IN
      e. 1100 - 1500 RPM: 0.2 IN
      f. Over 1500 RPM: 0.15 IN
   3. Upper Floors, Normal
      a. Under 400 RPM: 3.5 IN
      b. 400 - 600 RPM: 3.5 IN
      c. 600 - 800 RPM: 2 IN
      d. 800 - 900 RPM: 1 IN
      e. 1100 - 1500 RPM: 0.5 IN

f. Over 1500 RPM: 0.2 IN

4. Upper Floors, Critical
   a. Under 400 RPM: 3.5 IN
   b. 400 - 600 RPM: 3.5 IN
   c. 600 - 800 RPM: 3.5 IN
   d. 800 - 900 RPM: 2 IN
   e. 1100 - 1500 RPM: 1 IN
   f. Over 1500 RPM: 0.5 IN

C. Consider upper floor locations critical unless otherwise indicated.

D. Use concrete inertia bases for motors in excess of 40 HP and on base mounted pumps over 10 HP.

E. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

F. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook., HVAC Applications

1. Offices
   a. Executive: 30
   b. Conference rooms: 30
   c. Private: 35
   d. Open-plan areas: 40
   e. Computer/business machine areas: 45
   f. Public circulation: 45

## 1.4 SUBMITTALS

A. Section 01 33 00 - Submittal: Submittal procedures.

B. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials and dimensional data.

C. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.

D. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions.

E. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

F. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

## 1.5 CLOSEOUT SUBMITTALS

A. Division 1 Sections: Closeout procedures.

B. Project Record Documents: Record actual locations of hangers including attachment points.

## 1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AHRI 575.

B. Maintain one copy of each document on site.

## 1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Oregon.

### 1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 – Special Conditions: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

### 1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

### 1.10 WARRANTY

A. Division 01 Sections: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for inertia bases.

## PART 2 - PRODUCTS

### 2.1 INERTIA BASES

A. Manufacturers:
   1. Vibro-Acoustics.
   2. Or approved equal.

B. Structural Bases:
   1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
   2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

C. Concrete Inertia Bases:
   1. Mass: Minimum of 1.5 times weight of isolated equipment.
   2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
   3. Connecting Point: Reinforced to connect isolators and snubbers to base.
   4. Concrete: Reinforced 3,000 PSI concrete.

### 2.2 VIBRATION ISOLATORS

A. Manufacturers:
   1. Mason Industries, Inc.
   2. Or approved equal.

B. Open Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 PCT vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Spring Mounts: Furnish with leveling devices, minimum 0.25 IN thick neoprene sound pads, and zinc chromate plated hardware.
   4. Sound Pads: Size for minimum deflection of 0.05 IN; meet requirements for neoprene pad isolators.

C. Restrained Spring Isolators:
   1. Spring Isolators:
      a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
      b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 PCT vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 IN thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 IN; meet requirements for neoprene pad isolators.
5. Restraint: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 PCT vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 IN clearance.

E. Restrained Closed Spring Isolators:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 PCT vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 IN clearance and limit stops.

F. Spring Hanger:
1. Spring Isolators:
   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 PCT vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
   a. 30 durometer.
   b. Minimum 1/2 IN thick.
   c. Maximum loading 40 PSI.
   d. Height of ribs: not to exceed 0.7 times width.
2. Configuration: 1/2 IN thick waffle pads bonded each side of 1/4 IN thick steel plate.

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 IN deflection with threaded insert.

I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

J. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.

2. Neoprene Elements: Replaceable, minimum of 0.75 IN thick.
3. Capacity: 4 times load assigned to mount groupings at 0.4 IN deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Section 01 30 00 – Special Conditions: Coordination and project conditions.

B. Verify equipment and piping is installed before work in this section is started.

### 3.2 INSTALLATION

A. Install isolation for motor driven equipment.

B. Contractor is responsible to design and install piping and equipment supports, seismic restraints/bracings, hangers, etc. with anchors in accordance with SMACNA HVAC Duct Construction Standards and local building code.

C. Bases:
1. Set steel bases for 1 IN clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 IN clearance between housekeeping pad and base.

D. Adjust equipment level.

E. Install spring hangers without binding.

F. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

G. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

H. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

I. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 IN maximum clearance. Provide other snubbers with clearance between 0.15 IN and 0.25 IN.

J. Support piping connections to isolated equipment resiliently as follows:
1. Up to 4 IN Diameter: First three points of support.
2. 5 to 8 IN Diameter: First four points of support.
3. 10 IN Diameter and Over:First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0 IN static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 IN static deflection or 1/2 static deflection of isolated equipment.

### 3.3 FIELD QUALITY CONTROL

A. Division 1 Sections : Field inspecting, testing, adjusting, and balancing.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. Refer to Section 23 05 93 for sound measurements.

D. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial

sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

E. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

## 3.4 SCHEDULES

A. Pipe Isolation Schedule:

| PIPE SIZE INCH | ISOLATED DISTANCE FROM EQUIPMENT |
|---|---|
| 1 | 120 diameters |
| 2 | 90 diameters |
| 3 | 80 diameters |
| 4 | 75 diameters |
| 6 | 60 diameters |
| 8 | 60 diameters |
| 10 | 54 diameters |
| 12 | 50 diameters |
| 16 | 45 diameters |
| 24 | 38 diameters |

**END OF SECTION**

# SECTION 22 05 53
## IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   6. Labels.
   7. Lockout devices.

B. Related Sections include but are not necessarily limited to:
   1. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

### 1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTUERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Nameplates, Tags and Stencils:
      a. Brady Corporation.
      b. Panduit.

c. Seton by Brady Corporation.
d. National Band & Tag Company.
e. Carlton Industries, LP.

## 2.2 NAMEPLATES

A. Laminated two-layer phenolic or DR (high impact) acrylic with engraved black letters on light contrasting background color.
   1. Thickness: Minimum 1/16 IN.
   2. Color: Manufacturer standard or as specified.

B. Alternate: Laminated three-layer plastic with engraved black letters on light contrasting background color.
   1. Thickness: Minimum 60 MILS.
   2. Color: Manufacturer standard or as specified.

## 2.3 TAGS

A. Nonmetallic Tags:
   1. Fiberglass reinforced engraved black letters on light contrasting background color.
      a. Tag size: Minimum 1-1/2 IN diameter.
      b. Thickness: Minimum 100 MILS.
      c. Color: Manufacturer standard or as specified.

B. Metal Tags:
   1. Aluminum or stainless steel disc with stamped letters and finished edges.
      a. Tag size: Minimum 1-1/2 IN diameter.
      b. Thickness: Minimum 0.035 IN (20 Ga).
      c. Color: Black color filled into stamped text with natural metal background.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

## 2.4 STENCILS

A. With clean cut symbols and letters of following size:
   1. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
   2. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
   3. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
   4. Equipment: 1-3/4 IN high letters.

B. Stencil Paint: As specified in Section 09 96 00, colors and lettering size conforming to ASME A13.1.

## 2.5 SELF ADHESIVE PIPE AND EQUIPMENT MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
   1. Thickness: Minimum 5 MILS.
   2. Letter Height:
      a. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
      b. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
      c. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
      d. Equipment: 1-3/4 IN high letters.
   3. Indoor/outdoor grade.
   4. Weather and UV resistant inks.
   5. Permanent adhesive.

## 2.6 UNDERGROUND WARNING TAPE

A. Description: Polyethylene tape with metallic core for detection and location of piping with metal detector resistant to acids, alkalis and other soil components.

1. Size: 0.004 IN thick; 6 IN wide.
2. Color: As Specified.
3. Service Marking: Printed text as selected by Architect/Engineer in black color and repeated at maximum 40 IN intervals.

### 2.7 TRACER WIRE

A. 12 GA AWG.

B. Solid.

C. Waterproof type wire nuts.

D. Brass split bolts.

### 2.8 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 IN.

B. Valve Lockout Devices:
   1. Manufacturers:
      a. Brady Corporation.
      b. Master Lock Company, LLC.
   2. Nylon device preventing access to valve operator, accepting lock shackle.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 96 00 for stencil painting.

### 3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09 96 00.

B. Install identifying devices after completion of coverings and painting.

C. All identification devices to be printed by mechanical process. Hand printing is not acceptable.

D. Install nameplates with adhesive where equipment has sufficient surface area and texture.
   1. Attach tags with 1/8 IN flat head screws where adhesive application is not suitable.
   2. Attach tabs with plastic strap where screws should not or cannot penetrate substrate.

E. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

F. Install tags using corrosion resistant chain. Number tags consecutively by location.

G. Install underground plastic pipe markers 6 to 8 IN below finished grade, directly above buried pipe.

H. Identify air tanks, and water treatment devices with nameplates. Identify in-line pumps and other small devices with tags.

I. Tag single items of equipment enclosed in a housing or compartment on outside of housing.
   1. Tag multiple items mounted inside a housing or compartment individually inside the housing.

J. Identify control panels and major control components outside panels with plastic nameplates.

K. Identify valves in main and branch piping with tags.

L. Tag automatic controls, instruments, and relays. Key to control schematic.

M. Identify piping, concealed or exposed, with pipe markers. Use tags on piping 3/4 IN diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 FT on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

N. Tracer Wire:
   1. Attach to buried nonmetallic pipe at maximum of 10 FT intervals with tape or tie-wraps.
   2. Install continuously from structure to structure including valve boxes and buildings.
   3. Splice wire with split bolts or wire nuts only as needed; use continuous strands of no less than 100 FT length.

## 3.3 SCHEDULES

A. Above Grade Piping:
   1. Install labels on all piping in accordance with Article 3.2.
      a. Stencils or self-adhesive lablels.
   2. Color Coding: Per ASME A13.1.
      a. Black lettering on yellow background:
         1) Hazardous, flammable or high temperature fluids:
            a) Domestic Hot Water.
            b) Domestic Hot Water Return.
      b. White lettering on red background:
         1) Fire quenching fluids:
            a) Fire Protection Water.
      c. White lettering on green background:
         1) Low temperature water:
            a) Domestic Cold Water.
            b) Tepid Water.
            c) Nonpotable Water.
            d) Rain Water Leader.
            e) Condensate drain.

B. Below Grade Piping
   1. Use underground warning tape in accordance with Article 3.2.
      a. Lettering: Mimimum: 1-1/4 IN.
      b. Wording:
         1) First line: "CAUTION CAUTION CAUTION"
         2) Second line: "BURIED (Pipe Descriptor) LINE BELOW"
      c. Pipe Descriptors and color coding:
         1) Sewer or Waste: Black Lettering on Green Background.
         2) Water (potable): Black lettering on blue background.
         3) Water (nonpotable): Black lettering on Green background.

C. Valves:
   1. Install on all automatic valves used in temperature controls:
      a. Label per Control Drawings.
   2. Install on all manual valves:
      a. Number and schedule all valves utilized on project. Coordinate numbering system with Tag Chart.
   3. Utilize nonmetallic or metal tags.
      a. Use stainless steel metal tags only for corrosive areas.

D. Equipment:
   1. Provide nameplate or stencil as warranted per Article 3.2.
   2. Label with equipment tag as shown on the Drawings.
      a. Black lettering on white background.

3. Provide OSHA warning sign for equipment that starts automatically.
4. Label all equipment control panels located remote from unit.

**END OF SECTION**

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# SECTION 22 20 00
## PLUMBING FIXTURES AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Plumbing fixtures, trim, and equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. American National Standards Institute (ANSI):
      a. Z358.1, Emergency Eyewash and Shower Equipment.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. 90.1 IP, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   4. American Society of Mechanical Engineers (ASME):
      a. A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   5. American Society of Sanitation Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breaker.
   6. Canadian Standards Association (CSA).
   7. NSF International (NSF).
   8. Underwriters Laboratories, Inc. (UL).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03 and Specification Section 40 05 00.
   3. Color selection charts for Owner color selection.
   4. Fabrication and/or layout drawings:
      a. Layout plan(s) showing dimensions, elevations, etc.
      b. Details showing connections, installation, rough-in locations, etc.
   5. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Chemical-resistance data.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Plumbing fixtures (vitreous china):
      a. American Standard.
      b. Crane.
      c. Kohler.
      d. Eljer.
   2. Stainless steel sinks:
      a. Just Manufacturing.
      b. Elkay.
   3. Premolded mop sinks:
      a. Powers - Fiat.
      b. Standard - Elsmer Granite Co.
      c. Williams.
      d. Florestone.
   4. Premolded shower:
      a. Powers - Fiat.
      b. Standard - Elsmer Granite Co.
      c. Williams.
      d. Florestone.
   5. Water closet seats:
      a. Church.
      b. Beneke.
   6. Lavatory fittings:
      a. American Standard.
      b. Chicago Faucets.
      c. Kohler.
      d. Sloan.
   7. Mop sink fittings:
      a. American Standard.
      b. Chicago Faucets.
      c. Kohler.
   8. Sink fittings:
      a. American Standard.
      b. Kohler.
      c. Just.
   9. Laboratory Mixing faucets:
      a. Water Saver
      b. Or equal
   10. Shower fittings:
      a. Symmons.
      b. Leonard.
   11. Flush valves:
      a. Sloan.
      b. Zurn.
      c. Delany.
   12. Emergency shower and eyewash:
      a. Speakman.
      b. Haws.
      c. Guardian Equipment.
   13. Recessed Laboratory Units
      a. WaterSaver

b. Or Equal

14. Drains, roof drains, carriers, and shock absorbers:
    a. Wade.
    b. Josam.
    c. Zurn.
    d. Smith.
15. Trap primer:
    a. Precision Plumbing Products.
16. Hose bibs:
    a. Nibco.
    b. Woodford.
17. Hydrants:
    a. Wade.
    b. Josam.
    c. Smith.
18. Domestic water heater:
    a. A. O. Smith.
    b. Ruud.
    c. Rheem.
    d. State.
19. Reduced pressure backflow preventer:
    a. Watts.
    b. Febco.
    c. Clayton.
20. Domestic Hot water circulating pump:
    a. Bell and Gossett.
    b. Thrush.
    c. Taco.
21. Hose racks:
    a. Strahman Valves, Inc., Model HR-100.
22. Hose valve:
    a. Guardian Fire Equipment.
    b. Wilkins.
23. Bottle Fillers:
    a. Haws
    b. Elkay
24. Roof Hydrant
    a. PRIER
    b. Or Equal
25. Domestic Water Pressure Booster Pump:
    a. FlowTherm
    b. Or Equal

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MANUFACTURED UNITS

A. Plumbing Fixtures (Vitreous China):
    1. Water closet (WC):
        a. White.
        b. 1.28 GAL per flush.
        c. Siphon jet.
        d. Elongated bowl.
        e. 1-1/2 IN top spud.
        f. Bolt caps.
        g. Type:

1) WC-1 (Floor Mounted): Refer to plumbing fixture schedule.

2. Urinal (U):
   a. White.
   b. Top spud.
   c. 0.125GAL per flush.
   d. Urinal and Flushometer Combo
   e. Type:
      1) U-1 (wall hung) : Refer to plumbing fixture schedule.
3. Lavatory (L):
   a. White.
   b. Front overflow.
   c. Type:
      1) L-1 (oval, self-rimming, 20 x 17 IN): Refer to plumbing fixture schedule.
      2) L-2 (wall hung 20 x 18 IN): Refer to plumbing fixture schedule.

B. Sinks (S):
1. Stainless steel sink:
   a. Type 304, 18-8 stainless steel.
   b. Self-rimming, drop-in mount.
   c. Fully coated underside.
   d. Drain punch centered in each bowl.
   e. Basket strainer and tailpiece.
   f. 3-faucet holes on 4 IN centers (S-1).
   g. ASME A112.19.3.
   h. S-2 shall be seamless die drawn 304 SS construction, single bowl. Self rimming top mount grip rim plus with stainless steel mounting channels.
   i. Type:
      1) S-1: Refer to plumbing fixture schedule.
      2) S-2: Refer to plumbing fixture schedule.
2. Mop sink (MS):
   a. Precast terrazzo (marble chips cast in Portland cement, ground and polished with all air voids grouted).
   b. One-piece.
   c. 2 IN wide shoulder.
   d. Stainless steel threshold.
   e. Integral drain body, removable strainer and 3 IN drain pipe.
   f. Type:
      1) MS-1 (square) 24 x 24 x 12 IN. Refer to plumbing fixture schedule.

C. Showers (SH):
1. SH-1 shower:
   a. Precast shower floor:
      1) Four-piece molded stone with slip-resistant surface.
      2) Shoulder not less than 3-1/16 IN high.
      3) Tiling flange not less than 1-1/2 IN above shoulder.
      4) Threshold not less than 5 IN high.
      5) Factory installed drain stainless steel with removable stainless steel strainer plate.
      6) Provide drain with lead calk joint for 2 IN drain pipe.
      7) Basin of dimensions and shape as shown on Drawings.
      8) Color as selected by Owner.
      9) Refer to plumbing fixture schedule.

D. Toilet Seat:
1. Molded plastic.
2. Open front.
3. No cover.

4. Stainless steel hinge with check.
5. For elongated bowl.

E. Lavatory Fittings:
1. Lavatory faucets:
   a. Lever handles.
   b. Renewable washer.
   c. Renewable seats.
   d. Aerator.
   e. Stopper and 1-1/4 IN tail piece.
   f. Coupling nuts.
   g. Chrome plated.
2. Handicapped lavatory faucets:
   a. Chrome-plated wrist handles.
   b. Chrome-plated gooseneck.
   c. Aerator.
   d. Renewable seat.

F. Mop Sink Fittings:
1. Type:
   a. Refer to plumbing fixture schedule.

G. Sink Fittings:
1. Lever handle.
2. Renewable washer.
3. Renewable seats.
4. Aerator.
5. Stopper and 1-1/2 IN tail piece.
6. Coupling nuts.
7. Chrome plated.

H. Laboratory Mixing Faucets:
1. Deck mounted, 6" swing gooseneck.
2. Removable ten serration hose end, 3/8" IPS rigid gooseneck, water saver renewable units, forged brass four arm handle and forged brass valve body.
3. Mounting shank with locknut and washer.
4. Colored plastic index disc.
5. Provide vacuum breaker where required by code.
6. Refer to plumbing fixture schedule.

I. Shower Fittings:
1. Symmons 1-117-FS safety mix:
   a. Concealed valve.
   b. Integral volume control and stops.
   c. 1.5 GPM flow restrictor.
   d. Wall/hand shower with flexible metal hose.
   e. Wall connection with flange and two wall hooks.

J. Manual Flush Valve:
1. Rubber diaphragm type with filtered bypass.
2. Non-hold-open handle.
3. Screw driver Bak-Chek angle stop.
4. Adjustable tailpiece.
5. Vacuum breaker flush connection and spud coupling.
6. Wall and spud flanges.
7. Spud size as required.
8. Gallon per flush as required per fixture.
9. Type:

a. Water Closet: Sloan, Royal model 111.
b. Urinal: Sloan, Royal model 186.

K. Emergency Fixtures:
1. Emergency shower and eye/face wash (ES/EW):
a. ANSI Z358.1.
b. Flow switch:
1) Rating: 125/250 V, 5 A.
2) Single pole, double throw.
3) UL listed.
c. Deluge shower head:
1) Stay-open ball valve.
2) Pull-chain (ES/EW-1 & ES/EW-3).
d. Eye/face wash:
1) Aerated eye/face wash with stainless steel bowl.
2) Stay-open full port ball valve.
3) Push handle control for eye/face wash.
4) Supply line strainer for eye/face wash.
e. Type:
1) ES/EW-1: Refer to Plumbing fixture schedule
2) ES/EW-2: Refer to Plumbing fixture schedule
3) ES/EW-3: Refer to Plumbing fixture schedule

L. Recessed Laboratory Units (RLU-1):
1. Recessed barrier free eye/face wash and shower safety station with ceiling mounted exposed shower head and drain pan. Stainless steel cover. When activated, cover shall serve as pan to collect waste water and return it into unit for drainage.
2. Install at recommended height in compliance with ADA requirements.
3. Shower head: 10" diameter stainless steel
4. Shower valve: 1" IPS brass stay open ball valve with stainless steel panic bar actuator.
5. 16 gauge stainless steel combination cover and drain pan.
6. Two spray heads mounted on supply arms. Each spray head has individual flow control and filter to remove impurities from water.
7. ½" IPS brass plug type valve with O ring seals. Furnished with in line strainer to protect valve from debris and foreign matter.
8. Furnished with ANSI compliant identification sign.
9. Provide matching thermostatic mixing valve in compliance with ANSI Z358.1-2014.
10. Refer to plumbing fixture schedule for additional requirements.
11. Type: RLU-1: WaterSaver SSBF2150

M. Carriers:
1. Urinals: Wade W-400 series.
2. Lavatories: Wade W-520 series.

N. Drains, Roof Drains and Downspout Nozzle:
1. Floor drain (FD):
a. Bottom outlet.
b. Clamping seepage flange.
c. Seepage openings.
d. Size as shown on Drawings.
e. Type: Cast iron body.
1) FD-1: Refer to plumbing fixture schedule.
2) FD-2: Refer to plumbing fixture schedule.
3) FD-3: Refer to plumbing fixture schedule.
2. Roof drain (RD):
a. Roof drain and overflow drain combo with deck top mounting plate

b. Duco cast iron body, double deck plate with securing holes, combined flashing clamp and gravel stop for roof drain and external water dam for overflow drain, both with polyethylene dome.
c. Type:
1) RD-1: Jay R. Smith 1830

3. Downspout nozzle (DN-1):
a. Cast bronze downspout.
b. Wade W-3940.

O. Traps:
1. Floor and equipment drains:
a. Same material and coating as the piping system.
b. 3 IN minimum seal.
2. Fixture drains:
a. 2 IN minimum seal.
b. Cast brass.
c. Chrome plated.
d. Size as required.
3. Ventilation housing drains: Extra-deep seal sufficient to maintain seal against static pressure maintained in fan housing.

P. Trap Primer:
1. Electronic Trap Priming Assembly (ETPA).
a. Surface Mount
b. Atmospheric vacuum breaker, pre-set 24 hour adjustable timer, manual over ride switch/test button
c. 120V solenoid valve
d. Single point connection
e. ¾" FNPT connection
f. Calibrated manifold for equal water distribution.
g. NEMA 1 Enclosure.
h. UL listed.
i. Refer to equipment schedule for additional requirements.
2. Pressure drop activated trap primer
b. Vacuum breaker port
c. All brass construction.
d. 1/2 IN male NPT inlet.
e. 1/2 IN female NPT outlet.
f. Stainless steel debris screen.
g. Brass piston.
h. Trap primer distribution:
1) Up to 4 traps.
2) 2 IN copper body.
3) Brass outlet.

Q. Cleanouts (CO):
1. Cleanouts for cast iron pipe:
a. Tapped extra heavy cast iron ferrule.
b. Calked into cast iron fittings.
c. Extra heavy brass neoprene seal screw plug with solid hexagonal nut.
2. Cleanouts for steel pipe: Extra heavy brass screw plug in drainage fittings.
3. Cleanouts for polypropylene:
a. Tapped polypropylene ferrule.
b. Polypropylene screw plug with solid hexagonal nut.
4. Access housing with adjustable anchor flange and secured scoriated cast: Wade W-3800-MF.

5. Cleanouts turning out through walls and up through floor shall be made by long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to architectural finish in room.
    a. Where definite finish is not indicated, wall plates shall be chrome-plated cast-brass and floor plates polished brass.
6. Code:
    a. Provide cleanouts of same size as pipe up to 4 IN and not less than 4 IN for larger pipes.
    b. Close access openings for concealed cleanouts with flush floor or flush wall cover plates or flush ceiling access panels.
    c. Provide wall plates with chrome plated cast-brass round cleanout cover with flanged ring.
    d. Provide screws which match cover plate material.
7. Cleanouts installed in floor with a resilient tile finish: Wade W-6000-TS.
8. Cleanouts installed in floor with ceramic tile, concrete, or Terrazzo finish: Wade W-6000-U.
9. Cleanouts installed in finished rooms flush with wall: Wade W-8480-S stainless steel.
10. Cleanouts installed in completely accessible pipe chases or where piping is exposed do not require special covers.
11. Cleanouts in floating floors: Wade 8300-MF housing and cover with 8550 cleanout body and closure plug or Smith 4250 or 4260 Series housing and cover with 4280 or 4290 Series cleanout body and closure plug.

R. Hose Bibb (HB-1):
1. 3/4 IN boiler drain with attached vacuum breaker-backflow preventer.
2. Vacuum breaker: Non-removable, manual draining, meeting the requirements of the ASSE 1011.

S. Hose Valve:
1. Cast brass.
2. Minimum pressure rating 150 PSI.
3. Angle configuration.
4. Hose outlet connection 1-1/2 IN or 2-1/2 IN as shown on Drawings or scheduled.
5. Pin lug protective hose thread cap with chain.

T. Hydrants (WH):
1. Wall hydrant:
    a. Non-freeze.
    b. Integral vacuum breaker.
    c. Nylon seat.
    d. 3/4 IN hose connection.
    e. 3/4 IN inlet connection.
    f. Length as recommended by manufacturer for wall thickness.
    g. Type:
        1) WH-1: Refer to plumbing fixture schedule.

U. Hose Racks:
1. Stainless steel.
2. 3/4 IN hose capacity: 50 FT.
3. Provide hose rack next to each hose bibb and hose valve inside building.

V. Domestic Water Heater (DWH):
1. Electric tank type:
    a. Size and capacity as scheduled.
    b. UL listed.
    c. Internal surfaces:
        1) Glass-lined with alkaline borosilicate composition fused-to-steel.

2) Provide magnesium rods rigidly supported for cathodic protection.
d. Low watt density heating elements with zinc-plated copper sheath.
1) Provide thermostat with each element, high temperature cutoff and temperature and pressure relief valve.
e. Insulate tank with vermin-proof glass fiber insulation or equal.
f. Heavy gage steel jacket with baked enamel finish.
g. Warranty against corrosion for three year period.
h. Provide water heaters meeting ASHRAE/IESNA 90.1 IP for energy efficiencies.

W. Reduced Pressure Backflow Preventer (RPBP-1 and RPBP-2):
1. Backflow preventers consist of two check valves, shut off valves, test cocks and relief valve, all assembled as an integral unit.
2. Reduced pressure backflow preventers Watts 909.
3. Backflow preventer to have threaded ends in sizes through 2 IN, flanged 2-1/2 IN and larger.
4. Pressure loss through backflow preventer not exceeding 14 PSI at design flow.
5. Provide air gap and pipe discharge to within 6 IN of finished floor.

X. Water Meter:
1. As indicated of a type approved by Water Department / local Utility.
a. Coordinate meters furnished by Water Department as to type and size.
b. Obtain and pay necessary permits and approvals required to complete installation of water service.
c. Provide valve on each side of meter and 3/4 IN drain valve spilling over floor drain.
2. Install water meter per manufacturer's installation instructions.

Y. Domestic Hot Water Circulating Pump (RCP-1001, 3001, 3002):
1. Pump casing and impeller: Bronze, designed for domestic water circulating.
2. Provide pump as scheduled on Drawings.

Z. Bottle Filler (BF-1):
1. Recessed, wheelchair accessible bottle filling station
2. Durable ABS plastic and 16 gauge, type 304 stainless steel with a stain finish
3. Electric sensor for touch free hygienic operation
4. 30 second timeout preventing unwanted use
5. 0.5 gpm flow rate
6. 2,500 gallon carbon block filter reduces chlorine and lead, and removes 99.99% of cysts.
7. Lead free, NSF/ANSI standard 61, section 9, NSF/ANSI standards 42 & 53, NSF/ANSI 372 and CSA standard B483.1.
8. Provide extra set of replacement filter
9. 115V, 0.1 amp.

AA. Roof Hydrant (RH-1)
1. Refer to plumbing schedule for requirements.

BB. Domestic Water Pressure Booster Pump (DWPBP-3001):
1. Variable speed Simplex Multistage Booster
2. UL Listed and NSF 61 and 372 certified.
3. Complete system with ball valve, in line check valve, pump, and pump controller
4. Single point power connection at control panel.
5. Assembled system to be painted with industrial machine enamel prior to shipment.
6. TEFC enclosure.
7. Refer to equipment schedule for additional requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Install and secure equipment per manufacturer's installation instructions. Provide all equipment supports for securing equipment in compliance with all local codes.

C. Fixtures:
   1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
   2. Connect plumbing supply, drain and vent line sizes as shown on Drawings.
   3. Set proper grounds to form secure base for each fixture and rigid setting.
   4. Install fixtures except water closets with water supply above rim and with Code approved backflow preventers.
   5. Seal fixture joints abutting walls and floors with silicone sealant.
   6. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.
   7. Install emergency fixtures in accordance with ANSI Z358.1.
   8. Install emergency fixture thermostatic mixing valves per manufacturer installation instructions.

D. Drains:
   1. Install drains at locations indicated on Drawings and in compliance with local Codes.
   2. In quarry tile floors:
      a. 24 x 24 IN 6 LB lead sheet clamped to drain.
      b. Set 1-1/2 IN above structural slab for mortar set and 1/2 IN for thin set.
   3. In uncovered concrete slabs:
      a. Install at the low points of surface areas to be drained or as indicated.
      b. Set tops of drains flush with the finished floor.
      c. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces.
      d. Maintain the integrity of waterproof membranes, where penetrated.
   4. Trench drains:
      a. Install in accordance with manufacturer's instructions and approved Shop Drawings.
      b. Install trench sections with the top edges level and straight at elevations indicated.
         1) Support channel sections in place while concrete is placed under and around sections as indicated.
   5. Plans are diagrammatic. All drain and vent connections, pipe fittings, and related components shall be installed in accordance with local codes.

E. Shower:
   1. Coordinate all work with architecture before ordering and before start of work.

F. Wall Hydrants:
   1. Install 24 IN above exterior grade.
   2. Support units from the structure and mount flush with structure face.
   3. Prior to final setting, fill the back of the face with a non-hardening silicone caulk and press firmly in place to stop infiltration and water leakage.
   4. Install isolation valves in line to each wall hydrant.

G. Hose Racks:
   1. Adjacent to hose bibbs, top of rack 36 IN above finished floor or grade.
   2. Concrete or masonry walls: Mount with 5/8 IN x 2-1/2 IN stainless steel expansion anchors.
   3. Handrail:
      a. Bolt hose rack to 24 IN x 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.

b. Attach to handrail with 3/8 IN stainless steel through bolt at each corner of the plate.

4. Pedestal:
   a. Bolt hose rack to 24 IN to 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.
   b. Attach to pedestal with two, 1/2 IN stainless steel bolts through handrail.

H. Hose Bibbs:
1. Install 36 IN above finished floor.
2. In exterior locations, provide interior isolation valve.

I. Shock Absorbers:
1. Install on hot and cold water lines adjacent to each battery of fixtures or other equipment per manufacturer's recommendations.
2. Size as recommended by manufacturer for length of pipe served.
3. Locations having two fixtures or less, install capped air chamber 12 IN long on hot and cold water runouts to each fixture, same size as runout.
4. Runouts to hose bibbs and wall hydrants do not require air chambers.
5. Install units vertically on top of pipe or as detailed on the Drawings.
6. QTY. and location shown are approximate. Provide and install in accordance with he manufacturer's installation instructions.

J. Cleanouts:
1. Install cleanouts:
   a. Above floor in each vertical riser that connects to horizontal branch below floor.
   b. At test tee to receive proper test plugs in each vertical riser at least every other floor.
   c. As required by local Code.

K. Wall Plates and Escutcheons: Install as specified in Specification Section 40 05 00 or this Specification Section.

L. Water Heater:
1. Install all water heaters in accordance with details, manufacturer's recommendations, and applicable Codes.
2. For units located on concrete pads, plumb level and orient to allow access to the controls, elements and other items requiring service.
3. Connect hot and cold water piping to the unit with line-size, isolation valves and dielectric unions.
4. Connect recirculating hot water to cold inlet piping with unions and valves at check valves as detailed.
5. Start up the unit and adjust all controls for proper temperature control and maximum efficiency.
6. Where indicated, install instantaneous electric water heaters in enclosure rated for area classification.
   a. Silicone seal all piping and wiring penetrations.

M. Reduce Pressure Backflow Preventer: Install on water lines as required by Code.

## 3.2 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 40 05 00.

**END OF SECTION**

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# DIVISION 23

## HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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# SECTION 23 05 48
## VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Inertia bases.
   2. Vibration isolators.

B. Related Requirements:
   1. Section 07 92 00 - Joint Sealants: Product requirements for joint sealers specified for placement by this Section.
   2. Section 08 90 00 - Louvers and Vents: Product requirements for acoustic wall louvers.
   3. Section 23 05 93 - HVAC Systems Balancing and Testing for HVAC: Requirements for sound and vibration measurements performed independent of this Section.
   4. Section 23 31 00 – HVAC: Ductwork: Product requirements for both solid and flexible duct connectors for duct sound attenuators specified for placement by this section.
   5. Section 01 81 10 – Wind and Seismic Design: All vibration and seismic component design and installation must comply with 01 81 10 unless otherwise dictated by a more stringent requirement in this section.

### 1.2 REFERENCE STANDARDS

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 300, Reverberant Room Method for Sound Testing of Fans.

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   1. 575, Method of Measuring Machinery Sound within an Equipment Space.

C. American National Standards Institute (ANSI):
   1. S1.4, Specification for Sound Level Meters.
   2. S1.8, Reference Quantities for Acoustical Levels.
   3. S1.13, Measurement of Sound Pressure Levels in Air.
   4. S12.60, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   1. 68, Laboratory Method of Testing to Determine the Sound Power in a Duct.
   2. Handbook - HVAC Applications.

E. ASTM International (ASTM):
   1. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   2. E477, Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
   3. E596, Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Duct Construction Standards - Metal and Flexible.

### 1.3 PREINSTALLATION MEETINGS

A. Section 01 30 00 - Special Conditions: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

## 1.4 SUBMITTALS

A. Section 01 33 00 - Submittal: Requirements for submittals.

B. Product Data:
   1. Submit schedule of vibration isolator type with location and load on each.
   2. Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Shop Drawings:
   1. Indicate static and dynamic load of both inertia bases and vibration isolators.
   2. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for fabricated sound attenuation products.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions indicating that maximum room sound levels are not exceeded.

F. Manufacturer Instructions:
   1. Submit special procedures and setting dimensions.
   2. Indicate installation requirements maintaining integrity of sound isolation.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

H. Manufacturer Reports: Certify that sound isolation installation is complete and complies with instructions.

I. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

## 1.5 CLOSEOUT SUBMITTALS

A. Division 01: Closeout Procedures

B. Project Record Documents:
   1. Record actual locations of hangers including attachment points.

## 1.6 QUALITY ASSURANCE

A. Perform Work according to AMCA 300, ANSI S1.13, AHRI 575 standards and ASHRAE 68 recommendations.

B. Maintain 3 copies of each standard affecting Work of this Section on Site.

## 1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Oregon.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

### 1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

### 1.10 WARRANTY

A. Division 01: Requirements for warranties.

B. Furnish five -year manufacturer's warranty for inertia bases.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide vibration isolation devices on motor-driven equipment over 0.5 HP, plus connected piping and ductwork.

B. Minimum Static Deflection of Isolators:
   1. Basement - Under 20 hp.
      a. Under 400 RPM: 1.0 IN.
      b. 400 to 600 RPM: 1.0 IN.
      c. 600 to 800 RPM: 0.5 IN.
      d. 800 to 900 RPM: 0.2 IN.
      e. 1,100 to 1,500 RPM: 0.15 IN.
      f. Over 1,500 RPM: 0.1 IN.
   2. Upper Floors - Under 20 hp.
      a. Under 400 RPM: 3.5 IN.
      b. 400 to 600 RPM: 3.5 IN.
      c. 600 to 800 RPM: 2.0 IN.
      d. 800 to 900 RPM: 1.0 IN.
      e. 1,100 to 1,500 RPM: 0.5 IN.
      f. Over 1,500 RPM: 0.2 IN.

C. Consider upper floor locations critical unless otherwise indicated.

D. Use concrete inertia bases for fans having static pressure greater than 3.5 IN wg, motors larger than 40 hp, and on base-mounted pumps larger than 10 hp.

E. Maintain indicated maximum sound level of spaces by using acoustical devices.

F. Maintain rooms at following maximum sound levels, according to Noise Criteria (NC) as defined by ASHRAE Handbook - HVAC Applications.
   1. Offices:
      a. Executive: 25.
      b. Conference Rooms: 30.
      c. Private: 30.
      d. Open-Plan Areas: 40.
      e. Computer/Business Machine Areas: 45.
      f. Public Circulation: 45.

### 2.2 INERTIA BASES

A. Manufacturers:
   1. Vibro-Acoustics
   2. Or approved equal.

3. Substitutions: As specified in Section 01 65 50 - Product Delivery, Storage, and Handling.

B. Structural Bases:
   1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine and to transmit design loads to isolators and snubbers.
   2. Construction: Welded structural steel with gusset brackets, supporting equipment, and motor with motor slide rails.

C. Concrete Inertia Bases:
   1. Minimum Mass: 1.5 times weight of isolated equipment.
   2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, and concrete filled.
   3. Connecting Point: Reinforced to connect isolators and snubbers to base.
   4. Concrete:
      a. Type: Reinforced.
      b. Compressive Strength: 3,000 PSI.

## 2.3 VIBRATION ISOLATORS

A. Manufacturers:
   1. Mason Industries, Inc.
   2. Substitutions: As specified in Section 01 65 50 - Product Delivery, Storage, and Handling.

B. Open Spring Isolators:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.
   2. Springs:
      a. Minimum Horizontal Stiffness: 75 PCT of vertical stiffness.
      b. Working Deflection: Between 30 and 60 PCT of maximum deflection.
   3. Spring Mounts: Furnish leveling devices, minimum 0.25 IN thick neoprene sound pads, and zinc chromate-plated hardware.
   4. Sound Pads:
      a. Size: Based on minimum deflection of 0.05 IN.
      b. As specified for neoprene pad isolators.

C. Restrained Spring Isolators:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.
   2. Springs:
      a. Minimum Horizontal Stiffness: 75 PCT of vertical stiffness.
      b. Working Deflection: Between 30 and 60 PCT of maximum deflection.
   3. Spring Mounts: Furnish leveling devices, minimum 0.25 IN thick neoprene sound pads, and zinc chromate-plated hardware.
   4. Sound Pads:
      a. Size: Based on minimum deflection of 0.05 IN.
   5. As specified for neoprene pad isolators.
   6. Restraints: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.
3. Springs:
   a. Minimum Horizontal Stiffness: 75 PCT of vertical stiffness.
   b. Working Deflection: Between 30 and 60 PCT of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 IN.

E. Restrained Closed Spring Isolators:
1. Spring Isolators:
   a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
   b. Code: Color-code springs based on load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.
3. Springs:
   a. Minimum Horizontal Stiffness: 75 PCT of vertical stiffness.
   b. Working Deflection: Between 30 and 60 PCT of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 IN and limit stops.

F. Spring Hangers:
1. Spring Isolators:
   a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
   b. Code: Color-code springs based on load carrying capacity.
2. Springs:
   a. Minimum Horizontal Stiffness: 75 PCT of vertical stiffness.
   b. Working Deflection: Between 30 and 60 PCT of maximum deflection.
3. Housings: Incorporate neoprene isolation pad as specified for neoprene pad isolators.
4. Misalignment: Capable of 20-degree hanger rod misalignment.

G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
   a. Hardness: 30 durometer.
   b. Minimum Thickness: 1/2 IN.
   c. Maximum Loading: 40 PSI.
   d. Rib Height: Not greater than 0.7 times width.
2. Configuration: 1/2 IN-thick waffle pads bonded to each side of 1/4 IN-thick steel plate.

H. Rubber Mount or Hanger:
1. Material: Molded rubber.
2. Deflection: 0.5 IN.
3. Insert: Threaded.

I. Glass-Fiber Pads: Neoprene-jacketed, pre-compressed, molded glass fiber.

J. Seismic Snubbers:
1. Description: Non-directional and double-acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Neoprene Elements:
   a. Replaceable.
   b. Minimum Thickness: 0.75 IN.
3. Capacity: Four times assigned load to mount groupings at 0.4 IN deflection.
4. Attachment Points and Fasteners: Capable of withstanding three times rated load capacity of seismic snubber.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify that equipment, ductwork, and piping are installed before starting Work of this Section.

### 3.2 INSTALLATION

A. Install isolation for motor-driven equipment.

B. Contractor is responsible to design and install piping and equipment supports, seismic restraints/bracings, hangers, etc. with anchors in accordance with SMACNA HVAC Duct Construction Standards and local building code.

C. Bases:
   1. Steel: Provide 1 IN of clearance between housekeeping pad and base.
   2. Concrete Inertia: Provide 2 IN of clearance between housekeeping pad and base.

D. Make equipment level.

E. Install spring hangers without binding.

F. Isolators:
   1. Closed Spring Isolators: Adjust such that side stabilizers are clear under normal operating conditions.
   2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than 6.0 IN of static pressure and on hanger-supported, horizontally mounted axial fans.

H. Snubbers:
   1. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers.
   2. Provide each inertia base with minimum of four seismic snubbers located close to isolators.
   3. Equipment Designated for Post-Disaster: Snub to 0.05 IN maximum clearance.
   4. Other Snubbers: Provide clearance between 0.15 and 0.25 IN.

I. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector.

J. Support piping connections to isolated equipment resiliently as follows:
   1. Up to 4-Inch Diameter: First three points of support.
   2. 5- to 8-Inch Diameter: First four points of support.
   3. 10-Inch Diameter and Larger: First six points of support.

### 3.3 FIELD QUALITY CONTROL

A. Division 01: Requirements for inspecting and testing.

B. Inspect isolated equipment after installation and submit report, including static deflections.

C. Sound Measurements:
   1. After startup, final corrections, and balancing of systems, take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations.
   2. Provide 1/3 octave band measurements of artificial sound sources in areas indicated as having critical requirements.
   3. Submit complete report of test results, including sound curves.

D. Testing Agency:
   1. Furnish services of testing agency to take noise measurement.
   2. Use meters according to ANSI S1.4.

## 3.4 SCHEDULES

A. Pipe Isolation Schedule:

| Pipe Size Inch | Isolated Distance from Equipment diameters |
|---|---|
| 1 | 120 |
| 2 | 90 diameters |
| 3 | 80 diameters |
| 4 | 75 diameters |
| 6 | 60 diameters |
| 8 | 60 diameters |
| 10 | 54 diameters |
| 12 | 50 diameters |
| 16 | 45 diameters |
| 24 | 38 diameters |

**END OF SECTION**

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# SECTION 23 05 53
## IDENTIFICATION FOR HVAC, DUCTWORK, PIPING AND HVAC EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   6. Labels.
   7. Lockout devices.

B. Related Sections include but are not necessarily limited to:
   1. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit Identification Register including list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

D. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

### 1.4 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

## PART 2 - PRODUCTS

### 2.1 MANUFACTUERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Nameplates, Tags and Stencils:
      a. Brady Corporation.
      b. Panduit.

c. Seton by Brady Corporation.
d. National Band and Tag Company.
e. Carlton Industries, LP.

2. Ceiling tacks:
   a. Marking Services, Inc.
   b. R&R Identification Co.
   c. Seton by Brady Corporation.

## 2.2 NAMEPLATES

A. Laminated two-layer phenolic or DR (high impact) acrylic with engraved black letters on light contrasting background color.
   1. Thickness: Minimum 1/16 IN.
   2. Color: Manufacturer standard or as specified.

B. Alternate: Laminated three-layer plastic with engraved black letters on light contrasting background color.
   1. Thickness: Minimum 60 mils.
   2. Color: Manufacturer standard or as specified.

## 2.3 TAGS

A. Nonmetallic Tags:
   1. Fiberglass reinforced engraved black letters on light contrasting background color.
      a. Tag size: Minimum 1-1/2 IN diameter.
      b. Thickness: Minimum 100 mils.
      c. Color: Manufacturer standard or as specified.

B. Metal Tags:
   1. Aluminum or stainless steel disc with stamped letters and finished edges.
      a. Tag size: Minimum 1-1/2 IN diameter.
      b. Thickness: Minimum 0.035 IN (20 Ga).
      c. Color: Black color filled into stamped text with natural metal background.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

## 2.4 STENCILS

A. With clean cut symbols and letters of following size:
   1. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
   2. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
   3. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
   4. Ductwork and Equipment: 1-3/4 IN high letters.

B. Stencil Paint: As specified in Section 09 96 00, colors and lettering size conforming to ASME A13.1.

## 2.5 SELF ADHESIVE PIPE AND DUCT MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
   1. Thickness: Minimum 5 mils.
   2. Letter Height:
      a. Up to 2 IN Outside Diameter of Insulation or Pipe: 1/2 IN high letters.
      b. 2-1/2 to 6 IN Outside Diameter of Insulation or Pipe: 1 IN high letters.
      c. Over 6 IN Outside Diameter of Insulation or Pipe: 1-3/4 IN high letters.
      d. Ductwork and Equipment: 1-3/4 IN high letters.
   3. Indoor/outdoor grade.
   4. Weather and UV resistant inks.
   5. Permanent adhesive.

### 2.6 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 IN.

B. Valve Lockout Devices:
   1. Manufacturers:
      a. Brady Corporation.
      b. Master Lock Company, LLC.
   2. Nylon device preventing access to valve operator, accepting lock shackle.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 96 00 for stencil painting.

### 3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09 96 00.

B. Install identifying devices after completion of coverings and painting.

C. All identification devices to be printed by mechanical process. Hand printing is not acceptable.

D. Install nameplates with adhesive where equipment has sufficient surface area and texture.
   1. Attach tags with 1/8 IN flat head screws where adhesive application is not suitable.
   2. Attach tabs with plastic strap where screws should not or cannot penetrate substrate.

E. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

F. Install tags using corrosion resistant chain. Number tags consecutively by location.

G. Install underground plastic pipe markers 6 to 8 IN below finished grade, directly above buried pipe.

H. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with nameplates. Identify in-line pumps and other small devices with tags.

I. Tag single items of equipment enclosed in a housing or compartment on outside of housing.
   1. Tag multiple items mounted inside a housing or compartment individually inside the housing.

J. Identify control panels and major control components outside panels with plastic nameplates.

K. Identify valves in main and branch piping with tags.

L. Identify air terminal units and radiator valves with numbered tags.

M. Tag automatic controls, instruments, and relays. Key to control schematic.

N. Identify piping, concealed or exposed, with pipe markers. Use tags on piping 3/4 IN diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 FT on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

O. Identify ductwork with nameplates. Identify service and direction. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction and change of direction and not to exceed 20 FT spacing on straight runs.

## 3.3 SCHEDULES

A. Ductwork:
   1. Install labels on all duct in accordance with Article 3.2.
      a. Stencils or self-adhesive labels.
   2. Color Coding:
      a. Black lettering on yellow backgrouond:
         1) Supply Air, Outside Air or Makeup Air.
      b. White lettering on green background:
         1) Return Air, Exhaust Air and Relief Air.

B. Above Grade Piping:
   1. Install labels on all piping in accordance with Article 3.2.
      a. Stencils or self-adhesive lablels.
   2. Color Coding: Per ASME A13.1.
      a. Black lettering on yellow background:
         1) Hazardous, flammable or high temperature fluids:
            a) Refrigerant Piping.
      b. White lettering on red background:
         1) Fire quenching fluids:
            a) Fire Protection Water.

C. Valves:
   1. Install on all automatic valves used in temperature controls:
      a. Label per Control Drawings.
   2. Install on all manual valves:
      a. Number and schedule all valves utilized on project. Coordinate numbering system with Tag Chart.
   3. Utilize nonmetallic or metal tags.
      a. Use stainless steel metal tags only for corrosive areas.

D. Equipment:
   1. Provide nameplate or stencil as warranted per Article 3.2.
   2. Label with equipment tag as shown on the Drawings.
      a. Black lettering on white background.
   3. Provide OSHA warning sign for equipment that starts automatically.
   4. Label all equipment control panels located remote from unit.
   5. Label all thermostats with self-adhesive markers with tag of equipment served.

**END OF SECTION**

# SECTION 23 05 93
## HVAC SYSTEMS - BALANCING AND TESTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems, including the following systems:
      a. Air distribution and exhaust systems.
      b. Air moving equipment.
      c. Circulating water systems, including pumps.
      d. Control systems.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 23 31 00 - HVAC - Ductwork.
   4. Section 23 80 00 - HVAC - Equipment.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   2. American Industrial Hygiene Association (AIHA):
      a. Z9.5, Laboratory Ventilation.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Laboratories".
      b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing".
   4. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:
   1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
      a. Associated Air Balance Council (AABC).
      b. National Environmental Balancing Bureau (NEBB).
      c. Other certification entity approved by Engineer.
   2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certifications:
      a. Letter stating the name and qualifications of the firm proposed.
      b. Evidence that relevant subcontractors have been notified of the requirement to coordinate balance and test elements in the work with the testing and balancing firm.
   3. Report forms:
      a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

B. Informational Submittals:
   1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
      a. Insert recorded information on report forms required by specifications and approved for use on project.
      b. Additional written verification and other related information clearly identifying project, date and specifics of verification.
      c. Utilize report forms similar to those shown in Section V of AABC Standard.
      d. Provide forms typed and signed by the testing and balancing firm.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:
   1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.
   2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.
   1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review design Drawings, specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.
   1. Report deficiencies to the Engineer.
   2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

### 3.2 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:
   1. Adjust equipment RPM to design requirements.
   2. Report motor full load amperes.
   3. Obtain design CFM at fans.
      a. Make pitot tube traverse of main supply and exhaust ducts within 5 PCT.
   4. Test and record system static pressures, suction and discharge.
   5. Obtain design CFM for recirculated air.
   6. Obtain design CFM outside air.
   7. Test and record entering air temperatures, (DB, heating and cooling).
   8. Test and record leaving air temperatures, (DB, heating and cooling).
   9. Test and record leaving air temperatures, (WB, cooling).
   10. Adjust dampers in supply, exhaust and return air ducts to design CFM.
   11. Test diffusers, grilles, and registers as follows:
      a. Adjust to comply with design requirements within 10 PCT.
      b. Identify location and area of each.

c. Adjust face velocity to establish required CFM.
    1) Retest after initial adjustments.
d. Adjust to minimize drafts and to ensure uniform air distribution in all areas.

12. Identify and list size, type and manufacturer of diffusers, grilles, registers, and HVAC equipment.
    a. Use manufacturer's ratings on equipment to make required calculations.
13. Adjust and assure that the operation of automatically operated dampers are as specified.
    a. Check and calibrate controls.
14. Prepare and submit reports.

B. Balance and Test Water Systems:
1. Domestic Hot Water Recirculation System:
    a. Set pumps to proper flow delivery.
    b. Upon completion, mark settings and record data.
    c. List mechanical specifications of pumps.
    d. Record rated and actual running amperage of pump motor.
    e. Prepare and submit report.

**END OF SECTION**

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# SECTION 23 09 00
## INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Instrumentation and control for HVAC systems.
2. Temperature control.
3. Ventilation control.
4. Heating control.
5. Cooling control.
6. Control wiring.
7. Panels and accessories.
8. Miscellaneous.

B. Related Specification Sections include but are not necessarily limited to:
1. Section 23 31 00 - HVAC - Ductwork.
2. Section 23 80 00 - HVAC - Equipment.
3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
4. Section 26 05 33 - Raceways and Boxes.
5. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

A. See Specification Section 01 61 03.

B. Referenced Standards:
1. ASTM International (ASTM):
   a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
2. The International Society of Automation (ISA):
   a. S5.1, Instrumentation Symbols and Identification.
   b. S5.4, Standard Instrument Loop Diagrams.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL).

C. Miscellaneous:
1. Controls to be in compliance with Specification Section 26 05 00 for NEMA and NFPA 70 enclosure class requirements unless noted or specified otherwise.
2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

### 1.3 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.
1. Assemble control system with complete system of wiring to fulfill requirements of the Contract Documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operation," are designed to illustrate operating functions only.
   1. Control sequence shall be considered supplementary to "Sequence of Operation".
   2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.

E. Sequence of Operation - General:
   1. Sequence of operation indicated on drawings illustrates basic operating functions only.
   2. Review Drawings and submit complete installation data, including minor details, to provide proper operation in this proposal.
   3. Where an item differs from specifications, control manufacturer shall submit manufacturer's recommendations subject to Engineer's approval.
   4. HVAC units shall be controlled by controls provided as part of the system.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
   2. Information on equipment proposed for use including corrosion protection.
   3. Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.
      a. Show components in system and ensure diagrams are in full compliance with ISA S5.1 (Instrumentation Symbols and Identification) and other related ISA standards.

B. Quality Control Submittals:
   1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
      a. Provide the above information to control manufacturer.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Manufacturer's catalog numbers hereinafter are for reference to type, style, dimension, related items and to establish a standard of quality.
      a. Reference to a manufacturer's number hereinafter does not imply full compliance to these Specifications.
   2. Instrumentation and control systems:
      a. Honeywell.
      b. Johnson Control Co.

### 2.2 EQUIPMENT

A. Dampers:
   1. Refer to Specification Section 23 31 00.

B. Damper Operators:
   1. Provide operators of proper size and number to secure true throttling or two-position action as required.
   2. Furnish damper operators for installation inside ductwork and attached to frame of damper, or installed outside ductwork and connected to extended shaft as required.
   3. Provide operators for outside air, spring-loaded with sufficient power to assure tight closing of dampers on fan shutdown or in the fail safe position indicated by "Sequence of Controls."
   4. Electric operators:
      a. Provide damper operators with integral spring return motor springs to make controls fail safe in position specified under "Sequence of Controls."
      b. Provide fully modulating operators from proportional electric controllers.
      c. Provide end switches or proportioning controllers permitting simultaneous operation or interlocking with other equipment.
      d. Provide separate electrical circuits for damper operators with no more than four operators on a circuit.
   5. Coordinate with dampers provided:
      a. Provide damper operators that are rated for the required torque.
      b. If single damper operator can not meet torque requirement, provide sectional dampers to match operator torque.
   6. Ensure coordination to provide for the installation of tight closing dampers low leakage type (6 CFM per square foot at 4 IN WC pressure across damper) with compatible dampers, damper operators and related controls.

C. Electric Control Instruments:
   1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
      a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.
      b. Provide sensing elements minimum of 60 IN in length and suitable for operation from -30 to 300 DEGF.
      c. Provide reverse acting on-off type thermostats for controlling ventilating fans.
      d. Provide multiple stage thermostats where designated in Paragraph "Sequence of Operation".
   2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125% of energy requirements of equipment connected for not less than 1 HR.
      a. Enclose transformers in UL listed cabinets with conduit connections.
      b. Provide fused disconnect switches on both primary and secondary sides.
   3. Provide low limit electric thermostats of two-position type with 20 FT bulb and manual reset.
      a. Shall be capable of opening thermostat circuit if any 1 FT section of bulb is subjected to a temperature below thermostat setting.
      b. Each thermostat shall have two circuits, one to shut down fan, another for alarm.
      c. Install all freeze-stats to override starter circuits regardless of position.
      d. For corrosive environments provide thermostats with stainless steel sensing elements.
         1) Ensure element is installed to sense coldest point should stratification occur.
   4. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.
   5. Label thermostat with identification tag of HVAC equipment controlled using phenolic nameplate in accordance with Specification Section 23 05 53.

D. Industrial Controllers:
   1. Provide control instruments, devices, and incidentals of industrial process control quality capable of producing the outlined performances.

2. Electronic (and electric) controller shall have three control mode capabilities of proportional rate (time), and dead band within following minimum performance and application criteria:
   a. Setpoint adjustment: 0 to 110% of span.
   b. Repeatability: Setpoint repeats within +0.1% of span.
   c. Dead band: 1% of span, standard.
   d. Rate: 5 to 30 seconds adjustable.
   e. Response level: 50 milliseconds for a step change of 1% of span beyond setpoints.
   f. Output: SPDT relay contacts, 5 amps at 117 VAC noninductive.
3. Controller shall be capable of remote setpoint adjustment, permanently mounted in air flow control panel unless otherwise indicated.
4. Provide each controller with instruments (pressure gages, milliampmeters, voltmeters, etc.) to indicate magnitude of output signal in both medium of signal (psig, mA, volt DC, etc.) and percentage of full output signal.
5. Recording controllers:
   a. Where recording controllers are required by "Sequence of Controls," they shall be 10 IN chart, 24 HR or 30-day charts (field selection), with one, two, or three pens as listed in control sequence.
   b. Pens shall have capillary ink supply and cartridge type ink supply.
   c. Recorders shall operate on 110 V power supply.
   d. Optional 4 IN strip chart recorders may be used with the strip traveling vertically.

E. Static Pressure Gages:
1. Install gages on control panel for each system.
   a. One gage shall serve each filter while others shall serve as a check on system.
   b. Gages shall be Magnahelic by Dwyer 2000 ASF, flush mounted with signal flag for filter gage.
   c. Install static pressure tips as scheduled under control panel indication points.
   d. Static pressure ranges:
      1) Filter (cartridge): 0 to 2.0 IN WC.
      2) Air-handling systems: 0 to 10.0 IN WC (one per air-handling unit).

F. Local Temperature Control Panel:
1. Panel shall be floor or wall-mounted and be sized to accommodate electrical switches, protective devices (except electrical switches and devices furnished as an integral part of air handling unit).
2. Mount indicating controllers or receiver-controllers, three-way air valves, relay, EP and PE switches, switching relays, ammeters and other accessory items on local sub-panels set in vicinity of equipment to be served.
   a. Where two similar items of equipment, such as pumps, are installed adjacent to each other a single panel may be used to contain all instruments.
3. Fully compensated capillaries connected to instruments shall be of sufficient length to allow them to be run between equipment and placed in such a position so that they will not obstruct service of equipment or become damaged.
4. Miniature milliamp meters for electronic temperature transmission may be used.
5. Manufacture panels in one of the following manners:
   a. NEMA electrical panel boxes with windows.
   b. Install gages flush mounted in swing out panel behind window with instruments and other control items located inside enclosures behind panel.
      1) Refer to Paragraph "Corrosion Protection."
6. Mount all relays, PE switches, pressure switches, etc., on rear inside of enclosure.
   a. Tag each instrument corresponding to symbols used on control diagrams.
7. Temperatures, pressures, equipment operation, and related items shall be continuously indicated on panels.
8. Points to be monitored are scheduled under another paragraph of this Specification Section.

## 2.3 FABRICATION

A. Corrosion Protection:
   1. Protect metal parts of controls, instrumentation and related items from corrosive atmosphere by either protective coatings or select materials.
      a. Aluminum and stainless steel require no further protection.
   2. Provide NEMA 4X fiberglass control enclosures with tempered glass windows and vapor tight gaskets, illustrated in Hoffman Bulletin A-50, for protection of controls from corrosive environment.
      a. Install control instruments inside enclosure and extend remote stainless steel sensing elements through enclosure wall.
      b. Provide vaportight seals for penetrations of enclosure.
   3. Provide in each enclosure industrial corrosion inhibitors, Hoffman Corrosion Inhibitors, as illustrated in Hoffman's technical Bulletin HCI.
   4. Protect metal accessory items such as mounting brackets and fasteners not stainless steel, fiberglass or aluminum by epoxy or phenolic coatings.
   5. Protect electric motor operator with corrosion inhibitors inside enclosure.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Comply with requirements of Specification Section 26 05 19 and Specification Section 26 05 33.

B. Identification: See Specification Section 23 05 53.

C. Connect control devices to perform functions indicated and perform in required sequence.

D. Use remote element temperature transmitters for points of temperature transmitters for points of temperature measurement occurring in air ducts or shafts, or in mechanical piping system.

E. Use remote element pressure transmitters of panel-mounted pressure gages.

F. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.
   1. Pipe continuous indication signal to a receiver on panel.
   2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.

G. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.
   1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
   2. Prior to installation, coordinate thermostat location with Engineer.

H. Mount local control panels adjacent to equipment served.

I. Where a temperature indicating gage is used at the panel, a pressure gage indicating transmitter signal is not required.

J. Provide appropriate type continuous reading indicator for each controller, transmitter and transducer.
   1. Mount in-line or tapped on controller.
   2. Mount at local control panel.

K. Gages with flexible hose terminating with hypodermic needle may be used for checking control system.
   1. Do not substitute for in-line gages.

L. Locate panels so visual observation and adjustment can be accomplished from floor level.

**END OF SECTION**

# SECTION 23 31 00
## HVAC - DUCTWORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. HVAC ductwork and accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 08 90 00 - Louvers and Vents.
   4. Section 01 61 03 - Equipment - Basic Requirements.
   5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
   2. National Fire Protection Association (NFPA).
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Ducted Electric Heat Guide for Air Handling Systems.
      b. HVAC Duct Construction Standards - Metal and Flexible.
   4. Underwriters Laboratory, Inc. (UL):
      a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
      b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.
      c. Building Materials Directory.

B. Qualifications:
   1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three years.
   2. Installers: Firm with at least five years installation experience on products similar to that required for this Project.

### 1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03.
   3. Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.
   4. Scaled ductwork drawings (1/4 IN equals 1 FT) showing duct and accessory layout and support.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Miscellaneous Submittal:
1. Documentation of qualifications for fabricators and installers.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Transverse joints (factory fabricated aluminum):
a. Ductmate Industries, Inc.
2. Flexible ducts:
a. Thermaflex.
b. Condu-flex.
c. Glass-flex.
3. Turning vanes:
a. Ductmate Industries, Inc.
b. Duro Dyne.
c. SEMCO Incorporated.
d. Ward Industries, Inc.
4. Flexible duct connections:
a. Vent Fabrics.
b. Duro Dyne.
5. Flexible connector thrust restraint:
a. Mason WB.
6. Access doors in ductwork:
a. Vent Fabrics.
b. American Warming.
7. Backdraft dampers:
a. Air Balance.
b. Ruskin.
c. American Warming.
8. Ceiling diffusers:
a. Anemostat.
b. Carnes.
c. Titus.
9. Grilles and registers:
a. Anemostat.
b. Carnes.
c. Titus.
10. Air filters:
a. American Air Filter.
b. Farr.
c. Continental.
11. Manual (volume) dampers:
a. Air Balance.
b. Ruskin.
c. American Warming.
12. Duct sealers:
a. Durkee-Atwood.
b. Unitec McGill.
c. Benjamin Foster.
d. Design Polymerics.

13. Roof mounted intake and relief hoods:
    a. Loren Cook
    b. Greenheck
14. Temperature control and automatic dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
15. Louvers:
    a. Ruskin.
    b. Air Balance.
    c. American Warming.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 COMPONENTS

A. Duct and Fittings (Metallic):
1. Materials:
    a. 3003 H-14 aluminum alloy:
        1) Comply with ASTM B209.
2. Fabrication (aluminum):
    a. Minimum sheet material thickness:
        1) Ducts with largest side or diameter to 30 IN: 0.05 IN thick.
        2) Ducts with largest side or diameter greater than 30 IN: 0.08 IN thick.
    b. Utilize SMACNA HVAC Duct Construction Standards for minimum of 2 IN water gage static pressure for the minimum sheet material thickness specified herein.
        1) Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.
        2) Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.
    c. Longitudinal seams:
        1) 0.050 material:
            a) Pittsburgh seam.
            b) Continuously welded.
        2) 0.080 material: Continuously welded.
    d. Continuously weld seams on factory assembled units.
    e. Transverse joints (Alternate A):
        1) SMACNA T-22 companion flange.
        2) Gasketed.
        3) Rigidity class:
            a) Ducts with largest side or diameter to 30 IN: SMACNA Class D (1-1/2 x 1-1/2 x 1/8 IN angles).
            b) Ducts with largest side or diameter greater than 30 to 54 IN: SMACNA Class H (2-1/2 x 2-1/2 x 3/16 IN angles).
    f. Transverse joints (Alternate B):
        1) Materials and fabrication:
            a) Angles: Aluminum.
                (1) Ductmate 35.
            b) Corners: Aluminum.
                (1) Ductmate DC 35.
            c) Snap cleats: Aluminized or stainless steel.
            d) Gaskets: Closed cell neoprene.
            e) Bolts: Stainless steel.
            f) Sheet metal screws: Self-drilling stainless steel with unthreaded section under head.
        2) Fabrication:

a) Rigidity class: SMACNA Class H.
b) 3/8 IN DIA x 1 IN bolts.

B. Supports and Hangers:
1. Materials (for aluminum duct):
a. Support angles: Aluminum or stainless steel, minimum 1-1/2 by 1-1/2 by 1/4 angle.
b. Hanger rods: Stainless steel.
c. Anchors: Stainless steel wedge type.
2. Materials (for galvanized duct):
a. Support angles: Galvanized or stainless steel, minimum 1-1/2 by 1-1/2 by 1/4 angle.
b. Hanger rods: Galvanized or Stainless steel.
c. Anchors: Stainless steel wedge type.
3. Fabrication: Trapeze type units.
4. Strap hangers are not allowed.

C. Turning Vanes:
1. Materials: Same as duct.
2. Fabrication:
a. Fabricate double vane units.
b. Pressure drop through elbows: Maximum 20 PCT of velocity pressure.

D. Flexible Connections:
1. Materials: Hypalon, double coated closely woven glass fabric.
2. Fabrication: Withstand 4.5 IN water column, positive and negative pressure.

E. Access Doors:
1. Materials:
a. Inner panel, out panel and frame: Same as duct.
b. Gaskets: Closed cell neoprene.
c. Insulation: 1 LB density fiberglass.
d. Hinges: Stainless steel.
e. Latches:
1) Aluminum-zinc alloy.
2) Outside lever handle.
3) Adjustable spacer.
4) Beveled inside flange.
5) Studs:
a) Minimum 3/8 IN DIA stud for doors up to 24 IN wide x 48 IN high.
b) Minimum 1/2 IN DIA stud for doors larger than 24 x 48 IN.
2. Fabrication:
a. Provide four-side continuous gaskets.
b. Utilize continuous piano hinges.
c. Latches required:
1) 12 IN in any direction: One.
2) Up to 18 x 18 IN: Two.
3) Up to 24 x 48 IN: Two with inside handles.
4) Up to 24 x 72 IN: Three with inside handles.
5) Minimum door size: 12 x 12 IN.

F. Flexible Duct:
1. Material: Continuous steel supporting spiral covered with 100 PCT continuous filament fiberglass with nonporous fiberglass/vinyl liner and reinforced Mylar/neoprene outer cover.
2. UL listed, Class 1 with flame spread of 25 or less and smoke development rating not to exceed 50.

G. Drain Pan:
1. Materials: Aluminum.
2. Fabrication: 0.080 IN.

H. Backdraft Dampers:
   1. Material:
      a. 6063 T5 aluminum or G90 galvanized steel matching ductwork material.
      b. Blade edge seals: Extruded vinyl.
   2. Fabrication:
      a. Frame thickness: 0.125 IN minimum.
      b. Blade thickness: 0.070 IN minimum.
      c. Linkage: 1/2 IN tie bars.
      d. Bearings: Synthetic.

I. Diffusers:
   1. Materials:
      a. Body: Extruded aluminum.
      b. Ceiling diffuser gaskets: Sponge rubber.
   2. Fabrication:
      a. Type: Square or rectangular with removable core.
      b. Finish:
         1) Circular diffusers: Clear satin anodized.
         2) Interior of perforated supply and return diffusers: Flat black paint.

J. Volume Dampers and Flow Equalizers for Round Neck Diffusers:
   1. Material: Aluminum.
   2. Fabrication:
      a. Design for neck velocity: 2500 FT/MIN.
      b. Center rod operator accessible through diffuser without removing diffuser.
      c. Furnish with screws, duct collars, transitions and air pattern deflectors as required.

K. Air Grille and Register Assembly:
   1. Materials:
      a. Assembly: Extruded aluminum.
      b. Gaskets: Sponge rubber.
   2. Fabrication:
      a. Supply registers: Two sets individually adjustable louvers.
      b. Exhaust and return registers: 45 DEG deflection front blades.
      c. Dampers: Key-operated opposed blade.
      d. Screws, duct collars, and transitions as required.
      e. Finish:
         1) Manufacturer's standard factory applied finish.
         2) Color: White.

L. Roof-Mounted Intake and Relief Hood:
   1. Materials:
      a. Hood: Aluminum.
      b. Screen: Expanded aluminum.
   2. Fabrication:
      a. Type indicated on Drawings.
      b. 0.080 IN thick material.
      c. Insulated.
      d. 85 PCT free area bird screen.
      e. Design to withstand 30 LBS/SQFT snow load and 100 MPH winds.

M. Air Filter Enclosure:
   1. Housing:
      a. Factory fabricated.
      b. 16 GA galvanized steel.
      c. Bracing to eliminate racking.
      d. Two-side access doors.

2. Access doors:
    a. 16 GA galvanized steel.
    b. Replaceable positive sealing latches.
    c. Replaceable hinges.
    d. Neoprene door gasket.
    e. Holding frame to door gasket: Polyurethane foam.
3. Tracks:
    a. Field adjustable.
    b. Anodized extruded aluminum.
    c. Polypropylene seal between holding frame and track.
4. Holding frame:
    a. Galvanized steel.
    b. Multiple fastener lances.
    c. Polyurethane foam gasket.
        1) Internally.
        2) Frame sides.
    d. Accommodate nominal 24 x 24 IN or 12 x 24 IN filters without modifications to frame or housing.

N. Air Filters:
1. Materials:
    a. Holding frame: Aluminum.
2. Fabrication:
    a. Factory built and assembled unit.
    b. Efficiency rating as per ASHRAE 52.
    c. 2 IN thickness minimum.
    d. Efficiency: Refer to schedules on plans for requirements.
    e. Air velocity: 450 FPM maximum.
    f. Clean pressure drop: 0.2 IN WG maximum.
    g. Size, capacity, and type: As indicated on Drawings.

O. Temperature Control, Automatic and Manually (Volume) Operated Dampers:
1. Material:
    a. Body: 6063 T5 aluminum.
    b. Seal blade edge: Extruded vinyl.
2. Fabrication:
    a. Frame thickness: 0.125 IN minimum.
    b. Provide flanged connections.
    c. Blades:
        1) Two-position damper: Parallel blade.
        2) Mixing and volume damper: Opposed blade.
        3) Airfoil shape.
        4) Maximum 6 IN width.
    d. Linkage: Concealed in frame.
    e. Axles: 1/2 IN plated steel hex.
    f. Bearings: Molded synthetic.
    g. Seals:
        1) Jamb: Flexible compression type.
    h. Control shaft: Removable, 1/2 IN DIA.
    i. Air leakage (4 FT SQ damper) at 4 IN WG pressure: 99 CFM maximum.
    j. Motors for motor operated damper: See Specification Section 23 09 00.
    k. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.
    l. Provide stainless steel locking quadrants for manual (volume) dampers.
    m. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.

n. Finish: 215 R1 anodized.

P. Duct sealer:
1. NFPA rating of "Non-Combustible".
2. Flame spread rating: 25 or lower, in dry condition.
3. Smoke developed rating: 50 or lower, in dry condition.
4. Resistant to water and water vapors.
5. Comply with UL 181.
6. Pressure rupture rating: 16 IN WG, minimum.

Q. Louvers: See Specification Section 08 90 00.

### 2.3 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Owner with the following extra materials:
a. 12 complete filter media changes for each filter unit.
b. Filter media used during construction is in addition to this requirement.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Specification Section 01 61 03.

B. Metal Ductwork:
1. Install with longitudinal seams sealed for zero leakage.
a. For welded seams, submit sample for approval by Engineer.
2. Install gaskets at each transverse joint and fasten sections together with bolts.
a. Tighten for zero leakage.
3. The contractor is responsible for designing and installing duct supports, seismic restraints/bracings, hangers, and all required anchors in accordance with SMACNA HVAC Duct Construction Standards and all applicable local building code.
4. Install turning vanes in square elbows:
a. Unsupported vane length not to exceed 48 IN.
b. Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
a. Locate as close as possible to fan.
b. Allow 1 IN of slack to prevent vibration transmission.
c. Install thrust restraints across connectors.
6. Install access doors where indicated on Drawings and at smoke and fire damper in accordance with NFPA requirements.
7. Volume dampers:
a. Install at supply branch connections from ducts.
8. The contractor is responsible for providing and installing all required duct supports and seismic bracing in accordance with the building code, SMACNA standards, and all applicable local codes.

C. Flexible Ductwork:
1. Install in concealed areas between: low velocity duct work and diffusers, return air grilles or exhaust outlets and ducts.
2. Use low loss fittings for connection to duct.
3. Connect to metal duct collars by means of non-combustible synthetic rubber sealing compound and stainless steel drawband.
4. Install with maximum length of 6 FT.

D. Drain Pans:
1. Install at fan coil cooling coils, control valves above finished ceilings and at other sources of moisture.

2. Install metal tubing at drain and terminate above floor drain, equipment drain and as shown on Drawings.

E. Dampers:
   1. Install where indicated on Drawings of sizes shown.

F. Diffusers:
   1. Install where shown on Drawings of size and capacities scheduled on Drawings.
   2. Install painted lay-in type in lay-in ceilings.
   3. Install prime painted diffusers in areas where duct work is concealed.
   4. Install anodized diffusers in exposed duct work.

G. Air Grille and Register Assemblies:
   1. Install where shown on Drawings of size and capacities scheduled on Drawings.
   2. Install prime painted grilles and registers in areas where duct work is concealed.
      a. Field paint to match adjacent surface finish.

H. Roof-mounted Intake and Relief Hoods: Install where shown on Drawings.

I. Air Filters:
   1. Install where shown on Drawings of size and capacity scheduled on Drawings.
   2. Do not operate equipment during construction without filters.

**END OF SECTION**

# SECTION 23 34 00
HVAC - FANS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 23 05 93 - HVAC Systems - Balancing and Testing.
   5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   6. Section 23 31 00 - HVAC - Ductwork.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
      a. AMCA Publication 203 "Field Performance Measurement of Fan Systems".
      b. ANSI/AMCA 210 "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating".
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Roofing Contractors Association (NRCA).
   8. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Wiring diagrams.
      d. Control diagrams.
      e. Manufacturer's catalog cuts and technical data.

f. Corrosion-protection information.
g. Fan curves.
h. Sound data.
i. Vibration isolation.
j. Performance data on all equipment.

3. Certifications:
   a. Provide certification of thickness of corrosion-protection coating.
   b. Fan systems have been tested in accordance with AMCA Standard 210 or 260, and are licensed to bear the AMCA Certified Ratings Seal.

B. Factory Performance test for any fan having a flow rate greater than 1,000 CFM and/or a total static pressure rating equal to or greater than 1.5 IN WC.
   1. Pursuant to AMCA Publication 203 or 210 with no plus tolerances on Power and no minus tolerances on flow or pressure.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vibration isolation assemblies:
      a. Mason.
      b. Vibration Mounting and Controls Co.
      c. Vibro-Acoustics.
   2. Corrosion-protective coatings:
      a. Heresite and Chemical Co.; "Heresite."
      b. Aero-Marine Engineering, Inc.
   3. In-line centrifugal fans:
      a. Loren Cook.
      b. Greenheck
      c. New York Blower.
      d. Aerovent.
   4. Toilet room exhaust fans:
      a. PennBarry Ventilator Co., Inc.
      b. Loren Cook.
      c. Greenheck

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 GENERAL

A. All Manufactured Units:
   1. Comply with Specification Section 01 61 03.
   2. Factory wired and assembled.
   3. Use fasteners made of same material as unit.
   4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
      a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
   1. Type:
      a. Corrosion-resistant materials:

1) Aluminum.
2) Stainless steel.
3) FRP.

b. Corrosion-resistant coating:
1) Phenolic-based coating.
2) 3 MIL minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DEGF.
3) 5 MIL baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DEGF.
4) Factory applied.
5) Provide factory certification of application.

## 2.3 MANUFACTURED UNITS

A. In-Line Centrifugal Fans:
1. AMCA certified Class I, II, or III.
2. Non-overloading horsepower capability.
3. Materials:
a. Wheel, impeller hub and blades: Aluminum or stainless steel.
b. Housing, innertube and belt well: Aluminum or stainless steel.
c. Inlet cone: Aluminum or stainless steel.
d. Driver shaft: Solid stainless steel.
4. Airfoil design blades.
a. All welded construction.
5. All welded housing, innertube and belt well.
6. Innertube construction:
a. Isolates bearings and drive from airstream.
b. Removable end covers.
7. Bearings:
a. Cast iron pillow blocks.
b. Concentric bearing locking collar for drive shafts 1 IN and larger.
1) SKF "ConCentra."
2) Dodge "D Lock."
c. Regreaseable.
d. 200,000 HR average life.
8. Motor:
a. See Specification Section 01 61 03.
b. Belt Drive Units:
1) Driver and driven sheaves:
a) Keyed hub type.
b) Drive sheaves: Fixed pitch diameter.
c) Driver:
(1) Shipped with variable pitch diameter sheave.
(2) Fixed pitch diameter size based on approved test and balance reports.
d) V-belt drives sized for 150 PCT motor horsepower.
2) Automatic drive belt tensioner.
c. Adjustable motor base.
9. Flanged inlet and outlet.
10. Accessories:
a. Internal inlet damper with external control linkage.
b. Cam type access door.
c. Ceramic felt shaft seal.
d. Extended grease links and fittings.
11. Size and capacity as scheduled on Drawings.
12. Refer to equipment schedule for additional requirements.

B. Toilet Room Exhaust Fans:
   1. AMCA certified.
   2. UL listed.
   3. Materials: Galvanized steel.
   4. Centrifugal wheels.
   5. Permanently lubricated motor.
   6. Acoustically insulated housing.
   7. Resilient rubber-in-shear vibration isolation.
   8. Fan, motor, and wheel assembly removable from housing.
   9. Duct flanged outlet.
   10. Integral backdraft damper.
   11. Minimum 85 PCT free open area face grill.
   12. Accessories:
      a. Wall cap.
      b. Refer to equipment schedule for additional requirements.

## PART 3 - SIZE AND CAPACITY AS SCHEDULED ON DRAWINGSEXECUTION

### 3.1 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

C. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.

D. Provide all required equipment supports. Install and secure fan in accordance with the manufacturer's installation instructions.

### 3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

### 3.3 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

## END OF SECTION

# SECTION 23 74 36
## REFRIGERANT PIPING SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Refrigeration piping system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   2. Section 40 05 07 - Pipe Support Systems.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 15, Safety Code for Mechanical Refrigeration.
   2. ASTM International (ASTM):
      a. B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   3. Federal Specification (FS):
      a. WW-T-799, Tube, Copper, Seamless, Water (For Use With Solder-Flared or Compression-Type Fittings).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Test reports:
      a. A dated declaration of the test of the refrigerant piping for each system shall be provided.
         1) The dated declaration shall include the information outlined in Article 12.3 of ASHRAE 15.
      b. Test reports of the refrigerant piping leak tests for all refrigerant piping systems installed.
      c. The test reports shall contain the following information:
         1) System refrigerant and high and low side pressure used.
         2) Listing of the necessary repairs made before the refrigerant piping system passed the leak test.
         3) Identification of specific system by referencing specific equipment identification numbers.
         4) Leak testing media used.
         5) Suction and discharge refrigerant gas pressures and temperatures taken after the refrigerant system has been charged.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 WARRANTY

A. The completed refrigerant piping system shall be guaranteed to be sufficiently free from leaks so that the loss of refrigerant for 18 months from the date of final payment shall not exceed 5 percent.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Refrigerant piping specialties:
      a. Sporlan.
   2. Expansion valves:
      a. Sporlan.
      b. Alcoa.
   3. Silver solder - "Easy-Flow 45 IN:
      a. Harman.
   4. Moisture indicator - "SEE-ALL":
      a. Sporlan.

### 2.2 REFRIGERANT PIPING AND FITTINGS

A. Refrigerant Piping:
   1. Copper tubing conforming to ASTM B280 and/or FS WW-T-799, dehydrated for refrigerant use, with high-temperature soldered joints and wrought copper (400 PSIG) fittings.
      a. For underground use: Type K.
      b. For aboveground use: Type L.

B. Piping Joints:
   1. Joints between copper tubing and fittings to be high temperature soldered (melting point not less than 1000 DEGF, but less than that of the metal being joined) with phos-copper alloys.
   2. Joints between copper and brass, steel, etc., shall be silver soldered only.
      a. Silver solder to be Handy Harmon "Easy-Flow 45."

C. Precharged Line Sets: Size per manufacturer's recommendations.

D. Field Assembled Units:
   1. Size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
      a. Suction lines: 2 DEGF.
      b. Liquid lines: 1 DEGF or 2 PSI.
      c. Hot gas lines: 1 DEGF or 3.6 PSI.
      d. Size discharge and hot gas risers for positive oil return to compressors.

E. Hangers: As specified in Specification Section 40 05 07.

### 2.3 REFRIGERANT PIPING SPECIALTIES

A. Refrigerant Dryer:
   1. Sporlan material "CATCH-ALL" filter-drier with aluminum molded core:
   2. In each liquid line.
   3. A three-valve bypass around filter-drier.
   4. Install so core can be removed without cutting or breaking any refrigerant line.

B. Moisture Indicator:
   1. Show presence of moisture in system by change of color.
   2. Install full size in the main liquid line adjacent to the filter-drier.
   3. Use Sporlan "SEE-ALL."

C. Strainers:
   1. Design to permit removing screen without removing strainer from piping system.
   2. Screens not larger than 80 mesh.
   3. Strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.

D. Oil Traps: Provide in lines as recommended by the equipment manufacturer.

### 2.4 VALVES

A. All Valves:
   1. All bronze.
   2. 2 IN and less: Solder ends.
   3. 3 IN and over: Four bolt union ends.

B. Shut-Off Valves:
   1. Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.
   2. Wheel, globe, angle or "T" handle.

C. Check Valves:
   1. In liquid lines 5/8 IN and less: Lift check type.
   2. In lines 3/4 to 2 IN: Swing check type.
   3. In lines 3 IN and over: Wafer type swing check with bronze disc.

D. Expansion Valves:
   1. Sized by manufacturer for refrigerant used.
   2. Provide one in each circuit with liquid distributor connection immediately after.

E. Vent and Test Valves: Angle cap type with seal and outlet caps.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Precharged Line Sets: Install and size per manufacturer's recommendations.

B. Contractor is responsible for providing and installing all required pipe supports and seismic bracing in accordance with the building code, SMACNA standards, and all applicable local codes.

C. Field Assembled Lines:
   1. Refrigerant piping:
      a. In accordance with Specification Section 40 05 00.
      b. Purge refrigerant piping of all air while connections of refrigerant piping are being made.
         1) Shut-off valves.
         2) Connect tank of dry nitrogen to line on back side of valve.
         3) Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.
   2. Testing:
      a. Refrigerant piping systems: Follow general testing guidelines of ASHRAE 15, except as modified herein.
      b. Pressurize the high and low pressure sides of the piping system after completion of the refrigerant piping.
         1) Pressurize at the test pressures specified in ASHRAE 15 for the refrigerant type to be used in the system.
      c. Repair any leaks and repeat tests until no further leaks are found and the system passes a static leak test at test pressure for a duration of 24 HRS.

3. Cleaning:
    a. Disconnect suction and discharge lines from compressor for clean up after complete system is tested.
    b. Valve or blank off system into three separate systems for purpose of cleanup.
        1) Suction side including cooling coils.
        2) Discharge side including air cooled condenser.
        3) Hot gas reheat side including heating DX coils.
    c. Thoroughly clean each system using pumped refrigerant until system is proven clean to satisfaction of refrigeration compressor serviceman.
    d. Notify Engineer for a visual inspection of both cleaning process and completely cleaned system.
4. Evacuation and Drying:
    a. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to gas pressure as recommended by the equipment manufacturer.
    b. Evacuate to 100 micron Hg and hold for 72 HRS.
        1) Use laboratory type vacuum pump capable of holding absolute pressure of 50 micron Hg.
        2) Check the vacuum with a suitable mercury column gage.
    c. Admit another drying charge of refrigerant and allow 4 to 6 HRS to absorb moisture and install dryer cores.
    d. Use second evacuation to remove all refrigerant and moisture.
    e. After second evacuation, charge system with refrigerant.
    f. Charge the system with refrigerant as required after final evacuation.

**END OF SECTION**

# SECTION 23 80 00
HVAC - EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 23 05 93 - HVAC Systems - Balancing and Testing.
   5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   6. Section 23 31 00 - HVAC - Ductwork.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Roofing Contractors Association (NRCA).
   8. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Wiring diagrams.
      d. Control diagrams.
      e. Manufacturer's catalog cuts and technical data.
      f. Corrosion-protection information.
      g. Fan curves.

h. Sound data.
i. Vibration isolation.
j. Control description.
k. Performance data on all equipment.

4. Certifications:
   a. Provide certification of thickness of corrosion-protection coating.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vibration isolation assemblies:
      a. Mason.
      b. Vibration Mounting and Controls Co.
      c. Vibro-Acoustics.
   2. Corrosion-protective coatings:
      a. Heresite and Chemical Co.; "Heresite."
      b. Aero-Marine Engineering, Inc.
      c. Luvata ElectroFin.
   3. Cooling coils - direct expansion:
      a. Carrier.
      b. Daikin Applied.
      c. AAON.
   4. Heating coil - electric:
      a. Carrier.
      b. Daikin Applied.
      c. AAON.
   5. Fan coils:
      a. Carrier.
      b. Daikin Applied.
      c. AAON.
      d. Lennox.
      e. Mitsubishi
   6. Unit heater - electric:
      a. Brasch.
      b. Chromalox.
      c. QMark.
      d. Reznor
   7. Make-up air units, electric:
      a. Hastings.
      b. Daikin Applied.
      c. AAON.
      d. Carrier.
   8. Energy recovery units - fixed plate type:
      a. Temp-X-Changer.
      b. Exothermic.
      c. Innovent
      d. Spinnaker
   9. Air-cooled condensing units - split system:

a. Carrier.
b. Daikin Applied.
c. AAON.
d. Lennox.
e. Mitsubishi
f. TempMaster

10. Packaged heat pump units:
    a. Daikin Applied.
    b. AAON.
    c. Carrier.
    d. TempMaster.
11. Dedicated outside air unit:
    a. Oxygen 8
12. Unitary split system heat pump:
    a. Carrier.
    b. Lennox.
    c. Bryant.
    d. Mitsubishi

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 GENERAL

A. All Manufactured Units:
1. Comply with Specification Section 01 61 03.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
    a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
1. Type:
    a. Corrosion-resistant materials:
        1) Aluminum.
        2) Stainless steel.
        3) FRP.
    b. Corrosion-resistant coating:
        1) Phenolic-based coating:
        2) 3 MIL minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DEGF.
        3) 5 MIL baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DEGF.
        4) Factory applied.
        5) Provide factory certification of application.

## 2.3 MANUFACTURED UNITS

A. Equipment Coils:
1. Cooling coils - direct expansion:
    a. ARI certified.
    b. Material:
        1) Aluminum.
        2) Copper with aluminum fins for use in administration units only.
    c. Fin spacing: Minimum 80 fins per foot.
    d. Minimum standard operating limit: 250 PSI.
    e. Size and capacity as scheduled.
2. Heating coil - electric:

a. ARI certified.
b. 80 PCT nickel, 20 PCT chromium elements.
c. Maximum heating density: 35 watts/SQIN.
d. Built-in thermal protection.
e. Airflow switch.
f. Built-in circuit fusing.
g. Control voltage transformer.
h. Terminal block.
i. Magnetic contactor.
j. Fused disconnect switch.
k. Step controller as required by instrumentation.
l. Single point electrical connection.
m. Size and capacity as scheduled on Drawings.

B. Fan Coils:
1. ARI certified.
2. Coils: See paragraph(s) in Article 2.3, Equipment Coils.
3. Blower:
a. Fan wheels: Centrifugal forward-curved, double width.
b. Fan housing: Galvanized steel.
c. Statically and dynamically balanced.
d. Motor:
1) See Specification Section 01 61 03.
2) Integral overload protection.
4. Cabinet:
a. Material: Galvanized steel, 18 GA minimum.
b. Exposed units equipped with hinged access panel, intake and discharge grilles.
c. Concealed units equipped with return plenum, filter section and discharge duct collar.
5. Drain pans:
a. Material: Galvanized steel.
b. Equip with drain connection.
c. Insulated.
6. Filters: See Specification Section 23 31 00.
7. Size and capacity as scheduled on Drawings.
8. Refer to equipment schedule for additional requirements.

C. Unit Heater - Electric:
1. Type: Horizontal.
2. UL listed for non-rated areas.
3. Material:
a. Cabinet: 18 GA steel.
b. Heating elements: Copper-clad steel.
4. Fan motors:
a. See Specification Section 01 61 03.
b. Built-in automatic reset overload protection.
5. Dynamically balanced fan.
6. Built-in automatic reset cutout protection.
7. Accessories:
a. Mounting bracket.
b. 40 to 90 DEGF, 5 DEGF differential internal thermostat.
8. Electrical, fan motor, and airflow data as scheduled on Drawings.
9. Refer to equipment schedule for additional requirements.

D. Unit Heater - Electric:
1. UL listed, corrosion-resistant washable.
2. Material:

a. Fan: Non-sparking aluminum.
b. Heater case: Stainless steel.
c. Heating Monel fintube.
d. Junction box: NEMA 4X.

3. Fan motor:
   a. See Specification Section 01 61 03.
   b. Built-in overload protection.
4. Louvered outlet grille.
5. Rear grille.
6. Built-in over temperature protection.
7. Accessories:
   a. Mounting bracket: Stainless steel.
8. Refer to equipment schedule for additional requirements.

E. Make-Up Air Units, Electric:
1. ARI certified.
2. Sectionalized construction.
3. Materials:
   a. Cabinet: Galvanized steel.
   b. Scroll housing: Galvanized steel.
4. Blower section:
   a. Blower wheels:
      1) Statically and dynamically balanced.
      2) Forwardly curved double width, double inlet.
      3) Mounted on solid turned ground steel shaft.
   b. Bearings:
      1) Self-aligning grease lubricated ball type.
      2) Extended lubrication lines with external grease fittings.
      3) Average life rating: 200,000 HRS.
   c. Blower scrolls, bearings and adjustable base to be mounted on reinforced angle iron frame.
   d. Internal spring isolation.
   e. Driver and driven sheaves:
      1) Keyed hub type.
      2) Drive sheaves: Fixed pitch diameter.
      3) Driver: Variable pitch diameter sheave.
      4) V-belt drives sized for 150 PCT motor horsepower.
   f. Motors: See Specification Section 01 61 03.
   g. Insulated cabinet.
5. Heating section:
   a. Coils: See paragraph(s) in Article 2.3, Equipment Coils.
   b. Insulated cabinet.
6. Drain pan: Double pan construction, insulated.
7. Accessories:
   a. Factory-built heavy-duty filter section with access doors.
   b. Filters: See Specification Section 23 31 00.
   c. Combination Angular filter and mixing box with parallel acting blade dampers.
8. Motor starter.
9. Size and capacity as scheduled on Drawings.
10. Refer to equipment schedule for additional requirements.

F. Energy Recovery Units - Fixed Plate Type:
1. Heat exchanger:
   a. Cross flow air to air flat plate.
   b. Plate shall be 8 mil thickness 3003 series aluminum. End plates, corners, and frames shall be constructed of aluminum.

c. Thermal performance shall be as scheduled.
d. Air leakage shall be no more than 0.1% airflow at 3" w.c. pressure differential.

2. Casing:
   a. Gasketed and bolted access cover.
   b. Integral flanged duct connections.
3. Accessories:
   1) Refer to equipment schedule.
4. Performance and capacity as scheduled on Drawings.
5. The fan wheel shall be non-overloading centrifugal type. Fan wheel shall be finished with a protective coating to inhibit corrosion. Plenum fans shall be of the unhoused direct drive centrifugal type. Supply and exhaust fan motors shall be TEFC. Mounting shall be on a unitary isolation base.
6. Dampers shall be aluminum frame and blade type. Provide outside, exhaust and bypass damper. Bypass damper shall be of modulating actuator. Outside and exhaust air damper shall be 2 position.
7. Refer to equipment schedule for additional requirements.

G. Air-Cooled Condensing Units - Split System:
1. ARI rated.
2. UL listed.
3. Materials:
   a. Casing: Galvanized steel.
   b. Mounting/lifting rails: Steel.
   c. Outdoor coil: Seamless aluminum tubing and aluminum fins.
   d. Fan blades: Aluminum.
4. Weatherproof casing:
   a. Hail screen for condenser coil.
   b. Access panels.
5. Compressor:
   a. Hermetically sealed.
   b. Internal pressure protector.
   c. Crankcase heater.
   d. Internal spring mounts.
   e. Centrifugal oil pump.
   f. Built-in overload protection.
6. Condenser fans and motors:
   a. Vertical discharge.
   b. Direct drive.
   c. Statically and dynamically balanced.
   d. Motor:
      1) See Specification Section 01 61 03.
      2) Permanently lubricated bearings.
      3) Built-in current and thermal overload protection.
7. Built-in refrigerant filter dryer.
8. Built-in liquid line and gas line service valves with gage ports.
9. Outdoor coil:
   a. Fins mechanically bonded to tubing.
   b. Lab tested to 2000 PSI.
10. 24 V factory-wired controls to include fusing and control power transformer.
11. Size and capacity as scheduled on Drawings.
12. Refer to equipment schedule for additional requirements.

H. Packaged Heat Pump Units:
1. ARI certified.
2. UL listed. Dedicated 100% outside air pre-conditioning, DX air source heat pump with electric heat. Single point power connection. Horizontal supply with no return.

3. Unit Construction:
    a. Fabricate unit with 16 GA channel posts and panels secured with mechanical fasteners.
        1) Seal all panels, access doors, and ship sections with permanently applied bulb-type gasket.
        2) Loose shipped gasketing is not allowed.
    b. Construct panels and access doors as a 2 IN nominal thick; thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13.
        1) Construct the outer panel and the inner liner of G90 galvanized steel.
    c. Panel deflection:
        1) Do not exceed L/240 ratio at 125 PCT of design static pressure, maximum positive or negative 8 IN of static pressure.
        2) Measure deflection at the midpoint of the panel height.
    d. Casing leakage rate: Do not exceed 0.5 CFM per square foot of cabinet area at 6 IN of negative static pressure or 5 IN of positive static pressure.
    e. Module to module assembly:
        1) Provide an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
    f. Entire unit: Provide a 4 IN full perimeter base rail for structural rigidity and condensate trapping.
    g. Access doors:
        1) Flush mounted to cabinetry, with minimum of two, 6 IN long stainless steel piano-type hinges, latch and full size (4.5 IN minimum) handle assembly (provide inspection window for fan section).
        2) Swing outward for unit sections under negative pressure (inward for unit sections under positive pressure).
        3) Provide a secondary latch to relieve pressure and prevent injury upon access on doors limited from swinging inward (such as side access filter sections) on positive pressure sections.
    h. Construct drain pans from microbial resistant coated galvanized steel with cross break and double sloping pitch to drain connection.
        1) Provide drain pans under cooling coil section.
        2) Drain connection centerline: A minimum of 3 IN above the base rail to aid in proper condensate trapping.
        3) Drain connections that protrude from the base rail are not acceptable.
        4) There must be a full 2 IN thickness of insulation under drain pan.
4. Fan section:
    a. Fans:
        1) Double-width, double-inlet, multiblade centrifugal type.
        2) Statically and dynamically balanced.
        3) Solid shafts.
        4) Airfoil fans.
        5) Die formed fan housing.
        6) 200,000 HR grease lubricated ball-bearings.
5. Motors: See Specification Section 01 61 03.
6. V-belts and drives sized for 150 PCT motor capacity.
7. Heating coil section:
    a. Electric: See paragraph(s) in Article 2.3, Equipment Coils.
8. Cooling coil section:
    a. Direct expansion: See paragraph(s) in Article 2.3, Equipment Coils.
9. Filter section:
    a. Filters: See Specification Section 23 31 00.
    b. Non-insulated cabinet.
    c. Access doors for filter removal.
10. Insulated drain pan with drain connections.

11. Control panel for electric heat:
    a. Integral.
    b. Controls and safety devices, factory-wired, in accordance with NFPA 70 requirements.
    c. NEMA 12 construction.
12. Type: Draw through.
13. Size and capacity as scheduled on Drawings.
14. Provide factory mounted controls/ controller with standard program for standalone operation.
15. Refer to equipment schedule for additional requirements.

I. Dedicated Outside Air Unit:
    1. UL listed.
    2. Designed for indoor application. Horizontal configuration.
    3. Direct expansion.
    4. ECM direct drive.
    5. Unit construction:
        a. Fabricate unit with 14 GA channel posts and panels secured with mechanical fasteners.
            1) Seal all panels, access doors, and ship sections with permanently applied bulb-type gasket.
            2) Loose shipped gasketing is not allowed.
        b. Construct panels and access doors as a 2 IN nominal thick; thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13.
            1) Construct the outer panel and inner liner of G90 galvanized steel.
        c. Module to module assembly:
            1) Provide an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
        d. Access doors:
            1) Flush mounted to cabinetry, with minimum of two, 6 IN long stainless steel piano-type hinges, latch and full size (4.5 IN minimum) handle assembly (provide inspection window for fan section).
            2) Swing door outward for unit sections under negative pressure (inward for unit sections under positive pressure).
        e. Construct drain pans from microbial resistant coated galvanized steel.
            1) Provide drain pans under cooling coil section.
            2) Drain connection centerline: A minimum of 3 IN above the base rail to aid in proper condensate trapping.
            3) Drain connections that protrude from the base rail are not acceptable.
            4) There must be a full 2 IN thickness of insulation under drain pan.
    6. Cooling coil section:
        a. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.
        b. Evaporator coil circuiting:
            1) Adjustable thermal expansion valve per circuit with external equalizer.
            2) Combination row/split face circuiting.
        c. Drain pan:
            1) Mastic-coated:
            2) Threaded drain connections.
    7. Heating section:
        a. Electric heat:
            1) Coil: See paragraph(s) in the EQUIPMENT COILS Article.
            2) Automatic reset high limit control.
    8. Supply fan section:
        a. Supply fans:
            1) Direct drive type, ECM.
            2) Solid steel shafts.

3) 200,000 HR relubricative ball-bearings.
b. Fan motors:
1) See Specification Section 01 61 03.
2) Relubricative ball-bearings.
3) Adjustable base.
c. Driver and driven sheaves:
1) Keyed hub type.
2) Drive sheaves: Fixed pitch diameter.
3) Driver:
a) Shipped with variable pitch diameter sheave.
b) Fixed pitch diameter size based on approved test and balance reports.
4) V-belt drives sized for 150 PCT motor horsepower.
d. Isolated fan assembly.
9. Filter section:
a. Filters: See Specification Section 23 31 00.
b. Access doors for filter removal.
c. MERV 13 OA and MERV 8 RETURN.
10. Electrical:
a. Factory wired in accordance with NFPA 70 requirements.
b. System service switch.
c. Control circuit fuse.
d. Individually fused supply fan motor, compressor and condenser fan motor branch circuits.
e. Weatherproof control panel with dead-front cover over main power controls.
f. Disconnect switch.
11. Sensors, transmitters, relays, switches, detectors, operators, actuators, valves, etc. as required to perform sequence of operation shall be provided by the manufacturer to accomplish a standalone operation.
12. Unit shall be tested and shipped with the standard default factory sequence of operation setpoints and controllers for a complete standalone operation.
13. OA and EA dampers with actuators are factory wired and installed.
14. Provide 24-hour time clock, room temperature sensor, duct temperature sensor.
15. Size and capacity as scheduled on Drawings.
16. Refer to equipment schedule for additional requirements.

J. Unitary Split System Heat Pump:
1. Outdoor Unit:
a. Casing and frame:
1) Material: Heavy gage galvanized steel, factory painted.
2) Insulation: 1 IN thick neoprene-coated glass fiber.
3) Installation: Base equipped with lifting brackets with lifting holes.
4) Removable end panel for access to components and connections.
b. Compressors:
1) Modulating Scroll type, with five-year non-prorated warranty.
2) Suction and discharge service valves.
3) Crankcase heater.
4) Thermal overload protection.
c. Refrigeration circuit:
1) Sight glass.
2) Filter dryer.
3) Manual shut-off valve.
4) High pressure relief valve.
d. Compressor isolators.
e. Condenser coils:

1) Nominal 3/8 IN OD seamless copper mechanically bonded to corrugated aluminum fins.
2) Factory leak tested at 315 PSIG under water.

f. Condenser fans:
1) Direct drive: See Specification Section 01 61 03.
2) Propeller type.

g. Condenser fan motors:
1) Heavy duty, inherently protected, non-reversing.
2) Permanently lubricated bearings.
3) Integral rain shield.

h. Defrost control: Defrost cycles at a preselected time interval when the outdoor coil is below a preset initiation temperature.

i. Expansion valve: Designed and sized specifically for heat pump service.

j. Reversing valve: Four-way interchange reversing valve, operates on pressure differential between the outdoor unit and indoor unit.

2. Indoor unit:
a. Materials:
1) Casing: Heavy gage steel.
2) Framework: Steel angle.
3) Pan insulation: Foam-in-place insulation.
4) Casing insulation: 1 IN, 3/4 LB fiberglass blanket.

b. Casing:
1) Sectionalized construction.
2) Removable access panels.
3) Insulated weatherproof casing.

c. Evaporated fans:
1) Double-width, double-inlet centrifugal type.
2) Forward curved or airfoil.
3) Solid steel shafts.
4) 200,000 HR relubricative ball-bearings.

d. Fan motors:
1) See Specification Section 01 61 03.
2) Relubricative ball-bearings.
3) Variable pitch sheave.
4) Adjustable base.

e. V-belts and drives sized for 150 PCT motor capacity.

f. Isolated fan assembly.

g. Filter section:
1) Filters: See Specification Section 23 31 00.
2) Access doors for filter removal.

h. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.

i. Evaporator coil circuiting:
1) Adjustable thermal expansion valve per circuit with external equalizer.
2) Combination row/split face circuiting.

j. Drain pan:
1) Mastic-coated.
2) Threaded drain connections.

k. Electric heating coil: See paragraph(s) in Article 2.3, Equipment Coils.
1) Built-in static-pressure airflow switch.

l. Size and capacity as scheduled on Drawings.

3. Non-Ducted Recessed Ceiling Cassette Indoor Units:
a. Indoor unit shall be a ceiling cassette fan coil unit, operable with R-454B refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill.

b. It shall be a four-way air distribution type, white, impact resistant with a washable decoration panel.
c. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0 to 90 DEG.
d. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition.
e. The indoor units sound pressure shall range from 28 dB(A) to 34 dB(A) at low speed measured at 5 FT below the unit.
f. The indoor unit shall be completely factory assembled and tested.
    1) Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
g. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
h. Both refrigerant lines shall be insulated from the outdoor unit.
i. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
j. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
k. The indoor units shall be equipped with a condensate pan and condensate pump.
    1) The condensate pump provides up to 21 IN of lift and has a built in safety shutoff and alarm.
l. The indoor units shall be equipped with a return air thermistor.
j. Unit Cabinet:
    1) The cabinet shall be space saving and shall be located into the ceiling.
    2) Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
    3) The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
    4) Fresh air intake shall be possible by way of optional fresh air intake kit (3 x 3 FT model only).
    5) Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet (2 x 2 FT model only).
    6) A branch duct knockout shall exist for branch ducting supply air.
    7) The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
    8) Optional high efficiency MERV 8 and 13 air filters are available for each model unit (3 x 3 FT model only).
k. The fan shall be direct-drive fan type with statically and dynamically balanced impeller with high and low fan speeds available.
l. The fan motor shall operate on 208/230 V, 1 PH, 60 Hz with a motor output range from 0.06 to 0.12 HP. The airflow rate shall be available in high and low settings.
m. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with the MERV 8 and 13 filter options (3 x 3 FT model only).
n. The fan motor shall be thermally protected.
o. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
p. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
q. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.

r. The coil shall be a 2-row cross fin copper evaporator coil completely factory tested. The refrigerant connections shall be flare connections.
s. A condensate pan shall be located under the coil.
t. A condensate pump up to 21 IN lift shall be located below the coil in the condensate pan with a built in safety alarm.
u. A thermistor will be located on the liquid and gas line.
v. Electrical:
    1) A separate power supply will be required of 208/230 V, 1 PH, 60 Hz.
w. Control:
    1) The unit shall have on board controls to perform input functions necessary to operate the system.
x. Optional accessories available:
    1) A high efficiency disposable MERV 8 air filter kit (3 x 3 FT).
    3) Fresh air intake kit.
    4) The wall mounted, hard wired remote sensor kit is recommended for ceiling-embedded type fan coils, which often result in a difference between set temperature and actual temperature.
    5) The sensor for detecting the temperature can be placed away from the indoor unit (branch wiring is included in the kit).

4. Non-Ducted Wall mounted indoor Fan Coil Units:
    a. Indoor unit shall be a fan coil unit, operable with refrigerant R-454B, equipped with an electronic expansion valve, for installation onto a wall or ceiling within a conditioned space.
    b. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition.
    c. Condensate drain pan:
        1) A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.
    d. Sound Pressure:
        1) The indoor units sound pressure shall range from 31 dB(A) to 40 dB(A) at low speed measured at 3.3 FT below and from the unit.
    e. The indoor unit shall be completely factory assembled and tested.
        1) Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
        2) The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops.
    f. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
    g. Both refrigerant lines shall be insulated from the outdoor unit.
    h. Return air shall be through a resin net mold resistant filter.
    i. The indoor units shall be equipped with a condensate pan.
    j. The indoor units shall be equipped with a return air thermistor.
    k. Unit Cabinet:
        1) The cabinet shall be affixed to a factory supplied wall/ceiling hanging brackets and located in the conditioned space.
        2) The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
    l. Fan:
        1) The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
        2) The fan motor shall operate on 208/230 V, 1 PH, 60 Hz.
        3) The airflow rate shall be available in high and low settings.

4) The fan motor shall be thermally protected.

m. Coil:
   1) Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   2) The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   3) The coil shall be a 2-row (3-row floor console only) cross fin copper evaporator coil completely factory tested.
   4) The refrigerant connections shall be flare connections.
   5) A thermistor will be located on the liquid and gas line.
   6) A condensate pan shall be located in the unit.

n. Electrical:
   1) A separate power supply will be required of 208/230 V, 1 PH, 60 Hz.

o. Control:
   1) The unit shall have on board controls perform input functions necessary to operate the system.

p. Optional Accessories Available:
   1) Remote "in-room" sensor kit.
   2) A condensate pump.

5. Ducted Concealed Ceiling Fan Coil Units:
   a. The indoor unit shall be completely factory assembled and tested.
   b. The cabinet shall be located within the ceiling and ducted to the supply and return openings.
   c. The fan shall be direct-drive type fan, statically and dynamically balanced impeller with high and low fan speeds available.
   d. The fan motor shall be thermally protected.
   e. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
   f. Coils shall be ARI certified of the direct expansion type.
   g. The coils shall be pressure tested at the factory.
   h. A condensate pan shall be located under the coil.
   i. The condensate shall be capable of being gravity drained from the fan coil.

6. Refer to equipment schedule for additional requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install and support equipment in compliance with manufacturer's installation instructions.

C. Contractor is responsible to design and provide equipment supports in compliance with building and all local codes.

D. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

E. Provide all required control devices and controllers necessary to support a fully standalone operating system.

### 3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

### 3.3 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

## END OF SECTION

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# DIVISION 26

## ELECTRICAL

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# SECTION 26 05 00
## ELECTRICAL - BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 01 61 03 - Equipment - Basic Requirements.
   5. Section 03 15 19 - Anchorage to Concrete.
   6. Section 10 14 00 - Identification Devices.
   7. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   8. Section 26 05 33 - Raceways and Boxes.
   9. Section 26 05 48 - Electrical Seismic Bracing Systems.

### 1.2 DRAWINGS

A. The electrical drawings are diagrammatic and are not intended to show all raceway, wiring, exact locations of equipment, terminations, or number or types of fittings required by the electrical system. Provide all related electrical work which is specified herein, diagrammed or scheduled on the electrical drawings, required by code enforcing agencies and as indicated on other details or elevations for complete and operating electrical systems. Since the drawings of floor, wall, and ceiling installation are made at a small scale, outlets, devices, equipment, etc. are indicated only in their approximate location unless dimensioned or otherwise indicated. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate such locations with the work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings.

B. Branch Circuit Wiring:
   1. Duplex receptacles and miscellaneous power wiring are shown diagrammatically. In general, the panel and circuit numbers are shown adjacent to the device or equipment connection.
   2. Provide all conduit, wire, and junction boxes in accordance with all applicable code and standards.

### 1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM, Aluminum Design Manual.
   2. American Institute of Steel Construction (AISC):
      a. Steel Construction Manual.
   3. American National Standards Institute (ANSI).
   4. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC) – 2023.
7. National Electrical Manufacturers Association (NEMA):
8. Underwriters Laboratories, Inc. (UL).

B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
   1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
   2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

## 1.4 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
   3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
   4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
   5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
   6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

B. Definitions:

| | |
|---|---|
| Provide | Furnish and install |
| As Directed | As directed by the Owner's Representative |
| As Shown | As shown on the drawings |
| Concealed | Built into the construction and not exposed to view |
| Hot-Dip Galvanized | Galvanized after fabrication by hot-dip process |
| Per | According to; in accordance with |
| Engineer | Engineer responsible for electrical contract documents |

C. Abbreviations:

| | |
|---|---|
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| ETL | Electrical Testing Laboratories |
| FM | Factory Mutual |
| IBC | International Building Code (2009 edition) |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMC | International Mechanical Code |
| IPC | International Plumbing Code |
| NEC | National Electrical Code |
| NECA | National Electrical Contractors Association |
| NEMA | National Electrical Manufacturers Association |
| NETA | National Electrical Testing Association |
| NFPA | National Fire Protection Association |
| UL | Underwriters Laboratories, Inc. |
| VCP | Vendor Control Panel |

## 1.5 CODES AND STANDARDS

A. Comply with the National Electrical Code, NFPA regulations, and all other applicable national, state, and local codes and ordinances.

B. Workmanship shall comply with NECA "Standard of Installation."

## 1.6 SAFETY AND PROTECTION

A. Safety Measures To Be Taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site. It shall be the Contractor's responsibility to comply with "Safety and Health Regulations for Construction," Volume 36, No. 75, Part II of the Federal Register by the U.S. Department of Labor. Contractor shall be responsible for providing all such safety measures and shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether he is or is not in compliance with state or federal regulations.

B. Coordinate installation of the service transformer and metering with the serving utility.
   1. The serving utility for this Project is Ashland Electric.
      a. Contact: Rick Barton.
   2. Provide the transformer pad, cabinet pads, primary and secondary conduit, space in the switchboard for mounting of metering CT's, a 1 IN conduit from the CT compartment to the meter socket, vaults and manholes..
      a. Size and construct transformer pad in conformance with the utility's requirements.
   3. The utility will furnish the transformer, sectionalizing cabinets and wire, metering CT's to be mounted in the switchboard, meter and meter socket, and make all connections at the transformer, CT's and meter socket..
      a. Coordinate the switchboard supplier and the utility for the CT compartment.
      b. Coordinate all installation of the transformer, sectionalizing cabinets and vaults.
   4. Contractor will need to install primary conduits into existing power vault, located in the main road. Power will come from the existing sectionalizing cabinet, as shown on the drawings.

## 1.7 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of submittal process.
   2. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
   3. General requirements:
      a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      b. Include data sheets that include manufacturer's name and product model number.
         1) Clearly identify all optional accessories.
      c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
      d. Manufacturer's delivery, storage, handling and installation instructions.
      e. Product installation details.
      f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.

g. See individual specification sections for any additional requirements.

4. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
5. Fabrication and/or layout drawings:
   a. Concrete and reinforcing steel, per Division 03 requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

## 1.8 SYSTEM DESCRIPTION

A. Provide functioning systems in compliance with National Electrical Code (NEC), manufacturer's instruction, performance requirements specified or shown in the contract Documents, and modifications resulting from reviewed shop drawings and field coordinated drawings.

B. Provide power and control wiring to HVAC equipment (such as supply fans, exhaust fans, unit heaters, chillers, boiler, air handling units, Field Equipment Controllers, etc.) as shown in the electrical drawings. The Mechanical drawings and specifications define the requirements for the contractor-designed HVAC control system. The power and control conduit and cabling required by the contractor-designed HVAC control system may not be shown on the electrical plans but shall meet the installation requirements defined in Division 26. Provide coordination. Provide local equipment disconnects. Provide local control stations as shown on control diagrams and as required by the contractor-designed HVAC control system.

C. Provide complete power distribution systems including raceways, wiring, and power supply to all equipment shown.
   1. Includes design of required raceways and wiring where only the electrical device is in the Contract Documents.

D. Provide complete interior lighting system including all lighting equipment, raceways, wiring, and switching equipment:
   1. Includes design of required raceways and wiring.
   2. Only the fixtures, circuits, and switching schemes are shown in the Contract Documents.
   3. Fixture locations are approximate and shall be field adjusted as practical to avoid interferences with piping, cable tray, HVAC equipment, ductwork, etc.

E. Provide complete exterior lighting system including all lights, building exterior lighting equipment, and switching equipment:
   1. Includes design of required raceways and wiring.
   2. Only the fixtures, circuits, and switching schemes are shown in the Contract Documents.
   3. For each exterior light, provide a switch located inside near the associated door (or the nearest exterior door) that enables two operation modes: off or auto control by photocell. Provide photocell. Provide appropriate labels for switch.
   4. For each exterior, surface-mounted light near a canopy, install the fixture under the canopy, sheltered from weather and drips. Similarly located receptacles shall be similarly located and protected.

F. Site duct banks penetrate structure walls in various locations on the Contract Drawings. Coordinate these penetrations with other construction disciplines and submit a sketch for review of each duct bank penetration. Submit for review prior to construction.

G. The proposed utility transformers, proposed standby generator, proposed switchboards shall all have the same power system bus phase rotation. The Contractor shall provide a written phase rotation testing plan for review, prior to pulling in and terminating any major multiple conductors per phase feeder. Major feeders on this project consist of multiple large conductors per phase. Phase rotation confirmation shall be field verified prior to termination of major feeder conductors.

H. Provide Fiber Optic cable, conduit, handholes, etc. between Granite Street and the Water Treatment Plant Operations Building for complete, fully-functional system. Part of the Fiber Optic conduits and Handholes have been installed during the creek crossing project. Coordinate with installed equipment and conduits and provide full fiber optic cable run.

I. A new electrical service (City of Ashland, OR) shall be established. The City of Ashland is the electrical utility and is responsible for providing the conductors from the service pole to the utility transformer, and the cabling from the utility transformer to the utility metering Current Transformer (CT) enclosure. Provide trenching per utility requirements, conduit per utility requirements, CT enclosure per utility requirements, meter base per utility requirements, coordination with Northwestern Energy, concrete pad for utility transformer per utility requirements, conduits (including elbows) per utility requirements between the transformer and utility metering Current Transformer (CT) enclosure located outside. Anything associated with the installation of the new service not explicitly stated here is to be provided by contractor. During the recent creek crossing project, some of the conduits, vaults and sectionalizing cabinets were installed. Coordinate in the field for installed equipment and conduits. This project will continue the main power conduits and equipment up to the new transformer.

J. Where electrical equipment (such as control panels, control stations, etc.) is installed underneath piping, provide appropriately-sized drip shields.

K. Provide a local disconnect switch for each field-mounted instrument transmitter with a 120Vac power source.

### 1.9 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 50.

B. Protect nameplates on electrical equipment to prevent defacing.

### 1.10 AREA ENVIRONMENTAL DESIGNATION AND CLASSFICATION SCHEDULE AND MATERIAL APPLICATION SCHEDULE

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types and materials of conduits, mounting hardware materials, electrical equipment support system material, wiring devices and installation methods to be used in that area. See Material Application Schedule below for acceptable materials for areas with the given designations. The Area Environmental Designation and Classification Schedule on the Drawings gives the designation and classification for each area or room of the project. Use the Area Environmental Designation and Classification Schedule to determine the Designation and Classification; cross-reference the Designation with the Material Application Schedule below to determine appropriate materials. For areas not defined on the Area Environmental Designation and Classification Schedule, provide materials in accordance with the "Wet, Corrosive Areas" designation of the Material Application Schedule.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Provide all components of a similar type by one (1) manufacturer.

### 2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) B-Line by Eaton.
         3) Globe Strut.
         4) Superstrut by Thomas & Betts.
         5) Or approved equal.
   2. Material requirements:
      a. Modular strut:
         1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
         2) Stainless steel: AISI Type 316.
         3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.
      b. Structural members (e.g., I beams, L and C channels):
         1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
         2) Aluminum: AA Type 6061-T6 or 6063-T6.
      c. Mounting plates:
         1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
         2) Aluminum: A Type 6063-T6.
      d. Mounting hardware:
         1) Galvanized steel.
         2) Stainless steel.
      e. Anchorage per Specification Section 03 15 19.
      f. Concrete and reinforcing steel: See Division 03 specifications.

B. Equipment pads (interior and exterior):
   1. Concrete and reinforcing steel: See Division 03 specifications.

C. Field touch-up of galvanized surfaces.
   1. Zinc-rich primer.
      a. One coat, 3.0 MILS, ZRC by ZRC Products, or equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
   1. NFPA 70.
   2. IEEE C2.
   3. The manufacturer's instructions.
   4. Specification Section 26 05 48 for seismic bracing of suspended components and equipment anchorage.

C. In general, conduit routing is not shown on the Drawings.
   1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.

2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
   1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
   2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
   3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
   4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 46 IN.
      b. Receptacle in architecturally finished areas (to center): 18 IN.
      c. Receptacle on exterior wall of building (to center): 18 IN.
      d. Receptacle in non-architecturally finished areas (to center): 46 IN.
      e. Telephone outlet in architecturally finished areas (to center): 18 IN.
      f. Telephone outlet for wall-mounted phone (to center): 46 IN.
      g. Safety switch (to center of operating handle): 54 IN.
      h. Separately mounted motor starter (to center of operating handle): 54 IN.
      i. Pushbutton or selector switch control station (to center): 46 IN.
      j. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 12 inches in equipment locations.
      a. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   2. Wet areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   3. Corrosive areas:

a. Stainless steel system consisting of stainless steel channels and fittings, nuts and hardware.

4. Highly corrosive areas:
   a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 03 15 19.
   2. Do not cut, or weld to, building structural members.
   3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide non-metallic corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components in accordance with Specification Section 10 14 00.

R. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.

S. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
   1. Determine the SCCR rating by one of the following methods:
      a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
      b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
      c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
   2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
   3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

## 3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
   1. See Specification Section 01 73 20 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:
   1. See Specification Section 01 74 00.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.

2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
4. Repair surfaces which will be inaccessible after installation prior to installation.
5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

## 3.3 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01 75 00.

## 3.4 MATERIAL APPLICATION SCHEDULE

A. Material Application Schedule:

| Designation | NEMA 250 Enclosure Type (including Pull and Junction Boxes) | Conduit Material | Outlet and Device Boxes, Mounting Plates, and Fittings | Mounting Hardware and Support System | Notes |
|---|---|---|---|---|---|
| Indoor Hazardous Areas | 7, suitable for classification | RGS | Cast Metal | 316 stainless steel | |
| Wet, Corrosive Areas | 4X, metallic | PVC-coated RGS | PVC-coated cast metal, 316 stainless steel | 316 stainless steel | |
| Wet, Corrosive to Metals | 4X, nonmetallic | PVC-80 | Nonmetallic | Nonmetallic | |
| Hazardous and Corrosive Areas | 7 or 4X, suitable for classification | PVC-coated RGS | PVC-coated cast metal, 316 stainless steel | 316 stainless steel | |
| Wet, Indoors | 4X | RGS | Cast Metal | 316 stainless steel | |
| Dry Industrial | 12 | RGS | Cast Metal | Galvanized | |
| Dry, Indoors, Unfinished | 12 | RGS | Cast Metal | Galvanized | Route conduit concealed where noted |
| Dry, Indoors, Finished | 1 | EMT | Sheet Metal | Galvanized | Route conduit concealed |
| Nonhazardous Exterior Areas | 3R | RGS | Cast Metal | 316 stainless steel | |
| Wet, Damp Exterior Area | 4X | RGS | Cast Metal | 316 stainless steel | |
| Hazardous Exterior Areas | 7 or 4, suitable for classification | RGS | Cast Metal or 316 stainless steel | 316 stainless steel | |

| Designation | NEMA 250 Enclosure Type (including Pull and Junction Boxes) | Conduit Material | Outlet and Device Boxes, Mounting Plates, and Fittings | Mounting Hardware and Support System | Notes |
|---|---|---|---|---|---|
| Underground, Underslab, or Concrete Encased | N/A | PVC, except for specific circuits | N/A | N/A | Use PVC-RGS for signal/instrumentation wiring. |

**END OF SECTION**

# SECTION 26 05 09
MOTORS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Induction motors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 26 05 26 - Grounding.
   5. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 43, Recommended Practice for Testing Resistance of Rotating Machinery.
      b. 841, Standard for Petroleum and Chemical Industry - Premium-Efficiency, Severe-Duty, Totally-Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up To and Including 370 kW (500 HP).
   3. National Electrical Manufacturers Association (NEMA):
      a. MG 1, Motors and Generators.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) – 2017.
   5. Underwriters Laboratories (UL):
      a. 674, Electric Motors and Generators for Use in Hazardous (Classified) Locations.
      b. 1836, Outline of Investigation for Electric Motors and Generators for Use in Class I, Division 2, Class I, Zone 2, Class II, Division 2 and Zone 22 Hazardous (Classified) Locations.

B. Miscellaneous:
   1. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for assembling the motor and driven equipment as a complete unit, correctly aligned and coupled with the coupling or sheave specified on the driven equipment data sheet, and designing for vibration, special, or unbalanced forces resulting from equipment operation.
      a. See Specification Section 01 61 03 for requirements.
   2. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and ensure their compatibility. Where single source responsibility is not available, provide written approval for compatibility signed by both manufacturers.

### 1.3 DEFINITIONS

A. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

B. Abbreviations:
   1. DPFG - Drip proof Fully Guarded.
   2. ODP - Open Drip proof.
   3. RTD - Resistance Temperature Detector.

4. TEFC - Totally Enclosed Fan Cooled.
5. TENV - Totally Enclosed Non-ventilated.
6. WP-I - Weather Protected Type I.
7. WP-II - Weather Protected Type II.
8. Motor controllers:
    a. FVNR - Full Voltage Non-Reversing.
    b. RVSS - Reduced Voltage Solid State.
    c. VFD - Variable Frequency Drive.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Identify each motor by driven machine identification.
    b. Motor manufacturer and model number.
    c. Complete motor nameplate data.
    d. Weight.
    e. NEMA design type.
    f. Enclosure type.
    g. Frame size.
    h. Winding insulation class and temperature rise.
    i. Starts per hour.
    j. Performance data:
        1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 200 HP.
        2) Time-current plots with acceleration verses current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 200 HP.
        3) Guaranteed minimum efficiencies at 100 PCT, 75 PCT and 50 PCT of full load.
        4) Guaranteed minimum power factor at 100 PCT, 75 PCT and 50 PCT of full load.
        5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
        6) Starting, full load and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
    k. Bearing data and lubrication system.
    l. Motor space heater data.
    m. Thermal protection system including recommended alarm and trip settings for winding and bearing RTDs.
    n. Recommended size of power factor correction capacitors to improve power factor to 0.95 lagging when operated at full load.
3. Fabrication and/or layout drawings:
    a. Dimensioned outline Drawing.
    b. Connection diagrams including accessories (strip heaters, thermal protection, etc.).
4. Certifications:
    a. When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
5. Test reports:
    a. Motor test reports for all testing required in this Specification Section.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

2. Installation instructions.
3. Operation and maintenance instructions.
4. Recommended spare parts list.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 50.

B. Protect equipment during shipment, handling, and storage by suitable boxes, crates, or other complete enclosures.
   1. Protect equipment from exposure to elements and keep thoroughly dry.

C. Protect painted surfaces against impact, abrasion, discoloration, and other damage.
   1. Repaint damaged painted surfaces to satisfaction of Engineer.

D. Store all motors in a clean and dry indoor location until final installation.

E. Where space heaters are provided in motors, provide temporary electrical power and operate heaters during storage and after motors are installed in permanent location until equipment is placed in service.

F. For storage longer than one month, see manufacturer's storage instructions.

### 1.6 SITE CONDITIONS

A. Ambient air temperature: -10 to 115 DEGF.

B. Altitude: 2,400 FT above sea level.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. ABB.
   2. General Electric.
   3. Hyundai Heavy Industries.
   4. Marathon.
   5. Reliance by Rockwell Automation, Inc.
   6. Siemens.
   7. TECO-Westinghouse Motor Company.
   8. Toshiba U.S.
   9. Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC).
   10. U.S. Motors by Nidec Motor Corporation.
   11. WEG.
   12. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 EQUIPMENT

A. General Requirements:
   1. Standards: NEMA MG 1.
   2. Identify each motor by the driven machine identification.
   3. An embossed or engraved stainless steel nameplate, with the required NFPA 70 and NEMA data, to be permanently attached to the motor.
   4. Maximum motor loading shall not exceed motor nameplate horsepower rating, exclusive of service factor.
   5. All motors shall be sized to carry continuously all loads, which may be imposed through their full range of operation.

6. NEMA MG 1, Design B (unless otherwise required), constant speed squirrel-cage induction type having normal starting torque with low starting current.
7. Suitable for the starting method indicated (e.g., full voltage, autotransformer, solid state reduced voltage, VFD, etc.).
8. Where frequent starting occurs, design for frequent starting duty equivalent to duty service required by driven equipment.
9. Lifting devices: Motors weighing 265 LBS or more shall have suitable lifting eyes for installation and removal.
10. Grounding:
    a. Lug suitable to terminate ground wire in terminal box, sized as indicated on the Drawings.
11. Stator windings: Copper.
12. Rotor cage: Aluminum or copper.
13. Motor leads shall be non-wicking with permanent identifiers.
14. Totally enclosed motor to have one-way breather drains.
15. Efficiency:
    a. Meet NEMA MG 1 (NEMA Premium) efficiencies.
    b. If motor type, horsepower or speed is not included in the NEMA requirements for NEMA Premium, provide manufacturers "premium energy efficient" design.
16. Power factor:
    a. Minimum of 80 PCT lagging at full load, except on motors with speed slower than 900 RPM.
    b. Power factor correction capacitors to be utilized when indicated on the Drawings.
17. Service factor:
    a. 100 HP or less: 1.15.
    b. Greater than 100 HP: 1.0 unless noted otherwise.
    c. Inverter duty: 1.0.
18. Standards: NEMA MG 1, UL 674, UL 1836.

## 2.3 FRACTIONAL HORSEPOWER INDUCTION MOTORS

A. Electrical Ratings:
   1. Appropriate for the voltage system indicated, single phase, 60 Hz.
   2. Dual voltage rated motors (e.g., 115/230 V) are acceptable, provided all leads are brought out to the terminal box and permanently marked.

B. Enclosure: TENV or TEFC, rolled steel enclosure permitted.

C. Bearings: Lubricated-for-Life ball bearings.

D. Insulation: Class F insulation with temperature rise not to exceed the insulation class.

E. Thermal Protection: Integral manual or automatic reset thermal protector.

## 2.4 INDUCTION MOTORS, 600 VOLT AND LESS

A. Horizontal Shaft:
   1. Electrical rating:
      a. Appropriate for the voltage system indicated, 3 PH, 60 Hz.
      b. Dual voltage rated motors (e.g., 230/460 V) are acceptable, provided all leads are brought out to the terminal box and permanently marked.
   2. Enclosure:
      a. Cast iron (exception: fan covers can be steel).
      b. Type: DPFG, TEFC, WP-I or WP-II as indicated in the schedule.
   3. Terminal box:
      a. Gasketed.
      b. Diagonally split.
      c. Field adjustable in 90 DEG increments.
      d. Oversized to accept the required conductors and conduits.

e. Located on "F1" side unless specifically indicated to be on the "F2" side.
f. Separate terminal box with terminal blocks for winding thermal protection devices (RTD and thermocouples).

4. Bearings:
   a. 5 HP and less: Lubricated-for-Life ball bearings.
   b. Greater than 5 HP:
      1) Relubricatable.
      2) Antifriction.
      3) Minimum rated ABMA L-10 life of 10 years or 100,000 HRS.
5. Insulation:
   a. Class F insulation with Class B temperature rise.
   b. Dipped and baked with non-hydroscopic varnish or epoxy.
6. Accessories: See the ACCESSORIES Article in PART 2 and the SCHEDULES Article in PART 3.
7. Modifications:
   a. Inverter duty:
      1) At a minimum, applied to motors connected to a VFD.
      2) Windings insulated for 1600 peak volts and voltage rise times of 0.1 microseconds.
      3) Nameplate identification of meeting NEMA MG 1 Part 31 requirements.
      4) Have the following minimum turndown ratio without the use of a blower to provide continuous supply of cooling air over the motor.
         a) Variable torque: 10:1.
         b) Constant torque: 6:1.
      5) Insulated bearing on all motors located on the non-drive end.
      6) Motors 100 HP and larger, insulated non-drive and bearings.
      7) Shaft grounding ring on all motors:
         a) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
         b) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
         c) Install on drive end.
   b. Severe duty:
      1) Standard: IEEE 841.
      2) All cast iron enclosure.
      3) Terminal box threaded and gasketed.
      4) Internal and external epoxy base paint system.
      5) Drain and breather.

B. Vertical Solid or Hollow Shaft:
1. Electrical rating:
   a. Appropriate for the voltage system indicated, 3 PH, 60 Hz.
   b. Dual voltage rated motors (e.g., 230/460 V) are acceptable, provided all leads are brought out to the terminal box and permanently marked.
2. Enclosure:
   a. Cast iron.
   b. Type: DPFG, TEFC, WP-I or WP-II as indicated in the schedule.
3. Terminal box:
   a. Gasketed.
   b. Diagonally split.
   c. Oversized to accept the required conductors and conduits.
   d. Separate terminal box with terminal blocks for winding thermal protection devices.
4. Bearings (Solid Shaft):
   a. Relubricatable.
   b. Antifriction.
   c. Minimum rated AMBA L-10 life of 10 years or 100,000 HRS.

5. Bearings (Hollow Shaft):
    a. Relubricatable.
    b. Antifriction.
    c. Oil or grease lubricated thrust bearings.
    d. Grease lubricated guide bearings.
    e. Minimum rated ABMA L-10 life of 10 years or 100,000 HRS.
6. Non-reverse ratchets.
7. Insulation:
    a. Class F insulation with Class B temperature rise.
    b. Dipped and baked with non-hydroscopic varnish or epoxy.
8. Accessories: See the ACCESSORIES Article in PART 2 and the SCHEDULES Article in PART 3.
9. Modifications:
    a. Inverter duty:
        1) At a minimum, applied to motors connected to a VFD.
        2) Windings insulated for 1600 peak volts and voltage rise times of 0.1 microseconds.
        3) Nameplate identification of meeting NEMA MG 1 Part 31 requirements.
        4) Have the following minimum turndown ratio without the use of a blower to provide continuous supply of cooling air over the motor.
            a) Variable torque: 10:1.
            b) Constant torque: 6:1.
        5) Insulated bearing on all motors located on the non-drive end.
        6) Motors 100 HP and larger the non-drive end shall have an insulated bearing carrier.
        7) Shaft grounding ring on all motors:
            a) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
            b) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
            c) Install on drive end.
    b. Severe duty:
        1) Standard: IEEE 841.
        2) All cast iron enclosure.
        3) Terminal box threaded and gasketed.
        4) Internal and external epoxy base paint system.
        5) Drain and breather.

## 2.5 ACCESSORIES

A. Thermal Protection:
    1. Thermostats:
        a. One winding thermostat per phase for shutdown.
        b. Snap action, bi-metallic, temperature-actuated switch type.
        c. Normally closed, wired in series.
        d. Automatic reset.
        e. Switch point shall be pre-calibrated by the manufacturer.
    2. RTDs:
        a. One winding RTDs per phase imbedded in windings.
        b. 100 OHM platinum.

B. Space Heaters:
    1. Silicone rubber strip type, 120 V rated.
    2. Provided on:
        a. All motors 10 HP and larger mounted outdoors.
        b. Indoor motors in humid environments as indicated on the Drawings

### 2.6 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA, IEEE and manufacturer procedures.
   1. The test shall include but not necessarily be limited to the following:
      a. Routine test:
         1) No-load current and speed at rated voltage and frequency.
         2) Locked rotor current.
         3) Winding resistance.
         4) Vibration check.
         5) High potential.
      b. Complete test (in addition to the routine tests):
         1) Rated load temperature rise.
         2) Winding resistance.
         3) Slip test, measured in percent slip.
         4) Locked rotor amperes (3 PH, full voltage).
         5) Locked rotor torque.
         6) Breakdown torque.
         7) Efficiencies tabulated at 100, 75, and 50 PCT of full load.
         8) Power factor tabulated at 100, 75, and 50 PCT of full load.

B. Motors to be tested:
   1. As indicated in the schedule.
   2. All motors, at a minimum, to receive a routine test.

C. The Owner reserves the right to select and have tested any motor included within the project.
   1. If motor passes testing requirements, the Owner shall be responsible for any shipping and testing costs incurred.
   2. Costs shall be determined by current freight rates and manufacturer's published rates at the time of the test.
   3. If motor fails test, Supplier shall be responsible for all costs incurred.
   4. If two successive motors fail the test, the Owner has the right to reject any or all motors from that manufacturer.
   5. The Owner also reserves the right to witness any routine or complete tests at the Owner's expense.
   6. Notify the Owner a minimum of 14 days in advance of the testing.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Ground all motors in accordance with Specification Section 26 05 26.

### 3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 01 61 03.

**END OF SECTION**

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# SECTION 26 05 19
## WIRE AND CABLE - 600 VOLT AND BELOW

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Shielded VFD cable.
      e. Instrumentation cable.
      f. Fiber optic cable.
      g. Wire connectors.
      h. Insulating tape.
      i. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568-C.1, Commercial Building Telecommunications Cabling Standard.
      b. 568-C.3, Optical Fiber Cabling Components Standard.
      c. 569-C, Telecommunications Pathways and Spaces.
      d. 598-D, Optical Fiber Cable Color Coding.
      e. 606-B, Administration Standard for Telecommunications Infrastructure.
      f. 607-B, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
   6. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.

d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
e. 486C, Standard for Safety Splicing Wire Connections.
f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
i. 2250, Standard for Safety Instrumentation Tray Cable.

## 1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
a. Analog signal cable:
1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
2) Commonly used types are defined in the following:
a) TSP: Twisted shielded pair.
b) TST: Twisted shielded triad.
b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 12 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, ground wire(s), drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Wire connectors.
2) Insulating tape.
3) Cable lubricant.
b. See Specification Section 26 05 00 for additional requirements.
3. Test reports:
a. Testing plan and procedures.
b. Telecommunications cabling test results.
4. Provide Fiber Optic Cable pulling plan and calculations:
a. Provide calculations to ensure cable limits not exceeded:
1) Tension.
2) Sidewall pressure.
3) Include tensions for each portion of installation.
4) Submit prior to installation of conduit.

b. Provide plan that shows pull locations.
c. Ensure plan and calculations are coordinated.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. Aetna Insulated Wire.
      b. Alphawire.
      c. Cerrowire.
      d. Encore Wire Corporation.
      e. General Cable.
      f. Okonite Company.
      g. Southwire Company.
      h. Or approved equal.
   2. Shielded VFD cable:
      a. Belden Inc.
      b. General Cable.
      c. Okonite Company.
      d. Olfex Wire and Cable, Inc.
      e. Priority Wire and Cable (Prysmian).
      f. Rockbestos-Surprenant Cable Corp.
      g. Southwire Company.
   3. Or approved equal.Instrumentation cable:
      a. Analog cable:
         1) Alphawire.
         2) Belden Inc.
         3) General Cable.
      b. Or approved equal.
   4. Wire connectors:
      a. Burndy Corporation.
      b. Buchanan.
      c. Ideal.
      d. Ilsco.
      e. 3M Co.
      f. Teledyne Penn Union.
      g. Thomas and Betts.
      h. Phoenix Contact.
      i. Or approved equal.
   5. Insulating and color coding tape:
      a. 3M Co.
      b. Plymouth Bishop Tapes.
      c. Red Seal Electric Co.
      d. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.

2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, including a bare ground conductor.
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.
   b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC.

C. Control Cable:
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, provided with insulated ground conductor of the same AWG size.
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 1, Table E-2.
   b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Shielded VFD Cable:
1. Conductor shall be copper, stranded with 1,000 V or 2,000 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Cables No. 1 AWG and less:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type RHW-2 or XHHW-2 insulation with an overall PVC jacket.
   b. Shielding: 85 PCT tinned copper braid, full size tinned copper drain wire and 100 PCT foil shield.
   c. Number of conductors: 3 PH and 1 full size ground.
4. Cables No. 12 through 500 kcmil:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.

b. Shielding: 5 MIL copper tape, longitudinally applied with a minimum overlap of 15 PCT.
c. Number of conductors: 3 PH and 3 equally spaced ground conductors.

5. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.
   b. See PART 3 of this Specification Section for additional requirements.
6. When installed exposed outdoors, UL listed and marked as sunlight resistant.
7. For continuously corrugated cable, use manufacturer approved fittings.
8. Conform to NFPA 70, Type TC.

F. Instrumentation Cable:
1. Twisted Shielded Pair, Analog cable:
   a. Tinned copper conductors, #16AWG or #18AWG.
   b. Twisted with 100 PCT foil shield coverage with drain wire.
   c. 600 V PVC insulation with PVC jacket.
   d. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
   e. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
   f. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   g. Belden 9341 or equal.

G. Industrial Ethernet Cable:
a. Category 6 per TIA/EIA/ANSI 568.
b. Cable shall be label-verified.
c. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
d. Conductors: No. 23 AWG solid untinned copper.
e. Rated CMR and CMX-Outdoor per NFPA 70.
f. 600 V insulation.
g. Shielded.
h. Outdoor, sunlight, and wet rated.
i. Conform to UL 910 and NFPA 70 Type ITC.
j. As recommended by equipment (e.g., PLC) manufacturer.
k. Belden 7953A or equal.

H. Fiber Optic Cable:
1. Design and fabrication - Multi-mode:
   a. Type:
      1) Indoor: Tight buffered or loose tube with a dry gel water blocking system.
      2) Outdoor: Loose tube with a wet or dry gel water blocking system.
   b. Number of fibers: As indicated on the Drawings.
   c. Fiber size: 62.5/125 micrometer (core diameter/cladding diameter).
   d. Glass fiber core.
   e. Step index.
   f. Maximum attenuation:
      1) At 850 nm: 3.75 dB/km.
      2) At 1300 nm: 1.5dB/km.
   g. Minimum bandwidth:
      1) At 850 nm: 160 MHz/km.
      2) At 1300 nm: 500 MHz/km.
   h. Maximum tensile load:
      1) Installation: 225 LBS.
      2) Long term: 67 LBS.
   i. Cable jacket material:
      1) In rigid steel conduit: PVC, or polyethylene.
      2) In plenum or riser: Flame retardant material, PVC not allowed.

a) Plenum applications: Cable materials shall pass NFPA 262 requirements.
b) Riser applications: Cable materials shall pass UL 1666 requirements.
3) In cable tray: Polyethylene or equivalent; PVC not allowed.
a) Meet vertical flame tray test requirements of NFPA 262.

j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.
k. Optical fiber cable type utilized shall be in accordance with NFPA 70.
l. Utilize LC type connectors:
1) Tip material: Ceramic or ceramic/glass composite.
2) Utilize connectors which do not require adhesive, epoxy, or polish.

2. Design and fabrication - Single-mode:
a. Type:
1) Outdoor: Loose tube with a wet or dry gel water blocking system.
b. Number of fibers: As indicated on the Drawings.
c. Fiber size: Non-dispersion shifted, 9/125 micrometer (core diameter/cladding diameter).
d. Glass fiber core.
e. Step index.
f. Maximum attenuation:
1) At 850 nm: 0.5 dB/km.
2) At 1300 nm: 0.4 dB/km.
g. Minimum bandwidth:
1) At 850 nm: 160 MHz/km.
2) At 1300 nm: 500 MHz/km.
h. Maximum tensile load:
1) Installation: 600 LBS.
2) Long term: 200 LBS.
i. Cable jacket material:
1) In conduit: PVC, or polyethylene.
j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.
k. Optical fiber cable type utilized shall be in accordance with NFPA 70.
l. Fiber shall conform to TIA/EIA 492AAAA Class IV.
m. Fiber color code shall conform to TIA/EIA 598-C.
n. Utilize FC type connectors:
1) Tip material: Ceramic or ceramic/glass composite.
2) Utilize connectors which do not require adhesive, epoxy, or polish.

I. Wire Connectors:
1. Twist/screw on type:
a. Insulated pressure or spring type solderless connector.
b. 600 V rated.
c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
a. 600 V rated.
b. Ground conductors: Conform to UL 467.
c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.
c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.

J. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.

3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 MIL.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
   a. Insulating tape: Black.
   b. Color coding tape: Fade-resistant color as specified herein.
7. UV Resistant.
8. Comply with UL 510.

K. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Permitted Usage of Insulation Types:
   1. Type XHHW-2:
      a. Building wire and power and control cable in architectural and non-architectural finished areas.
      b. Building wire and power and control cable in conduit in outdoor areas and below grade.
      c. Building wire and power and control cable in cable tray in outdoor areas.
   2. Type THHN/THWN and THHN/THWN-2:
      a. Lighting and receptacles only.
   3. Type SIS and MTW:
      a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Shielded VFD Cable:
   1. For wiring between a VFD and motor.

C. Conductor Size Limitations:
   1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
   2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
   3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:
   1. Building wire:

| | 240 V, 208 V, 240/120 V, 208/120 V | 480 V, 480/277 V |
|---|---|---|
| Phase 1 | Black | Brown |
| Phase 2 | Red * | Orange |
| Phase 3 | Blue | Yellow |
| Neutral | White | White or Gray |
| Ground | Green | Green |

* Orange when it is a high leg of a 120/240 V Delta system.

      a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
      b. Conductors larger than No. 6 AWG:
         1) Insulated phase and neutral conductors shall be identified by one of the following methods:

a) Continuous colored outer finish along its entire length.
b) 3 IN of colored tape applied at the termination.

2) Insulated grounding conductor shall be identified by one of the following methods:
a) Continuous green outer finish along its entire length.
b) Stripping the insulation from the entire exposed length.
c) Using green tape to cover the entire exposed length.

3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Bare.
3. Shielded VFD cable ICEA S-58-679, Method 4 with:
a. Phase conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Green color insulation or bare.
4. Control cables ICEA S-58-679, Method 1, Table E-2:
a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.
2. Where field conditions dictate and written permission is obtained from the Engineer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
a. The combinations shall comply with the following:
1) 12 VDC, 24 VDC and 48 VDC may be combined.
2) 125 VDC shall be isolated from all other AC and DC circuits.
3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
a. The combinations shall comply with the following:
1) Analog signal circuits may be combined.
2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for similar loads may be combined in a common raceway, such as multiple lighting circuits or multiple receptacle circuits or other 120Vac circuits. Do not combine lighting and receptacle circuits.
a. Do not combine control device circuits with lighting or receptacle circuits.
b. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
2) The neutral conductors may not be shared.
3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one end only.
1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate, and written permission is obtained from the Engineer.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.
      c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
   4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 MIL vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 MIL vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 MIL, all weather vinyl tape.

J. Color Coding Tape Usage: For color coding of conductors.

K. Fiber Optic Cable:
   1. Cable pulling tension shall not be exceeded.
   2. Cable shall not be stressed such that twisting, stretching or kinking occurs.
   3. Cable shall not be spliced.
   4. All cable shall be installed in conduit or cable tray.
   5. Cable shall not be run through structural members or in contact with conduits, pipes, ducts, or other potentially damaging items.
   6. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 IN shall be maintained when such placement cannot be avoided.
   7. Cables shall be terminated; no cable shall contain unterminated elements.
   8. Minimum bending radius shall not be exceeded during installation or once installed.
   9. Only fabric hook and loop fasteners shall be used to wrap cables, 1/2 IN width minimum. Plastic or nylon cable ties shall not be used.
   10. Terminations:
      a. Each pair shall be terminated with appropriate connectors.
      b. No cable shall be unterminated or contain unterminated elements.

## 3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. See Specification Section 26 08 13.

B. Test installed fiber optic cable system to verify the following:
   1. Continuity of all installed fibers and associated connectors.
   2. Maximum attenuation requirements of specification are not exceeded.

**END OF SECTION**

# SECTION 26 05 26
## GROUNDING AND BONDING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding and bonding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) – 2017.
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 26 05 00 for additional requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. ERICO by Pentair.
      b. Harger Lightning & Grounding.
      c. Heary Bros. Lightning Protection Co. Inc.
      d. Burndy by Hubbell.

e. Robbins Lightning, Inc.
f. Blackburn by Thomas & Betts.
g. Thompson Lightning Protection, Inc.
h. Or approved equal.

2. Exothermic weld connections:
a. ERICO by Pentair - Cadweld.
b. Harger Lightning & Grounding - Ultraweld.
c. Burndy by Hubbell - Thermoweld.
d. FurseWELD by Thomas & Betts.
e. Or approved equal.

3. Prefabricated composite test stations:
a. Armorcast Products Company.
b. MacLean Highline.
c. Quazite by Hubbell.
d. Or approved equal

## 2.2 COMPONENTS

A. Wire and Cable:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
2. Insulated conductors: Color coded green, per Specification Section 26 05 19.

B. Conduit: As specified in Specification Section 26 05 33.

C. Ground Bars:
1. Solid copper:
a. 1/4 IN thick.
b. 2 or 4 IN wide.
c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.

D. Ground Rods:
1. 3/4 IN x 10 FT, with threaded end.
2. Copper-clad:
a. 10 MIL minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
b. Corrosion resistant bond between the copper and steel.
c. Hard drawn for a scar-resistant surface.
3. Where extended rods are required, provide threaded adapter to extend past 10'.

E. Grounding Clamps, Connectors and Terminals:
1. Mechanical type:
a. Standards: UL 467.
b. High copper alloy content.
2. Compression type for interior locations:
a. Standards: UL 467.
b. High copper alloy content.
c. Non-reversible.
d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
a. Standards: UL 467, IEEE 837.
b. High copper alloy content.
c. Non-reversible.
d. Factory filled with oxide inhibiting compound.

F. Exothermic Weld Connections:

1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

G. Prefabricated Composite Material Test Stations:
1. Body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 15.
3. Open bottom.
4. Stackable design as required for 3 FT depth.
5. Cover:
   a. Engraved legend of "GROUND".
   b. Lay-in non-bolt down.
6. Size: 12 IN round or 12 IN square.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01 73 20.
   a. Seal the sleeve interior to stop water penetration.
5. Do not splice grounding electrode conductors except at ground rods.
6. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
   a. Provide excavation required for installation of ground rods and conductors.
   b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
   d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
   e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
   a. All grounding electrode conductors terminate on a main ground copper bar located adjacent to the service entrance equipment.
   b. Main ground bar to be installed near base of floor and be the main connection point for all building grounds. Ground bar shall be up to 72" long x 4" x 0.25" thick. Provide with preassemble insulators, stainless steel brackets and accept several ground connections. More than one bar may be supplied depending on grounding layout. Diagrammatic grounding is shown on drawings. Contractor to determine optimal placement of ground bars and grounding of equipment, based on field installations.
2. Grounding electrode conductor terminations:
   a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.

b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
c. Piping systems: Use mechanical type connections.
d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
f. Ground rod: Compression type or exothermic weld, unless otherwise specified.
g. At all above grade terminations, the conductors shall be labeled per Specification Section 10 14 00.

3. Ground ring grounding system:
   a. Ground ring consists of ground rods and a conductor looped around the structure.
   b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
   c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
   d. Building/Structure grounding:
      1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
   e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
   f. Ground rod test stations:
      1) Provided where indicated on the Drawings.
      2) Grounding conductors connected to ground rod with removable ground clamps.

C. Supplemental Grounding Electrode:
1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
   a. See Grounding Electrode System paragraph for conductor termination requirements.
2. Metal light poles:
   a. Connect metal pole and pole base reinforcing steel to a ground rod.
   b.
   c. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
   a. Connect metallic structure to a ground rod.
   b. Grounding conductor: #6 AWG minimum.
4. Engine generator:
   a. Connect generator frame to the ground ring at two locations (opposite corners of frame).
   b. Grounding conductor: Bare conductor, size as indicated on the Drawings.
5. Ground cranes and hoists in accordance with NFPA 70, Article 610.
6. Ground elevators in accordance with NFPA 70, Article 620.

D. Other Bonding Requirements:
1. Other metal piping:
   a. Connect in a daisy chain or radial fashion: Interior hot and cold water piping system, process piping, fire sprinkler system service water pipe to the main ground bus as indicated on the Drawings.
   b. See Grounding Electrode System paragraph for conductor termination requirements.

E. Transformer Separately Derived Grounding System:
1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
2. Structures with a single electrical room/area:
   a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.

3. Structures with multiple electrical rooms/areas:
    a. Provide a ground bar mounted in each electrical room/area.
    b. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar as indicated on the Drawings.
    c. Connect grounding electrode conductor to the electrical room/area ground bar.
4. See Grounding Electrode System paragraph for conductor termination requirements.

F. Telecommunications Grounding System:
1. Coil 5 FT of insulated #6 AWG conductor at each telephone terminal board and mechanically connected to the ground bar.
2. Grounding bar: Mounted on or adjacent to telephone terminal board.
3. Interconnect all telecommunication ground bars in a daisy chain or radial fashion to the main ground bar.
    a. Grounding conductor: Bare conductor, size as indicated on the Drawings.

G. Raceway Bonding/Grounding:
1. Install all metallic raceway so that it is electrically continuous.
2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

H. Equipment Grounding:
1. Ground all utilization equipment with an equipment grounding conductor.

I. Manhole and Handhole Grounding:
1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
    a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

J. Prefabricated Composite Material Test Station:
1. Place test station on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
2. Provide concrete encasement ring around test station per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).

## 3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance testing:
1. See Specification Section 26 08 13.

**END OF SECTION**

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# SECTION 26 05 33
## RACEWAYS AND BOXES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 43 - Electrical - Exterior Underground.
   5. Section 26 27 26 - Wiring Devices.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Institute (AISI).
   3. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
      e. TC 14.AG, Aboveground Reinforced Thermosetting Resin Conduit and Fittings.
      f. TC 14.BG, Belowground Reinforced Thermosetting Resin Conduit and Fittings.
   5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.3, Steel Electrical Metallic Tubing (EMT).
      c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) 2017.
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Electrical Rigid Metal Conduit - Steel.
      c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      d. 360, Standard for Liquid-Tight Flexible Metal Conduit.

e. 467, Grounding and Bonding Equipment.
f. 514A, Metallic Outlet Boxes.
g. 514B, Conduit, Tubing, and Cable Fittings.
h. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
i. 797, Electrical Metallic Tubing - Steel.
j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
k. 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations. 2420, Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
l. 2515, Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

### 1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Conduit fittings.
2) Support systems.
b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
a. Proposed routing of raceways buried under concrete floors.
1) Identify conduit by tag number of equipment served or by circuit schedule number.
b. Proposed routing and details of construction, including raceway and rebar, for raceways embedded in floor slabs.
1) Identify conduit by tag number of equipment served or by circuit schedule number.
c. Proposed location and details of construction for openings in slabs and walls and footings for raceway runs.
d. Identify dimensional size of pull and junction boxes to be used.
e. Seismic location installation details.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Rigid metal conduits and electrical metallic tubing:
a. Allied Tube and Conduit.
b. Western Tube and Conduit Corporation.
c. Wheatland Tube.
d. Or approved equal.
2. PVC coated rigid metal conduits:
a. Ocal by Thomas & Betts.
b. Robroy Industries.
c. Or approved equal.
3. Rigid nonmetallic conduit:
a. Prime Conduit.
b. Cantex, Inc.
c. Osburn Associates, Inc.
d. Or approved equal.

4. Flexible conduit:
    a. AFC Cable Systems.
    b. Anamet, Inc.
    c. Electri-Flex Company.
    d. International Metal Hose Company.
    e. Southwire Company, LLC.
    f. Or approved equal.
5. Wireway:
    a. Hoffman Engineering.
    b. Wiegmann by Hubbell.
    c. Square D by Schneider Electric.
    d. Or approved equal.
6. Conduit fittings and accessories:
    a. Appleton by Emerson Electric Co.
    b. Carlon by Thomas & Betts.
    c. Cantex, Inc.
    d. Crouse-Hinds by Eaton.
    e. Killark by Hubbell.
    f. Osburn Associates, Inc.
    g. O-Z/Gedney by Emerson Electric Co.
    h. Raco by Hubbell.
    i. Steel City by Thomas & Betts.
    j. Thomas & Betts.
    k. Or approved equal.
7. Support systems:
    a. Unistrut by Atkore International, Inc.
    b. B-Line by Eaton.
    c. Kindorf by Thomas & Betts.
    d. Minerallac Company.
    e. CADDY by Pentair.
    f. Superstrut by Thomas & Betts.
    g. Or approved equal.
8. Outlet, pull and junction boxes:
    a. Appleton by Emerson Electric Co.
    b. Crouse-Hinds by Eaton
    c. Killark by Hubbell.
    d. O-Z/Gedney by Emerson Electric Co.
    e. Steel City by Thomas & Betts.
    f. Raco by Hubbell
    g. Bell by Hubbell.
    h. Hoffman Engineering.
    i. Wiegmann by Hubbell.
    j. B-Line by Eaton.
    k. Adalet.
    l. RITTAL North America LLC.
    m. Stahlin by Robroy Enclosures.
    n. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 RIGID METAL CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
    1. Mild steel with continuous welded seam.
    2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
    3. Threads galvanized after cutting.

4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
1. Nominal 40 MIL Polyvinyl Chloride Exterior Coating:
   a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
   b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
   a. Have a plastic sleeve extending a minimum of one pipe diameter or 2 IN, whichever is less beyond the opening.
   b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6, NEMA RN 1.

## 2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Mild steel with continuous welded seam.

B. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.

C. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.

D. Standards: NFPA 70 Type EMT, NEMA/ANSI C80.3, UL 797.

## 2.4 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DEGC wire and shall be marked "maximum 90 DEGC".
5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.

## 2.5 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: NFPA 70 Type FMC, UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: NFPA 70 Type LFMC, UL 360.

## 2.6 WIREWAY

A. General:
1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.
   b. Non-removable when passing through partitions.

4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. Raintight (NEMA 3R) Wiring Trough:
1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.

C. Watertight (NEMA 4X rated) Wireway:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

D. Dust-tight (NEMA 12 rated) Wireway:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

## 2.7 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:
1. General:
   a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
   a. Threaded steel or malleable iron.
   b. Gasketed or non-gasketed.
   c. Grounding or non-grounding type.
3. Bushings:
   a. Threaded, insulated metallic.
   b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
   a. Threaded straight type: Same material and finish as the conduit with which they are used on.
   b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Clip-on type with stainless steel screws.
      2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. With or without drain and breather.
   d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
   a. Liquid tight and arc resistant.
   b. Electrically conductive so no bonding jumper is required.

c. Dry and wet areas:
    1) Bronze braided covering over flexible brass core.
    2) Bronze end fittings.
    3) Zinc-plated steel or malleable iron unions and nipples.
d. Corrosive areas:
    1) Stainless steel braided covering over flexible stainless steel core.
    2) Stainless steel end fittings.

11. Expansion couplings:
    a. 4 IN nominal straight-line conduit movement in either direction.
    b. Galvanized steel with insulated bushing.
    c. Gasketed for wet locations.
    d. Internally or externally grounded.
12. Expansion/deflection couplings:
    a. 3/4 IN nominal straight-line conduit movement in either direction.
    b. 30 DEG nominal deflection from the normal in all directions.
    c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    d. Internally or externally grounded.
    e. Watertight, raintight and concrete tight.
13. Standards: UL 467, UL 514B, UL 1203.

B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:
1. Connectors:
    a. Straight, angle and offset types furnished with locknuts.
    b. Zinc plated steel.
    c. Insulated gland compression type.
    d. Concrete and raintight.
2. Couplings:
    a. Zinc plated steel.
    b. Gland compression type.
    c. Concrete and raintight.
3. Conduit bodies (ells and tees):
    a. Body: Copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. Cover:
        1) Screw down type with steel screws.
        2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.

D. Fittings for Use with FLEX:
1. Connector:
    a. Zinc plated malleable iron.
    b. Squeeze or clamp-type.
2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT:
1. Connector:
    a. Straight or angle type.
    b. Metal construction, insulated and gasketed.
    c. Composed of locknut, grounding ferrule and gland compression nut.
    d. Liquid tight.
2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Nonmetallic PVC Conduit:
   1. Coupling, adapters and conduit bodies:
      a. Same material, thickness, and construction as the conduits with which they are used.
      b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
      c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
   2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
   3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Weather and Corrosion Protection Tape:
   1. PVC based tape, 10 mils thick.
   2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
   3. Used with appropriate pipe primer.

## 2.8 ALL RACEWAY AND FITTINGS

A. Mark Products:
   1. Identify the nominal trade size on the product.
   2. Stamp with the name or trademark of the manufacturer.

## 2.9 OUTLET BOXES

A. Metallic Outlet Boxes:
   1. Hot-dip galvanized steel.
   2. Conduit knockouts and grounding pigtail.
   3. Styles:
      a. 2 IN x 3 IN rectangle.
      b. 4 IN square.
      c. 4 IN octagon.
      d. Masonry/tile.
   4. Accessories:
      a. Flat blank cover plates.
      b. Barriers.
      c. Extension, plaster or tile rings.
      d. Box supporting brackets in stud walls.
      e. Adjustable bar hangers.
   5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
   1. Zinc plated cast iron or die-cast copper free aluminum with manufacturer's standard finish.
   2. Threaded hubs and grounding screw.
   3. Styles:
      a. "FS" or "FD".
      b. "Bell".
      c. Single or multiple gang and tandem.
      d. "EDS" or "EFS" for hazardous locations.
   4. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.
   5. Standards: UL 514A, UL 1203.

C. See Specification Section 26 27 26 for wiring devices, wallplates and coverplates.

## 2.10 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
   1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. With or without concentric knockouts on four sides.
   3. Flat cover fastened with screws.

B. NEMA 3R Rated:
   1. Body and cover: 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. Drip shield top and seam-free sides, front and back.
   3. With or without concentric knockouts on bottom.
   4. Slip-on removable cover fastened on bottom edge with screws or continuous hinged cover fastened with screws.

C. NEMA 4 Rated:
   1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
   6. Cover with oil resistant gasket.

D. NEMA 4X Rated (metallic):
   1. Body and cover: 14 GA Type 316 stainless steel.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged door and stainless steel screws and clamps.
   6. Door with oil-resistant gasket.

E. NEMA 4X Rated (Nonmetallic):
   1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
   2. No knockouts.
   3. External mounting flanges.
   4. Hinged door with quick release latches and padlocking hasp.
   5. Door with oil resistant gasket.

F. NEMA 7 and NEMA 9 Rated:
   1. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
   2. Drilled and tapped openings or tapered threaded hub.
   3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   4. External mounting flanges.
   5. Grounding lug.
   6. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.

G. NEMA 12 Rated:
   1. Body and cover:
      a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. Type 5052 H-32 aluminum, unpainted.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   6. Flat door with oil resistant gasket.

H. Miscellaneous Accessories:
   1. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
   2. Split covers when heavier than 25 LBS.
   3. Weldnuts for mounting optional panels and terminal kits.
   4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

I. Standards: NEMA 250, UL 50.

### 2.11 SPECIAL PURPOSE BOXES

A. Pedestal-Type Floor-Mounted or Counter-Mounted Duplex Receptacles:
   1. Horizontal design housing with threaded conduit fittings in base with satin chromium finish.

B. Flush in Floor Duplex Receptacles:
   1. Dual level, fully adjustable box with power fitting and brass carpet flange.

### 2.12 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
   1. Material requirements.
      a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
      b. Stainless steel: AISI Type 316.
      c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 MIL PVC coating.

B. Single Conduit and Outlet Box Support Fasteners:
   1. Material requirements:
      a. Zinc plated steel.
      b. Stainless steel.
      c. Malleable iron.
      d. PVC coat malleable iron or steel: 20 MIL PVC coating.
      e. Steel protected with zinc phosphate and oil finish.

### 2.13 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
   1. See Specification Section 01 73 20.

B. Smoke and Fire Stop Fittings:
   1. 3 HR UL rating.
   2. Flanged and segmented.
   3. Cast malleable iron mounting frame and pressure plate.
      a. Elastomeric sealing material.
      b. Steel clamping hardware.

C. Sleeves through walls and floors:
   1. Uncoated or galvanized iron or steel:
   2. Wall thickness: Not less than standard Schedule 40 pipe.

## PART 3 - EXECUTION

### 3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
   1. NFPA 70.
   2. Manufacturer instructions.

B. Size of Raceways:
   1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
   2. Unless specifically indicated otherwise, the minimum raceway size shall be:
      a. Conduit: 3/4 IN, except exterior underground shall be 1 IN minimum.
      b. Wireway: 6 IN x 6 IN.

C. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.

2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   a. Total nominal thickness: 40 MIL.
4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
1. See Specification Section 01 73 20.
2. The same materials of construction shall be used for non-fire-rated walls.
3. Use the following to seal fire-rated walls:
   a. For single conduit penetrations:
      1) Flanged and segmented to install around in-place conduits.
   b. For blockouts:
      1) Mounting frame and elastomeric sealing material to be set in place prior to installation of conduits.

J. Conduit tagging.
1. Provide steel conduit tags per 10 14 00, at each end of conduit runs.
2. Tags shall be labeled per the one line diagrams and conduit scheduled.
3. Provide tags with stainless steel wire.
4. Tags shall be steel or brass, round or square.

## 3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
   a. Through areas of high ambient temperature or radiant heat.
   b. In suspended concrete slabs.

c. In concrete members including slabs, slabs on grade, beams, walls, and columns unless specifically located and detailed on structural Drawings..

4. Locate sleeves or conduits penetrating floors, walls, and beams so as not to significantly impair the strength of the construction. Do not place conduit penetrations in columns.
5. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
6. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 DEG of bends in the conduit run or in long straight runs to limit pulling tensions.
7. Provide 20% spare conduits where routed in underground ductbanks. Spare conduits shall be stubbed up 6" and capped next to major pieces of equipment, inside the building. Provide 1" spare conduits, and provide 1 for power, 1 for control and 1 for signal.

B. All conduits within a structure shall be installed exposed except as follows:
1. As indicated on the Drawings.
2. Concealed in or below non-suspended concrete slabs.
3. Concealed above gypsum wall board or acoustical tile suspended ceilings.
4. Conduits in architecturally finished areas shall be concealed.
5. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 VDC, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between instrumentation and greater than 600 VAC power: 12 IN.
5. Between telecommunication and 125 V, 48 V and 24 VDC, 2 IN.
6. Between telecommunication and 600 V and less AC power or control: 6 IN.
7. Between telecommunication and greater than 600 VAC power: 12 IN.
8. Between 125 V, 48 V and 24 VDC and 600 V and less AC power or control: 2 IN.
9. Between 125 V, 48 V and 24 VDC and greater than 600 VAC power: 2 IN.
10. Between 600 V and less AC and greater than 600 VAC: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
1. See Specification Section 01 73 20.

## 3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Motor leads from a VFD: A raceway types.
5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:

1. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings

C. Permitted Raceway Types Per Routing Locations:
   1. In stud framed walls:
      a. EMT.
      b. RGS.
   2. In concrete block or brick walls:
      a. PVC-40.
      b. PVC-80.
   3. Above acoustical tile ceilings:
      a. EMT.
      b. RGS.
      c. NEMA 1 rated wireway.
   4. Embedded in poured concrete walls and floors:
      a. PVC-40.
      b. PVC-80.
      c. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
   5. Beneath floor slab-on-grade:
      a. PVC-40.
      b. PVC-80.
   6. Through floor penetrations, see Specification Section 01 73 20:
      a. PVC-RGS in areas designated as wet, corrosive or highly corrosive.
   7. Direct buried conduits and ductbanks:
      a. PVC-80.
      b. 90 DEG elbows for transitions to above grade:
         1) PVC-RGS.
      c. Long sweeping bends greater than 15 DEG:
         1) PVC-RGS.
   8. Concrete encased ductbanks:
      a. PVC-40.
      b. 90 degree elbows for transitions to above grade:
         1) PVC-RGS.
      c. Long sweeping bends greater than 15 DEG:
         1) RGS for sizes 2 IN and larger.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures. Provide strapping.
      b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.
      b. 3 FT to motors.
      c. 2 FT to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 3 FT to motors.
      b. 2 FT to all other equipment.

G. NEMA 1 Rated Wireway:
   1. Surface mounted in electrical rooms.
   2. Surface mounted above removable ceilings tiles of an architecturally finished area.

H. NEMA 3R Wiring Trough:
   1. Surface mounted in exterior locations.

I. NEMA 4X Rated Wireway:
   1. Surface mounted in areas designated as wet and or corrosive.

J. NEMA 12 Rated Wireway:
   1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

K. Underground Conduit: See Specification Section 26 05 43.

## 3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:
   1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
   2. Fill plug and drain shall be accessible.
   3. Pour the conduit seals in a two-step process.
      a. Pour the seal and leave cover off.
      b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.

B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
   1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
   2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.
   3. Underground.

G. Terminate Conduits:
   1. In metallic outlet boxes:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   2. In NEMA 1 rated enclosures:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.

3. In NEMA 12 rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
    b. Use grounding type locknut or bushing when required by NFPA 70.
4. In NEMA 4 and NEMA 4X rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
5. In NEMA 7 and NEMA 9 rated enclosures:
    a. Into an integral threaded hub.
6. When stubbed up through the floor into floor mount equipment:
    a. With an insulated grounding bushing on metallic conduits.
    b. With end bells on nonmetallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

## 3.5 CONDUIT SUPPORT

A. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
2. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.
3. Support conduit from the building structure.
4. Do not support conduit from process, gas, air or water piping; or from other conduits.
5. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
    a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
    b. Conduit hangers:
        1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
    c. Do not use suspended ceiling support systems to support raceways.
    d. Hangers in metal roof decks:
        1) Utilize fender washers.
        2) Not extend above top of ribs.
        3) Not interfere with vapor barrier, insulation, or roofing.
6. Conduit support system fasteners:
    a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
    b. Do not use concrete nails and powder-driven fasteners.

## 3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.
5. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.

B. Outlet Boxes:
1. Permitted uses of metallic outlet boxes:
    a. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.
    b. Housing of wiring devices:
        1) Recessed in all stud framed walls and ceilings.

2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.

c. Pull or junction box:
1) Above gypsum wall board or acoustical tile ceilings.
2) Above 10 FT in an architecturally finished area where there is no ceiling.

2. Permitted uses of cast outlet boxes:
a. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.
b. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
c. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
a. Make covers of boxes accessible.

**END OF SECTION**

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# SECTION 26 05 43
## ELECTRICAL - EXTERIOR UNDERGROUND

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 03 11 13 - Formwork.
   5. Section 03 31 30 - Concrete, Materials and Proportioning.
   6. Section 10 14 00 - Identification Devices.
   7. Section 26 05 26 - Grounding.
   8. Section 26 05 33 - Raceways and Boxes.
   9. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.

C. Concrete ductbanks shall conform with City of Ashland standards. Provide red dye for concrete ductbanks where required by City of Ashland.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB-17, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) – 2017.
   4. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specifications for Underground Enclosure Integrity.

### 1.3 DEFINITIONS

A. Direct-Buried Conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete Encased Ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout drawings:

a. Provide dimensional drawings of each handhold and manhole indicating all specified accessories and conduit entry locations.
   1) Provide dimensioned, cross-sectioned sketch of each penetration and each side.
b. Provide cross-sectioned sketch of each concrete encased ductbank.
   1) Dimension spacing between conduits.
   2) Dimension concrete envelope and reinforcing, where applicable.
c. Provide cross-section sketch of each direct-buried ductbank.
   1) Dimension from grade to direct buried ductbank.
   2) Dimension from direct buried ductbank to other utilities in the route.
   3) Verification of trench covers rated for vehicle crossing.

4. Certifications.
5. Test reports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Armorcast Products Company.
      b. Quazite by Hubbell.
      c. Synertech by Oldcastle Enclosure Solutions.
      d. Or approved equal.
   2. Precast manholes and handholes:
      a. Lister Industries Ltd.
      b. Oldcastle Enclosure Solutions.
      c. Jensen Precast and Utility Concrete Products.
      d. Or approved equal.
   3. Manhole and handhole and ductbank accessories:
      a. Cantex, Inc.
      b. Condux International, Inc.
      c. Neenah Enterprises, Inc.
      d. Prime Conduit.
      e. Thomas and Betts.
      f. Underground Devices, Inc.
      g. Unistrut by Atkore International, Inc.
      h. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   2. Minimum load ratings: SCTE 77 Tier 15.
   3. Solid bottom.
   4. Stackable design as required for specified depth.
   5. Cover:
      a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Lay-in non-bolt down, when cover is over 100 LBS.
      d. One or multiple sections so the maximum weight of a section is 125 LBS.
   6. Cover lifting hook: 24 IN minimum in length.

B. Precast Manholes and Handholes:

1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cover extension rings as required.
7. Provide hole or knockout in bottom for ground rod.
    a. Diameter: as required, 2 IN minimum.
8. Cable pulling eyes opposite all conduit entrances.
    a. Coordinate exact location with installation contractor.

### 2.3 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

A. Cover and Frame:
1. Cast ductile iron: ASTM A536.
2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.
4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.
    a. Stainless steel penta-head bolts.

B. Cable Racks and Hooks:
1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
2. Hook loading capacity: 400 LBS minimum.
3. Rack loading capacity: Four hooks maximum.
4. Hook deflection: 0.25 IN maximum.
5. Hooks: Length, as required, with positive locking device to prevent upward movement.
6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
1. 7/8 IN DIA hot-dipped galvanized steel.
2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.

### 2.4 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete and reinforcing steel: See Division 03 Specifications.

B. Conduit: See Specification Section 26 05 33.

C. Duct Spacers/Supports:
1. High density polyethylene or high impact polystyrene.
2. Interlocking web or mesh design.
3. Provide 3 IN minimum spacing between conduits.
4. Accessories, as required:
    a. Hold down bars.
    b. Ductbank strapping.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.
1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
1. Approximately where shown on the Drawings.

2. As required for pulling distances.
3. As required to keep pulling tensions under allowable cable tensions.
4. As required for number of bends in ductbank routing.
5. Shall not be installed in a swale or ditch.
6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 31 23 33 for trenching, backfilling and compacting.

F. For all underground ductbanks, provide a minimum 20% of the total number of ducts with the size of the spare ducts equal to the largest size duct in the duct bank.

## 3.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
1. For use in areas subjected to occasional non-deliberate vehicular traffic.
2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:
1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
   a. Grout or seal all joints, per manufacturer's instructions.
   b. Support cables on walls by cable racks:
      1) Provide a minimum of two racks, install symmetrically on each wall of manholes and handholes.
         a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
      2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
   c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
      1) Drill opening in floor for ground rod.
      2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
      3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three.
         a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
      4) Provide 24 IN x 24 IN x 24 IN DEEP French drain just below each manhole and handhole drain sump. Drill hole in concrete drain sump to allow collected water to drain into French drain below.
3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.

a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.

5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
   a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
   b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.
7. Manhole size:
   a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
   b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

## 3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
   1. Ductbank types per location:
      a. Reinforced concrete ductbank:
         1) Under roadway and parking lot pavement.
         2) When routed above process piping systems.
         3) As indicated in the Ductbank Schedule or drawings.
      b. Concrete encased ductbank:
         1) Under roads.
         2) Conduits containing medium voltage cables.
         3) Pad mounted transformer secondaries.
         4) Plant process equipment feeders and controls.
         5) As indicated in the Ductbank Schedule or drawings.
      c. Direct-buried conduit(s):
         1) Area/Roadway lighting.
         2) As indicated in the Ductbank Schedule or drawings.
   2. Do not place concrete or soil until conduits have been observed by the Engineer.
   3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
      a. Low points shall be at manholes or handholes.
   4. During construction and after conduit installation is complete, plug the ends of all conduits.
   5. Provide conduit supports and spacers.
      a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 3 FT.
         2) 1-1/4 to 3 IN: 5 FT.
         3) 3-1/2 to 6 IN: 7 FT.
      b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 10 FT.
         2) 1-1/4 to 2-1/2 IN: 14 FT.
         3) 3 IN and larger: 20 FT.
      c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
   6. Stagger conduit joints at intervals of 6 IN vertically.
   7. Make conduit joints watertight and in accordance with manufacturer's recommendations.
   8. Accomplish underground changes in direction of runs exceeding a total of 15 DEG by long sweep bends having a minimum radius of 10 FT.
      a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
   9. Conduits to be installed straight except where direction change required.
   10. Furnish manufactured elbows at end of runs as the conduit transitions to above grade.

a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.

11. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
12. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN.
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
13. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
14. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
15. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10 14 00 and ductbank details.
16. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:
1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.
2. Install so that top of concrete encased duct, at any point:
    a. Is not less than 24 IN below grade.
    b. Is below pavement sub-grading.
3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.
    a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 03 Specification Sections or as detailed on the Drawings.
    b. Conduit supports to be staggered to minimize weak vertical shear point.
4. Conduit supports shall provide a uniform minimum clearance of 3 IN between the bottom of the trench and the bottom row of conduit.
5. Conduit separators shall provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
6. Install concrete per City of Ashland standards. Refer to division 3 for all concrete specifications.

C. Direct-Buried Conduit(s):
1. Install so that the top of the uppermost conduit, at any point:
    a. Is not less than 24 IN below grade.
    b. Is below pavement sub-grading.
2. Provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
    a. Maintain the separation of multiple planes of conduits by one of the following methods:

1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations and backfill with flowable fill (100 PSI) per Specification Section 31 23 33 or concrete per Division 03 specifications.
2) Install the multilevel conduits one level at a time.
   a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 23 33, to maintain the required separations.

**END OF SECTION**

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# SECTION 26 05 48
## ELECTRICAL SEISMIC RESTRAINT SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. The design and installation of seismic bracing and anchorage required for electrical equipment, conduit, and control panels.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
   2. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 PSI Tensile Strength.
      c. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 KSI (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.
      e. A992/A992M, Standard Specification for Structural Steel Shapes.
      f. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 KSI Yield Strength.
   3. Building code (current applicable editions, including amendments, for project location):
      a. International Code Council (ICC):
         1) International Building Code and associated standards, referred to herein as Building Code.
      b. International Building Code (IBC).
      c. National Fire Protection Association (NFPA) 5000 Building Construction and Safety Code.

### 1.3 SYSTEM DESCRIPTION

A. Contractor is responsible for design and installation of seismic bracing and anchorage systems.

B. Description of Systems:
   1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
   2. Anchorage of floor and roof mounted electrical equipment.

C. Seismic Design Requirements:
   1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit, and control panels, designed, constructed, and installed to resist stresses produced by lateral forces.

D. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and all suspended or wall mounted equipment weighing 20 LBS or more.

E. The following components are exempt from the requirements of this Specification Section:

1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor ($I_P$) is equal to 1.0.
2. Electrical components in Seismic Design Categories D, E, and F where $I_P$ = 1.0 and flexible connections between the components and associated conduit are provided and that are mounted at 4 FT (1.22 M) or less above a floor level and weigh 400 LBS (1780 N) or less.
3. Electrical components in Seismic Design Categories D, E, and F weighing 20 LBS (95 N) or less where $I_P$ = 1.0 and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 LBS/FT (7 N/M) or less.

F. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

### 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Seismic control devices.
3. Fabrication and/or layout drawings:
   a. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
   b. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location.
      1) Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
   c. Structural calculations for required lateral force level for each component.
   d. All submittals, including pre-approved systems, shall be signed and sealed by a licensed engineer, licensed in the state in which the project is located.
4. Certifications:
   a. Certificate that seismic bracing system installed is in accordance with approved Shop Drawings.
5. Test reports: Signed and dated.

### 1.5 PROJECT CONDITIONS

A. Seismic (Earthquake) Loads:
1. See General Structural Notes on Structural Sheets or Section 01 81 10 for seismic design parameters.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pre-engineered suspended bracing systems:
   a. International Seismic Application Technology (ISAT) "Engineered Seismic Bracing of Suspended Utilities".
   b. Unistrut by Atkore International, Inc.
   c. TOLCO by Eaton.
   d. B-Line by Eaton.
   e. Or approved equal.
2. Custom engineered systems designed using specified criteria and common building materials.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 EQUIPMENT ANCHORS AND SUPPORTS

A. Drilled-in-place concrete anchors shall have an approved ICBO Evaluation Services Report.

B. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554, 36 ksi.

C. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.

D. Structural steel for supports: ASTM A36, A588, A992 or A500.

E. Cold formed metal and connection material: Unistrut, or equal.

F. Any details provided are based on assumed equipment and arrangement.
   1. The Contractor shall be responsible for design and acquiring approval for support and anchorage of equipment and arrangement which varies from equipment and arrangement assumed in detail provided.

# PART 3 - EXECUTION

## 3.1 GENERAL REQUIREMENTS

A. Every run which requires bracing, shall have a minimum of two transverse braces and one longitudinal brace.
   1. A "run" is defined as suspended pipe, conduit, cable tray, bus duct or trapeze rack having a minimum 10 FT straight run length.

B. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

C. Bracing may be omitted from conduit, cable tray and bus duct runs less than 10 FT in length.

D. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 IN. (305 MM) in length are required.
   1. All unbraced suspended utility systems having 2 IN conduit and larger or systems weighing more than 5 LBS/FT shall be installed with a minimum 6 IN clearance to suspended ceiling vertical hanger wires.
   2. The conduit, cable tray, or bus duct shall be installed such that the lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.

E. A longitudinal brace at a 90 DEG change in direction may act as a transverse brace if it is located within 2 FT of the change in direction.

F. A transverse brace may act as a longitudinal brace if it is located within 2 FT of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

G. When bracing equipment or a utility system that is suspended from an overhead deck, brace back to the overhead deck or to the supporting structure supporting the deck.
   1. Do not brace to another element of the structure which may respond differently during a seismic event.

H. Obtain approval from the Structural Engineer prior to attaching any brace elements to structural steel or wood framing.

I. When utilizing cable bracing, tension the cable to remove slack without inducing uplift of the suspended element.
   1. Tension seismic bracing system prior to system start-up and adjust if necessary, after equipment start-up.

J. As a general rule, do not mix rigid bracing with cable bracing in the same run.

1. However, once bracing has transitioned a 90 DEG change in run direction, the bracing may switch from rigid to cable or vice versa if required due to a significant change in overhead deck elevation or to provide an implementable bracing scheme in a congested area.

K. Install brace members at an angle of 45 DEG from horizontal within a tolerance of +2-1/2 DEG or -45 DEG provided the brace length is accounted for in design.
   1. Brace angle may be increased to 60 DEG provided the brace spacing is reduced to 1/2 that required for a 45 DEG brace.

L. Seismic bracing may not pass through a building separation joint.
   1. Utility systems that pass through a separation joint must be seismically restrained no greater than 5 FT from the point of connection.
   2. Any hardware designed to accommodate seismic movement across the span of the separation joint shall be installed per manufacturer's installation and listing instructions.

M. With approval of the Structural Engineer, utility systems that are suspended from the overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that the walls and the overhead decks will respond similarly during a seismic event.

N. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

O. Conduit, cable tray, or bus duct constructed of non-ductile material (plastic or fiberglass), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials.

P. Where brace elements are through-bolted, the mounting hole in the element is to be no more than 1/16 IN in diameter larger than the bolt or threaded rod.

Q. Seismic braces shall directly brace the support and not the hanger.

## 3.2 SUSPENDED ELECTRICAL SYSTEMS

A. Install seismic bracing for all conduit 2-1/2 IN trade size or greater.

B. All trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering the total weight of the elements on the trapeze.
   1. For the purposes of calculating weight, all conduits are to be treated as full.

C. Brace all trapeze racks which support conduit 2-1/2 IN trade size or larger.
   1. Brace all other conduit rack, cable tray or bus duct trapezes having a minimum weight in excess of 10 LBS/LF.
   2. Include a minimum 10 PCT additional capacity for future additions.

D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 IN or less in length from the top of the element to the bottom of the structural attachment of the hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.

E. For steel and aluminum bus ducts, conduit and cable trays:
   1. Provide transverse bracing at 40 FT maximum spacing unless otherwise noted.
   2. Provide longitudinal bracing at 80 FT maximum spacing unless otherwise noted.

F. All vertical risers involving conduit 2-1/2 IN in diameter or larger shall include lateral restraint at maximum 30 FT intervals and at the top and bottom of the riser.

G. Make provisions to eliminate seismic impact between components.

## 3.3 FLOOR OR ROOF MOUNTED EQUIMENT

A. Provide one anchor on each leg or corner.
   1. Support with a minimum of three 3/8 IN DIA anchors.

B. Friction shall be neglected when designing anchors for shear.

C. Vertical seismic forces, when required, shall be presumed to act concurrently with horizontal seismic forces.

D. Batteries on racks or for generators shall have wrap around restrains to ensure that the batteries will not slide laterally. Spacers shall be used between the restraints and cases to prevent damage to the cases.

E. Electrical cabinet design shall comply with the applicable NEMA standards. Cutouts in the lower shear panel that have not been made by the manufacturer and reduce significantly the strength of the cabinet shall be specifically evaluated.

**END OF SECTION**

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# SECTION 26 05 74
## SHORT CIRCUIT AND COORDINATION STUDY, AND ARC FLASH REPORT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section specifies the short circuit and protective-device coordination study, and arc flash study and report, for the electrical power system for the City of Ashland, Oregon Water Treatment Plant.
   1. The "electrical power system" starts at the utility transformer and includes the Main Switchboard, generator, motor control centers, panelboards, VFDs, and all buses above 120V.
   2. Arc flash study shall include the method and recommendation in determining proper Personal Protective Equipment (PPE) and proper labeling of equipment as specified in this Section.
   3. Provide equipment labeling per City of Ashland. Coordinate with the City of Ashland and/or Owner and any of Oregon's addendums to the NEC.

B. Reports shall include the utility transformer, main plant switchboard, motor control centers, motor control equipment, VFDs, and all buses above 120V.
   1. Field data as needed shall be determined and gathered by the Contractor after Notice to Proceed to accomplish the Arc Flash Report and Coordination Study.
   2. The report shall include electrical equipment being installed in this Construction Contract.

### 1.2 RELATED SECTIONS

A. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Electrical: Basic Requirements.

### 1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. This Section incorporates by reference the latest revision of the following documents.
   2. These references are a part of this Section as specified and modified.
   3. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

| REFERENCE | TITLE |
|---|---|
| IEEE 1584 | IEEE Guide for Performing Arc-Flash Hazard Calculations |
| NFPA 70 | National Electrical Code – 2017 |
| NFPA 70E | Standard for Electrical Safety Requirements for Employee Workplaces |
| OSHA 29-CFR | Occupational Safety and Health Standards: Electrical Part 1910 Subpart S |

B. Qualifications:
   1. Prepared by the manufacturer of the electrical equipment or by an electrical testing service or an Engineering Company which is regularly engaged in power system studies.
   2. All calculations shall be prepared by or prepared under direct supervision of a registered Professional Electrical Engineer licensed in the State of Oregon.

C. Certification:
   1. Short circuit and coordination study and arc flash report to be stamped and signed by a registered Professional Electrical Engineer licensed in the State of Oregon.

### 1.4 SUBMITTALS

A. Short circuit and coordination study report.

B. Arc flash report.

C. Arc flash warning labels for the electrical equipment being installed in this construction contract.

D. Provide complete set of model files used to perform study to Owner's Representative as part of O&M documentation.

## 1.5 SHORT CIRCUIT AND COORDINATION STUDY

A. Coordinated Power System Protection:
   1. A study shall be prepared to demonstrate that the equipment and system constructed within the scope of these Contract Documents meet the specified requirements for equipment ratings, coordination and protection.
      a. The studies shall be performed in accordance with IEEE 242 and IEEE 399.
   2. Computer generated studies shall include the information about the software: name of the developer and software package and version number.
   3. System short circuit study report:
      a. The study shall include the utility transformer and extend down the system through all buses.
      b. A balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study shall be performed.
      c. A one-line diagram shall be prepared to show the electrical system buses, generator, transformers and all sources of fault current including generators and motors.
      d. Manufacturers' data for the actual proposed equipment shall be utilized (e.g., transformer impedance).
      e. The available utility fault current shall be coordinated with the power utility company.
      f. Input data shall be shown in tabular form in the report and/or on the one-line diagram.
         1) Input data shall include but is not limited to:
            a) Utility fault current or MVA and X/R ratio.
            b) Bus voltages.
            c) Conductor sizes and type of conduit.
            d) Motor sizes and contributions.
            e) Generator size and contributions.
            f) Transformer sizes and impedances.
      g. Available fault current at each bus shall be shown in tabular form in the report and/or on the one-line diagram.
      h. Perform studies for both normal power and standby power scenarios.
   4. System protective coordination study report:
      a. The study shall begin at each main service electrical switchgear and extend down the system through all buses as required to ensure a coordinated power system.
      b. The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions.
         1) Where necessary an appropriate compromise shall be made between system protection and service continuity.
         2) System protection and service continuity shall be considered to be of equal importance.
      c. A one-line diagram shall be prepared to show the electrical system buses, generator, transformers and protective devices.
      d. Manufacturer's data for the actual proposed protective devices shall be utilized.
      e. Summarize the coordination study, conclusions and recommendations.
         1) As a minimum, include the following:
            a) The manufacturer's information used to prepare the study.
            b) Assumptions made during the study.
            c) Recommended taps and settings of all adjustable devices in tabulated form.
            d) Composite coordination time-current curves on log-log paper showing:

(1) That the settings for each protective device will provide protection and selectivity.
(2) Identify each curve.
(3) Cable and equipment damage points.
(4) Circuit interrupting device operating and interrupting times.
(5) One-line sketch of the part of the system being investigated.
(6) Include as many curves as possible on a graph while maintaining readability.

e) One-line sketch of the part of the system being investigated.
f) Include as many curves as possible on a graph while maintaining readability.

f. Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
g. Advise the Engineer of potential coordination problems discovered during the study and include recommendations to resolve the problem.

B. Submit the reports for approval 90 days prior to equipment energization.

## 1.6 ARC FLASH STUDY

A. Perform arc flash hazard studies after the short circuit and protective device coordination studies have been completed.

B. For each major part of the electrical power system, determine the following:
1. Flash hazard protection boundary.
2. Limited approach boundary.
3. Restricted approach boundary.
4. Incident energy level.
5. PPE hazard/risk category.
6. Type of PPE required.

C. Produce arc flash warning labels listing items B 1-6 from above.
1. Also include the bus name and voltage.

D. Produce bus detail sheets that list the items B 1-6 from above and the following additional items:
1. Bus name.
2. Upstream protective device name, and type.
3. Bus line to line voltage.

E. Produce an arc flash evaluation summary sheet listing the following additional items:
1. Bus name matching existing and contract document identification numbers.
2. Upstream protective device name, and type.
a. Numbering shall match existing and contract document identification numbers.
3. Bus line to line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Solidly grounded column.
10. Equipment type.
11. Gap.
12. Arc flash boundary.
13. Working distance.
14. Incident energy.
15. Required protective fire rated clothing type and class.

F. Analyze the short circuit, protective device coordination and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation.

1. Propose approaches to reduce energy levels. Where possible the hazard/risk category shall be reduced to Category 2 and still maintain proper coordination through the means of resetting of breakers and relays.

G. Provide detailed one line diagrams for the entire plant.

### 1.7 ARC FLASH REPORT

A. Prepare a report summarizing the arc flash study and conclusions or recommendations which may affect the integrity of the electric power distribution system.

B. A qualified engineer must perform arc flash calculations to determine the incident energy, arc flash boundary, and minimum PPE requirements for locations throughout the power system.
   1. Arc flash warning labels shall be produced and attached to the electrical equipment by the Contractor.
   2. These labels must indicate approach boundaries, incident energy level, and the minimum PPE that is required when servicing the equipment within the arc flash boundary.

C. As a minimum, include the following in the report:
   1. Equipment manufacturer's information for the equipment installed.
   2. Assumptions made during the study.
   3. Reduced copy of the one line drawing.
   4. Arc flash evaluations summary spreadsheet.
   5. Bus detail sheets.
   6. Arc flash warning labels printed in color on adhesive backed labels.

D. Submit report 90 days before energizing electrical equipment.
   1. Labels shall be affixed on all new equipment prior to the new equipment being energized.

## PART 2 - PRODUCTS

### 2.1 LABELS

A. Provide weatherproof labels for equipment mounted outdoors.

B. Contractor shall apply the labels to all equipment on the project per the Arc Flash Study.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Perform each arc flash study in accordance with NFPA 70E, OSHA 29-CFR, Part 1910 Subpart S, and IEEE 1584 Standards.

B. Perform the studies using actual equipment data for the equipment provided.
   1. Provide data from the manufacturer of the protective relays, circuit breakers, fuses, devices, etc. provided by the contractor's subcontractors and vendors.

C. Provide arc flash warning labels on equipment as specified in this Section.
   1. Labels shall be printed in color on adhesive backed labels, UV resistant.
   2. Contractor shall apply labels on specific equipment in the field.

D. Set all low voltage circuit breakers settings/ratings as determined by the coordination study. Fuse ratings on equipment shall be based on the coordination study.

E. Provide a list of lockout and tagout devices that are compatible with the equipment.

F. Note: City of Ashland does not have a voltage level that they can't work on hot. City always deenergizes and performs LOTO per Oregon OSHA and City of Ashland policies, unless deenergizing is not possible.

**END OF SECTION**

# SECTION 26 08 13
ACCEPTANCE TESTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 26 32 14 - Engine Generator - Diesel.
   5. Section 26 99 00 – Photovoltaic Modules.
   6. Section 26 99 03 – Inverters.
   7. Section 26 99 04 – Meteorology Station System Description.
   8. Section 40 63 43 – PV SCADA Control System.
   9. Section 48 14 10 – PV Module Support Structures.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   2. Nationally Recognized Testing Laboratory (NRTL).
   3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Testing firm qualifications: See Specification Section 01 61 03.
   2. Field personnel:
      a. See Specification Section 01 61 03.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.
   3. Analysis personnel:
      a. See Specification Section 01 61 03
         As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03 for electrical equipment and connection testing plan submittal requirements.

B. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Prior to energizing equipment:
   a. Coordinated phasing diagram.
   b. Photocopies of continuity tests for all circuits connected to switchboards and motor control centers.
3. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
   a. Single report containing information including:
      1) Summary of Project.
      2) Information from pre-energization testing.
      3) See testing and monitoring reporting requirements in Specification Section 01 61 03.
      4) Forms documenting each inspection and test performed.

## PART 2 - PRODUCTS

### 2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 01 61 03.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

A. General:
   1. See Specification Section 01 61 03.
   2. Complete electrical testing in three phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   3. Perform testing in accordance with this Specification Section and NETA ATS.
   4. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.

B. Equipment Monitoring and Testing Plan: See Specification Section 01 61 03.

C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 01 61 03.

D. Testing and Monitoring Program Documentation: See Specification Section 01 61 03.

E. Electrical Equipment and Connections Testing Program:
   1. See Specification Section 01 61 03.
   2. See individual Division 26 Specification Sections for equipment specific testing requirements.
   3. Test all electrical equipment.
      a. Perform all required NETA testing.
      b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

### 3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchboards:
   1. Perform inspections and tests per NETA ATS 7.1.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
    a. Weatherproof switchgear/switchboards:
        1) Verify correct location, operation and current draw of heaters.
        2) Verify correct operation of thermostat.

B. Transformers - Small Dry Type:
1. Perform inspections and tests per NETA ATS 7.2.1.1.
2. Perform the following additional tests:
    a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2 PCT of nominal under normal load after approval of Engineer.
4. Record as-left tap connections.

C. Transformers - Large Dry Type:
1. Perform inspections and tests per NETA ATS 7.2.1.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
    a. Excitation current.
    b. Winding resistance.
    c. Overpotential.
4. Perform the following additional tests:
    a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
5. Adjust tap connections as required to provide secondary voltage within 2-1/2 PCT of nominal under normal load.
6. Record as-left tap connections.

D. Transformers - Liquid Filled:
1. Perform inspections and tests per NETA ATS 7.2.2. except the following:
    a. Bushing power factor.
    b. Core insulation resistance.
    c. Dissolved gas analysis.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
    a. Excitation current.
    b. Optional oil tests.
4. Perform the following additional tests:
    a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
5. Adjust tap changer setting as required to provide secondary voltage within 2-1/2 PCT of nominal under normal load after approval of Engineer.
6. Record as-left tap changer setting.

E. Cable - Low Voltage:
1. Perform inspections and tests per NETA ATS 7.3.2.

F. Cable - Medium Voltage:
1. Perform inspections and tests per NETA ATS 7.3.3.
2. Perform Dielectric Withstand Test.
3. Perform tan delta or partial discharge Baseline Diagnostic Tests.
4. Non-destructive partial discharge (PD) test:

a. After energization, perform a partial discharge test for baseline data for future partial discharge maintenance testing.
b. Perform the work while the medium voltage circuits and equipment are energized.
   1) The cables shall not be disconnected or de-energized and the testing shall not expose the cables to voltages that exceed normal operating voltage.
c. Use a frequency domain detection process incorporating a spectrum analyzer with radio frequency current transformer (RF CT) sensors.
   1) The detection system, including spectrum analyzer, RF CT's and interconnecting cable, shall have a partial discharge detection range that at least covers the frequency range of 10 kHz to 300 MHz.
   2) Testing shall be performed in a manner that complies with the requirements of IEEE 400 and IEEE 400.3.

G. Cable - Optical Fiber:
1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
   a. Optical time domain reflectometer test.
   b. Power attenuation test.
   c. Gain margin test.

H. Low Voltage Power Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.2.
   a. Tests shall include primary current injection testing of all breakers at final settings.
   b. Where short-time or instantaneous settings on large frame breakers are beyond the current capability of field testing, primary injection tests at reduced currents shall be permitted if combined with secondary injection calibration test of trip unit at final settings.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
   a. Control wiring insulation resistance.
4. Perform the following additional tests:
   a. Shunt trip devices minimum tripping voltage.
5. Record as-left settings.

I. Low Voltage Molded Case Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.1.
2. Components:
   a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
   c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

J. Network Protectors:
1. Perform inspections and tests per NETA ATS 7.8.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform all tests identified as optional per NETA ATS:
4. Perform the following additional tests:
   a. Verify reverse current sensitivity by opening transformer primary switch with feeder energized and no load on transformer and observing that network protector opens on magnetizing current alone.

K. Protective Relays:
1. Perform inspections and tests per NETA ATS 7.9.

a. Tests to be performed using secondary injection of 3 PH current and potential at final settings.
b. Test at manufacturer's recommended test points and critical timing points identified on relay setting sheet.

2. Perform all tests identified as optional per NETA ATS.
3. Perform the following additional tests:
   a. Verification of direct trip of associated lockout relay or circuit breaker(s) by using relay test function or shorting trip contact at relay case.
   b. Microprocessor-based relays:
      1) Complete commissioning procedure per manufacturer's instructions, followed by tests of each relay element at final settings.
      2) Verification of all internally-programmed logic.
   c. Verification of all auxiliary input and output signals.
   d. Verification of power supply/self-diagnostic alarm contact and remote annunciation.
4. Record as-left settings.

L. Instrument Transformers:
   1. Perform inspections and tests per NETA ATS 7.10.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Dielectric withstand test on potential transformers.

M. Metering:
   1. Perform inspections and tests per NETA ATS 7.11.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

N. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

O. Ground Fault Protection:
   1. Perform inspections and tests per NETA ATS 7.14.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
   4. Perform the following additional tests for four-wire systems:
      a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
      b. Verify no tripping for unbalanced load on each feeder and each main breaker.
      c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
      d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
      e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

P. Motors:
   1. Perform inspections and tests per NETA ATS 7.15.
   2. See Specification Section 01 61 03.

Q. Motor Control Equipment (Motor Control Centers):
   1. Perform inspections and tests per NETA ATS 7.16.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

R. Variable Frequency Drives:
   1. Perform inspections and tests per NETA ATS 7.17.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

S. Generators:
   1. Perform inspections and tests per NETA ATS 7.15.2.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following additional tests:
      a. Load and cycle crank test per Specification Section 26 32 14.
      b. Perform additional tests per Specification Section 26 32 14.

T. DC Power Systems:
   1. Perform inspections and tests per NETA ATS 7.18.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Cell impedance test.

U. PV Inverter:
   1. Perform inspections and tests per NETA ATS 7.18.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform all tests as recommended by inverter manufacturer.

V. PV Modules:
   1. Perform inspections and tests per NETA ATS 7.18.
   2. Perform and record all I-V curves on all PV strings.

W. PV Racking:
   1. Perform inspections and tests per NETA ATS 7.18.
   2. Perform all tests as recommended by racking manufacturer.

X. SCADA System:
   1. Perform and verify entire SCADA system configuration.
   2. Check the fiber optic infrastructure and loop connections associated with the SCADA.
   3. Verify functionality of all external device connections to the SCADA system such as inverter step-up transformer monitoring, meteorology sensor, pyranometer, wind speed sensor and other additional devices as required.

Y. Control System Functional Test:
   1. Perform test upon completion of equipment acceptance tests.
   2. The test is to prove the correct interaction of all sensing, processing and action devices.
   3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
   4. Perform the following tests:
      a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
      b. Verify the correct operation of all sensing devices, alarms and indicating devices.

**END OF SECTION**

# SECTION 26 09 13
## ELECTRICAL METERING DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Digital metering equipment.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.
   5. Section 26 24 43 – Switchboards
   6. Section 26 24 16 - Panelboards

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.13, Standard Requirements for Instrument Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.
   4. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Electrical wiring/connection diagrams.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Content of Operation and Maintenance Manual:
         1) Data sheet of the meters electrical parameters, configuration and characteristics including a complete model number and associated equipment connected too.
         2) Operating instructions of the meter(s) supplied.
         3) Operating instructions of the Power Management software.
         4) Maintenance instructions.
         5) As-constructed electrical wiring/connection diagrams.
         6) Acceptance testing data.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton.
   3. Electro Industries.
   4. General Electric Company.
   5. Power Measurement.
   6. Square D Company.
   7. Siemens.
   8. Or approved equal

### 2.2 DIGITAL METERING PACKAGE

A. General:
   1. Direct reading metered or calculated values.
   2. Microprocessor based.
   3. Integral LED or LCD display.
   4. Current and potential transformers as required.
   5. Integral fusing.
   6. Operating temperature: 0 DEGF to 150 DEGF.
   7. Network communications capability:
      a. Provide each meter with communication card, protocol and required programming for digital communication of all parameters to plant control system via:
         1) EtherNet/IP.
   8. Standards:
      a. NEMA/ANSI C12.20.
      b. UL 508.

B. Type 'C' High Range Meter:
   1. Display the following minimum electrical parameters (accuracy):
      a. RMS current per phase (+0.2 PCT full scale).
      b. RMS voltage line-to-line and line-to-neutral (+0.2 PCT full scale).
      c. Real power (W): 3 PH total (+0.4 PCT full scale).
      d. Apparent power (VA): 3 PH total (+0.4 PCT full scale).
      e. Reactive power (VAR): 3 PH total (+0.4 PCT full scale).
      f. Power factor (+1.0 PCT).
      g. Frequency (+0.04 PCT).
      h. Percent current individual harmonic and total harmonic distortion (50th).
      i. Percent voltage individual harmonic and total harmonic distortion (50th).
      j. Watt-hours (0.5 PCT).
      k. VAR-hours (1.0 PCT).
      l. VA-hours (0.5 PCT).
      m. Ampere demand (+0.2 PCT full scale).
      n. Watt demand (+0.4 PCT full scale).
      o. VAR demand (+0.4 PCT full scale).
      p. VA demand (+0.4 PCT full scale).
      q. Phaser diagram.
   2. Data logging:
      a. 128 KB.
      b. Selectable for parameters listed above for display.
      c. Software for configuration, retrieval, and trending.
   3. NEMA/ANSI C12.20, Class 0.2 revenue accuracy.
   4. Communication ports and protocols: EtherNet/IP.

5. Supply voltage: 120 VAC.
6. Provide smart power monitor, digital, with data communications to SCADA. Install at a readable height inside the switchboard, MCC or panelboard.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a complete and functioning system.
   2. Coordinate with the Owner on final computer screen layouts, trending requirements and printouts.
   3. Power quality meters to be installed by switchboard or panelboard manufacturers and provided by switchboard or panelboard manufacturer.

B. Meter Type Application:
   1. Type C meters: Integral to equipment as indicated on the Drawings.

C. Configure the meter to gather the following:
   a. Watt-hours.
   b. VAR-hours.
   c. VA-hours.
   d. Ampere demand.
   e. Watt demand.
   f. VAR demand.
   g. VA demand.
   h. Event capture

D. Communication Configuration:
   1. As indicated on the Drawings.
   2. Connect each meter to the plant control system.

### 3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Section 26 08 13.

### 3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 2 HRS of on-site training in the operation and maintenance of the metering system and its components.

**END OF SECTION**

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# SECTION 26 09 16
## CONTROL EQUIPMENT ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Industrial Control Panels.
   4. Operator Control Stations.
   5. Limit Switch Components:

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
      c. ICS 5, Control Circuit and Pilot Devices.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.
      c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

### 1.3 SYSTEM DESCRIPTION

A. This Specification specifies components used within other equipment as referenced in other technical specifications.

B. This Specification is used to specify the components and construction of following Operator Control Stations.

C. This Specification is used to specify the components and construction of Industrial Control Panels.

D. Vendor control panels (VCPs) shall be built per these specifications at a minimum.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
         1) When components are used within equipment specified in another Section, submittal data for components specified herein shall be included with the submittal for the equipment the components are used in.
      b. Industrial Control Panel bill of material.
      c. Control Station bill of material.
      d. See Section 26 05 00 for additional requirements.

3. Fabrication and/or layout drawings.
    a. Industrial Control Panel:
        1) Interior and exterior layout.
        2) Wiring/connection diagrams.
        3) Copy of the UL 508A label.
        4) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.
    b. Operator Control Station:
        1) Interior (if applicable) and exterior layout.
        2) Wiring/connection diagrams.
    c. Provide a table that associates Industrial Control Panel and Operator Control Stations with associated equipment name and tagging.

B. Informational Submittals:
1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Functional Test Plan.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
    b. Content of Operation and Maintenance Manual:
        1) Product technical data of components used within Industrial Control Panels and Operator Control Stations.
        2) As-constructed wiring/connection diagrams for Industrial Control Panels and Operator Control Stations.
        3) Operating instructions for time clocks.
        4) Functional Test Report.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pilot devices, relays, contactors, and termination equipment:
    a. Allen-Bradley by Rockwell Automation, Inc.
    b. ASCO by Emerson Electric Co.
    c. c3controls.
    d. Eaton.
    e. General Electric.
    f. IDEC Corporation.
    g. Phoenix Contact.
    h. Schneider Electric.
    i. Siemens Corporation.
    j. Time Mark Corporation.
    k. Or approved equal.
2. Photocells and time clocks:
    a. Grasslin by Intermatic.
    b. Tork by NSi Industries.
    c. Intermatic.
    d. Paragon Auto Control.
    e. Or approved equal.
3. Alarm devices:
    a. Edwards Signaling by United Technologies Corp.

b. Federal Signal Corporation.
c. Or approved equal.

4. Enclosures:
   a. Hoffman Engineering.
   b. Wiegmann by Hubbell.
   c. B-Line by Eaton.
   d. Adalet.
   e. Stahlin by Robroy Enclosures.
   f. Or approved equal.

## 2.2 PILOT DEVICES

A. General Requirements:
   1. Standards: NEMA ICS 5, UL 508.
   2. Heavy-duty NEMA 4/13 watertight/oiltight.
   3. Heavy-duty NEMA 4/4X corrosion resistant.
   4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
   5. Mounting hole: 30.5 MM.
   6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
   7. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
   1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
   2. Maintained contact type.
   3. Knob or lever type operators.

C. Pushbuttons:
   1. Non-illuminated type:
      a. Protective boot.
      b. Momentary contact.
      c. Standard flush and mushroom operators.
      d. Green colored buttons for START or ON and red color for STOP or OFF..
      e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.
   2. Illuminating type:
      a. Protective boot.
      b. Momentary contact.
      c. Standard flush operator.
      d. Serves as both pushbutton control and indicating light.
      e. Green colored lenses: START or ON.
      f. Red colored lenses: STOP or OFF.
      g. Resistor-type full voltage light unit with lens and panel gasket.

D. Indicating Lights:
   1. Allowing replacement of bulb without removal from control panel.
   2. Lamp: LED, 120 V or 24 V as required.
   3. Full voltage type.
   4. Push-to-test indicating lights.
   5. Plastic lens.
   6. Color code lights as follows:
      a. Green: ON or running; valve open.
      b. Amber: Alarm, Fail status.
      c. Red: OFF or stopped; valve closed.
      d. White: Power available and ready.

## 2.3 RELAYS

A. General Requirements:

1. Standards: NEMA ICS 5, UL 508.

B. Control Relays:
   1. General purpose (ice cube) type:
      a. Plug-in housing.
      b. Clear polycarbonate dust cover with clip fastener.
      c. Coil voltage: 120 VAC or as required.
      d. Contacts:
         1) 10 amp continuous.
         2) Silver cadmium oxide.
         3) Minimum of 3 SPDT contacts.
      e. Sockets: DIN rail mounted.
      f. Internal neon or LED indicator is lit when coil is energized.
      g. Manual operator switch.
   2. Industrial type:
      a. Coil voltage: 120 VAC or as required.
      b. Contacts:
         1) 10 amp, NEMA A600 rated.
         2) Double break, silver alloy.
         3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
         4) Expandable from 2 poles to 12 poles.
      c. Provide contacts for all required control plus two spares.

C. Time Delay Relays:
   1. General purpose type:
      a. Timing modes: On and Off delay, interval, one shot and repeat cycle.
      b. Plug-in housing.
      c. Polycarbonate dust cover with clip fastener.
      d. Coil voltage: 120 VAC or as required.
      e. Contacts:
         1) 10 amp continuous.
         2) Silver cadmium oxide.
         3) Two normally open and two normally closed DPDT contacts.
      f. Sockets: DIN rail mounted.
      g. External timing adjustment knob.
      h. Timing ranges: 0.05 seconds to 16.65 HRS.
      i. Repeat accuracy: +1 PCT.
   2. Solid State industrial type:
      a. Timing modes: On and Off delay and repeat cycle.
      b. Industrial housing.
      c. Coil voltage: 120 VAC or as required.
      d. Contacts:
         1) 5 amp, NEMA B150 rated.
         2) Silver alloy.
         3) Convertible On Delay and Off Delay contacts.
         4) One normally open and one normally closed timed contacts.
         5) One normally open and one normally closed instantaneous contacts.
      e. Furnish with "on" and "timing out" indicators.
      f. External timing adjustment knob.
      g. Timing ranges: 0.05 seconds to 10 HRS.
      h. Repeat accuracy: +1 PCT.
   3. Mechanical industrial type:
      a. Timing modes: On and Off delay.
      b. Coil voltage: 120 VAC or as required.
      c. Contacts:

1) 10 amp, NEMA A600 rated.
2) Double break, silver alloy.
3) Convertible On Delay and Off Delay contacts.
4) Convertible normally open and normally closed timed contacts.
5) Convertible normally open instantaneous contacts.

d. External timing adjustment knob.
e. Timing ranges: 0.2 - 60 seconds or 5 - 180 seconds.
f. Repeat accuracy: Greater than +10 PCT.

## 2.4 CONTACTORS

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.

B. Lighting and Remote Control Switches:
1. Electrically operated, electrically held.
2. Coil voltage: 120 VAC or as required.
3. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
4. Rated for ballasted lighting, tungsten and general use loads.
5. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
6. Auxiliary control relays, as indicated on Drawings or as specified.
7. Auxiliary contacts, as indicated on Drawings or as specified.

C. Definite Purpose:
1. Coil voltage: 120 VAC or as required.
2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
3. Resistive load and horsepower rated.
4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
5. Auxiliary contacts, as indicated on Drawings or as specified.

## 2.5 PHOTOCELLS AND TIME CLOCKS

A. Photocells:
1. Weatherproof enclosure.
2. Adjustable turn-on range, initially set at 1.0 foot-candles.
a. Turn-off level approximately three times turn-on.
3. Provide time delay device to eliminate nuisance switching.
4. Voltage, amperage and/or wattage ratings as required for the application.

B. General Requirements for Time Clocks:
1. Separate manual on-off operation without disturbing automatic settings.
2. Enclosure:
a. NEMA 1 for indoor locations.
b. Stand alone or DIN rail for mounting in control panel.
c. NEMA 3R or 4 for exterior locations.
3. Voltage, amperage and/or wattage ratings as required for the application.

C. Astronomical Clocks:
1. Adjustable for the installed latitude.
a. Settings for astro on/astro off, astro on/time off or time on/astro off.
2. 365 day programmable using solid state technology with block programming.
3. Minimum of 72 HR carryover power utilizing rechargeable battery or capacitor.
4. Minimum of 48 events per week, 16 individual holiday overrides daylight savings or standard time selectable, automatic leap year correction.

## 2.6 ALARM DEVICES

A. Alarm Horns:

1. Vibrating horn type.
2. PLC compatible as required.
3. Heavy-duty die cast housing with corrosion resistant finish.
4. Adjustable volume: 78 to 103 dB at 10 FT.
5. Voltage: 120 VAC or as required.
6. Enclosures/mountings:
    a. Flush wall or panel mounting in dry areas.
    b. NEMA 4X panel mounting in wet areas.
    c. Surface mounting in dry areas.
    d. NEMA 4X surface mounting in wet areas.
    e. NEMA 4X, hazardous location surface mounting in wet and hazardous areas.
        1) Fixed volume: 97 dB at 10 FT.

B. Alarm Lights:
1. Panel mounted:
    a. Strobe type.
    b. Shatter resistant polycarbonate lens and base.
    c. Lens color as indicated on Drawings.
    d. NEMA 4X enclosure.
    e. PLC compatible.
    f. Voltage: 120 VAC.
2. Wall mounted:
    a. Heavy-duty strobe type.
    b. Weatherproof shatter resistant polycarbonate lens and cast base.
    c. Optically designed fresnel lens with color as indicated on Drawings.
    d. Immune to shock and vibration, no moving parts.
    e. Xenon flash tube providing a minimum of 65 single flashes per minute.
    f. Mounting: Wall or corner wall brackets.
3. Hazardous and corrosive locations:
    a. Heavy-duty strobe type.
    b. Weatherproof and rated for the indicated hazardous location.
    c. Body: Zinc plated cast iron or cast copper free aluminum and/or coated with 20 mils of PVC.
    d. High impact glass dome with guard.
    e. Shatter resistant polycarbonate lens with color as indicated on Drawings.
    f. Immune to shock and vibration, no moving parts.
    g. Xenon flash tube providing a minimum of 65 single flashes per minute.
    h. Mounting: Wall bracket or pendant.

## 2.7 MISCELLANEOUS DEVICES

A. Run Time Meters:
1. Six-digit wheels including a 1/10 digit.
2. Non-reset type.
3. Time range in hours.
4. Automatic recycle at zero.
5. Accuracy: 1 PCT.
6. Sealed against dirt and moisture.
7. Tamperproof.

B. Control Power Transformer:
1. Primary voltage: 480 V.
2. Secondary voltage: 120 V.
3. Sized for 125 PCT of required load.
4. Fused on primary and secondary.
5. Standard: NEMA ST 1.

## 2.8 TERMINATION EQUIPMENT

A. General Requirements:
   1. Modular type with screw compression clamp.
   2. Screws: Stainless steel.
   3. Current bar: Nickel-plated copper alloy.
   4. Thermoplastic insulation rated for -40 to +90 DEGC.
   5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
   6. End sections and end stops at each end of terminal strip.
   7. Machine-printed terminal markers on both sides of block.
   8. Spacing: 6 MM.
   9. Wire size: 22-12 AWG.
   10. Rated voltage: 600 V.
   11. DIN rail mounting.

B. Standard-Type Block:
   1. Rated current: 30 A.
   2. Color: Gray body.

C. Bladed-Type Disconnect Block:
   1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
   2. Rated current: 10 A.
   3. Color:
      a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
      b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-Type Block:
   1. Electrically grounded to mounting rail.
   2. Terminal ground wires and analog cable shields.
   3. Color: Green and yellow body.

E. Fuse Holders:
   1. Blocks can be ganged for multi-pole operation.
   2. Spacing: 9.1 MM.
   3. Wire size: 30-12 AWG.
   4. Rated voltage: 300 V.
   5. Rated current: 12 A.
   6. Fuse size: 1/4 x 1-1/4.
   7. Blown fuse indication.
   8. DIN rail mounting.

## 2.9 ENCLOSURES

A. Industrial Control Panels:
   1. NEMA 4 rated:
      a. Seams continuously welded and ground smooth.
      b. No knockouts.
      c. External mounting flanges.
      d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
      e. Cover with oil resistant gasket.
   2. NEMA 4X rated:
      a. Body and cover: 14 GA Type 316 stainless steel.
      b. Seams continuously welded and ground smooth.
      c. No knockouts.
      d. External mounting flanges.
      e. Hinged door and stainless steel screws and clamps.
      f. Door with oil-resistant gasket.

3. NEMA 7 and 9 rated:
    a. Cast gray iron alloy or copper-free aluminum.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
    d. External mounting flanges.
    e. Grounding lug.
    f. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.
4. NEMA 12 enclosure:
    a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts.
    c. External mounting flanges.
    d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
    e. Flat door with oil resistant gasket.
5. Control panel miscellaneous accessories:
    a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
    b. Interiors shall be white or light gray in color.
    c. Wire management duct:
        1) Bodies: PVC with side holes.
        2) Cover: PVC snap-on.
        3) Size as required.
    d. Rigid handles for covers larger than 9 SQFT or heavier than 25 LBS.
    e. Split covers when heavier than 25 LBS.
    f. Floor stand kits made of same material as the enclosure.
    g. Weldnuts for mounting optional panels and terminal kits.
    h. Ground bonding jumper from door, across hinge, to enclosure body.
6. Standards: NEMA 250, UL 508.

B. Operator Local Control Stations:
1. NEMA 4/13 rated:
    a. Die cast aluminum body with manufacturer's standard finish.
    b. Gasketed die cast aluminum cover with manufacturer's standard finish.
    c. Number of device mounting holes as required.
2. NEMA 4X rated:
    a. Type 304 or 316 stainless steel body.
    b. Gasketed Type 304 or 316 stainless steel cover.
    c. Number of device mounting holes as required.
3. NEMA 7 and 9 rated:
    a. Zinc plated cast iron or die-cast copper free aluminum, with threaded hubs, grounding screw and with manufacturer's standard finish.
    b. "EDS" or "EFS" style.
    c. Single or multiple gang or tandem.
    d. Accessories: 40 MIL PVC exterior coating and 2 MIL urethane interior coating.

## 2.10 FABRICATION

A. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A or UL 698A.
1. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
2. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
    a. Determine the SCCR rating by one of the following methods:

1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.

b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.

3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

## 2.11 LIMIT SWITCH COMPONENTS

A. Personnel Door Switches, Surface-Mounted:
1. Acceptable Manufacturers:
a. GE – Sentrol 2707AD.
2. Design and fabrication:
a. High security surface mount.
1) Switch includes a supervised loop with a magnetic tamper feature.
2) Switch includes a pry tamper connection.
b. Switch contains six independent Form C biased reed contacts, wired in DPDT configuration.
c. Brushed anodized aluminum housing.
d. Gap distance: 0.2 to 0.6 IN.
e. Three foot stainless steel armored cable.
f. Contact rating:
1) Voltage: 30V AC/DC maximum.
2) Current: 0.25A maximum.
3) Power: 3.0 W maximum.
g. Use approved contacts for fire rated doors.
h. UL Listed.

B. Overhead Door Magnetic Door Position Switches:
1. Acceptable Manufacturers:
a. GE – Sentrol 2507AH.
2. Design and fabrication:
a. Industrial wide gap surface mount.
b. High security biased.
c. Anodized aluminum cover.
d. Hermetically sealed reed switch.
e. Gap distance: 0.75 to 2.0 IN.
f. Three foot stainless steel armored cable.
g. Form C contact:
1) Voltage: 30V AC/DC maximum.
2) Current: 0.25A maximum.
3) Power: 3.0 W maximum.
h. Provide and use specific mounting hardware recommended by the switch manufacturer.
i. UL Listed.

C. Hatch Limit Switches:
1. Acceptable Manufacturers:
a. GO Switch 80 Series with AMC5 target magnet
2. Design and Fabrication:
a. General:
1) Function: indicate open/closed position of doors, hatches, panels, etc.
2) Type: limit switch with magnetic actuator.
3) Parts: limit switch body, target magnet.

b. Features:
    1) Brass housing.
    2) Sensing range: up to 3-7/8 IN.
    3) Target magnet: ferrous type.
    4) Lead wires: #18 AWG, potted-in SO rubber covered cable and 36 IN length.
c. Signal Interface:
    1) Type: SPDT Form C contacts.
    2) Rating: 5 amperes at 120VAC.
        a) 5A at 120 VAC.
        b) 3A at 24 VDC.
    3) Contact material: silver cadmium oxide, gold flashed.
d. Enclosure: NEMA 4.
e. UL Listed.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
    1. Size as required to mount the equipment.
    2. Permitted uses of enclosure types:
        a. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.

C. Operator Control Stations:
    1. Permitted uses of enclosure types:
        a. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.

### 3.2 FIELD QUALITY CONTROL

A. See Section 26 05 00.

B. Industrial Control Panel(s) and Operator Control Station Functional Test:
    1. The test is to prove the correct interaction of all sensing, processing and action devices.
    2. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
        a. Plan shall have witness signature lines for the contractor and engineer or owner's and submitted when system pass the test.
    3. Perform the following tests:
        a. Verify functionality of all control states.
        b. Verify the correct operation of all interlock safety devices for fail-safe functions
        c. Verify the correct operation of all sensing devices, alarms and indicating devices.

### 3.3 TRAINING

A. A qualified supplier representative shall provide the Owner with on-site training in the operation and maintenance of the Industrial Control Panel(s) and its components.

**END OF SECTION**

# SECTION 26 09 43
## LOW VOLTAGE LIGHTING CONTROL SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Design and Provide Low Voltage Lighting Control System.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 13 - Special Construction.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.
   6. Section 26 27 26 - Wiring Devices.
   7. Section 26 09 16 - Control Equipment Accessories.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017:
         1) Article 725, Class 1, Class 2, Class 3 Remote-Control, Signaling, and Power-Limited Circuits.
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

### 1.3 SYSTEM DESCRIPTION

A. Design and provide a low voltage switching system consisting of low voltage relay panels, momentary contact switches, intelligent switches, and photocells.

B. All relay panels to be interconnect by a digital communication system.

C. Provide 24 VDC switching for areas indicated on plans.

D. Switching system shall be complete and conform to NEC Article 725 for Class 2 wiring.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Wiring diagrams for all components including, but not limited to, relay panels, relays, low voltage switches and photocells.
      b. One-line diagram of the system configuration.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Low voltage switching system components:
      a. Cooper Controls.
      b. Lighting Control and Design (LC&D).
      c. Watt Stopper.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 COMPONENTS

A. Relay Panels:
   1. Modular relay panels:
      a. Tub: Empty NEMA 1 enclosure that can accept an interior sized to accept up to 12, 24, or 48 mechanically latching relays.
      b. Power supply:
         1) Transformer assembly with two, 40VA transformers with separate secondaries.
         2) Transformers include internal overcurrent protection with automatic reset and metal oxide varistor protection against power line spikes.
         3) Supply voltage: 120 or 277 VAC as required, 60 Hz ±10 PCT.
      c. Cover: Surface or flush as required, with captive screws in a hinged, lockable configuration.
      d. Interior:
         1) Bracket and intelligence board backplane with pre-mounted relays.
         2) Interiors shall be provided with up to 12, 24, or 48 installed and tested relays.
      e. Panel shall be provided with an integral DIN rail mounting bar for easy installation of other system components (such as a time clock and/or photocell controller).
         1) Terminals shall be included in the interior to accept a data line for the connection of data line switches to the system, or to allow a data line to be run between multiple panels for network communications.
      f. Eight channels for grouping relays shall be provided in each interior regardless of size, each with an associated pushbutton to toggle the channel ON/OFF, and a terminal block for a separate dry contact input.
         1) Any number of relays in the panel can be assigned to each channel, with overlapping allowed.
         2) Set up channels via the data line to main computer, i.e., no hand held programmer or keypad is required.
         3) Provide LED status indication for each channel pushbutton:
            a) RED: All relays within the channel group are ON.
            b) No LED: All relays within the group are OFF.
            c) GREEN: The channel's relays are in a MIXED state (some OFF, some ON).
      g. Relays:
         1) Momentary-pulsed mechanically latching contactors with plug in connector.
         2) Mechanically latching contacts with single moving part design for improved reliability.
         3) Characteristics:
            a) Coil:
               (1) Magnetically held, momentary coil activation (50 milliseconds).
               (2) 2.2 VA max per relay to allow up to 20 relays to be controlled in parallel using Class 2 wiring.

(3) Split coil: 1/2 for ON, 1/2 for OFF.

b) Power contacts:

(1) 20 amp tungsten and NEMA electronic ballast rated.

(2) Rated for 50,000 ON/OFF cycles at full load.

(3) Support #10 - #14 AWG solid or stranded wire.

(4) 120 and 277 volt rated.

c) 30 VAC isolated contacts for status feedback and pilot light indication.

d) FCC approved for commercial and residential use.

h. Next to each relay shall be an individual override button and a bi-color LED to indicate status.

i. Panels shall support the "blink warning" function, with LED indication for each relay.

j. Captive screw terminations will be provided for all wiring connections.

k. Each channel button's dry control contact input terminal shall accept either 2- or 3-wire, maintained or momentary inputs.

1) They shall also accept a 2-wire toggling input.

l. Each channel shall also have an associated 1 amp, 30 VDC isolated contact which may be used for status feedback or pilot light control.

m. Each panel shall include simple dials for setting a 2-digit panel address.

n. The relay panel shall use an EEPROM to record the channel's wiring assignments and the current status of all relays, thus insuring a 20 year backup of information in the event of a power failure.

1) Systems that require a chargeable battery with less than 10 year's life shall not be allowed.

o. The unit shall provide LED status indication of the power supply status.

1) Access to 24 VAC and 24 V rectified power for accessory devices shall be provided within the panel.

p. The panel shall have an integrated DIN rail for mounting dataline control modules.

2. Interior shall use relays with an optional pilot contact to provide individual relay feedback to other control systems.

a. Terminal blocks shall be located next to each relay to allow standard low voltage switching devices to control the relay state.

b. Devices can be either 2 or 3-wire, maintained or momentary inputs.

c. They shall also accept a 2-wire toggling input.

B. Network Dataline:

1. The intelligence in multiple panels shall be linked over a single data line that uses the open Echelon/LonTalk® protocol for communications.

a. The data line shall provide a highly reliable communications bus for transferring control and status between the relay panels.

b. The data line shall not require any ancillary equipment to function properly.

2. The data line, in addition to linking together multiple relay panels, shall be capable of extending out from the electrical closet, and provide a single communications bus to allow data line switches to communicate with the panels.

3. The data line can also connect to a single Network Clock or a single BMS Interface Module mounted in the interior of a relay panel or a separate enclosure.

4. Dataline shall be 18/4 twisted conductor (two independent twisted pairs) meeting Class 2P NEC code requirements.

a. The data line can be run in a loop, serial, or star configuration.

b. Minimum one turn per 3 IN, 30 pF/FT maximum, per NFPA 262.

5. Maximum length for all data line wire in the system is 1,500 FT without repeaters.

6. Maximum number of data line devices (panels/switch units/controllers) is 64 without a repeater.

7. Provide the required network power supplies, option cards, RS232 converters and connectivity modules for connection to the Plants Ethernet/IP network.

C. Dataline Switches:

1. To allow individual overrides, data line switches shall be terminated to each panel's 4-wire local data line.
    a. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs.
    b. The single, dual, and quad devices shall mount in a standard single gang box.
        1) The octal version shall mount in a two-gang box.
2. Each button in a switch module can be individually programmed.
    a. Programming is done by data line rather than with a handheld keypad or computer.
    b. Each button can control any one of the following options:
        1) Any individual relay in any single panel.
        2) Any group of relays in any single panel.
        3) Any of the eight channels (A-H) in a single panel.
        4) The same channel letter (A-H) in multiple panels in the system (requires Network Clock or BMS Interface Module).
3. For applications that require pattern switching, any button can perform its function using a ON/OFF/Not Controlled pattern of relays instead of the normal All ON/ALL OFF.
4. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screwless Lexan wall plate.
5. Individual buttons shall have a removable clear cover to allow standard 3/8 IN labeling tape to be used to identify the controlled loads.
6. Each switch module shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays.
    a. LED indications are:
        1) RED for All ON.
        2) GREEN for Mixed State (some relays in the group ON and others OFF).
        3) No LED for All OFF.
7. Switch LED pilot lights shall flash GREEN to indicate impending off sweep during the five (5) minute grace period following blink warning of the lights.
    a. Once the button is pressed, the LED will change to RED to acknowledge the occupant's override command to keep lights ON.
8. Multiple data line switches wired to control the same relay or relay group shall indicate the same status automatically.
9. Each switch unit shall also include a locator light.
10. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state.
    a. Each switch's master button configuration can be altered to perform a master ON/OFF, OFF Only, or Disabled function if desired.
11. Switch modules can be configured to follow a "Cleaning" scenario.
    a. This specific scenario shall prevent the cleaners from overriding OFF any relays turned ON by the occupant.
12. Each switch module is available in a Keylock Override version.
    a. Once a key is inserted, the individual buttons will function for five minutes.

D. Momentary Contact Switches: See Specification Section 26 27 26.

E. Network Clock:
1. Using the same data line as mentioned above, provide a Network Clock.
    a. Network Clock can be used to schedule any of the eight global channel groups (A-H) in the relay panel network.
    b. Schedules are defined using Occupied versus Unoccupied (after-hours) times to simplify data entry.
2. Network shall include user-selectable intelligent scenarios to handle standard lighting control functions for each channel independently, including:
    a. Schedule ON / Schedule OFF.
    b. Manual ON / Schedule OFF.
    c. Photocell ON / Photocell OFF (with user selectable offsets).

d. Photocell ON / Schedule OFF (with user selectable offsets).
e. Manual ON / Multiple OFF Sweeps using Automatic Control Switch.

3. Network Clock shall automatically detect the presence of a data line Photocontrol Module and alter the Astronomic scenarios to Dark, accepting actual light level readings for the following scenarios:
   a. Dark ON / Dark OFF.
   b. Dark ON / Schedule OFF.
4. Each channel can be assigned a standard time delay from 1-240 minutes (4 HRS).
   a. During Occupied hours, the time delays do not take effect.
   b. During Unoccupied hours, the time delays will ensure that overridden lights are automatically turned off.
5. Each channel can be assigned an automatic blinking of the lights before they are turned off to allow occupants the opportunity to enter an override without being put in the dark.
6. Network Clock shall include a switch to change its function from Scheduling mode to Programming mode.
   a. In programming mode, the unit shall be able to wire relays to switch buttons or channels anywhere in the system using simple menus.
7. Network Clock shall include system diagnostic functions to identify devices anywhere on the network data line.
8. The Network Clock will provide a clear eight line, 22-character per line display and a simple user interface.
9. Network clock will take into account leap year, daylight savings time, and holidays.
10. The Network Clock will provide system diagnostics for all components connected to the system.
11. The Network Clock will allow the user to plug into each data line switch, run diagnostics, and reprogram the switch to any relay or channel.
12. The Network Clock shall retain memory and time for a minimum of 10 years.

F. Photocontrol Module:
1. A single photocell shall be mounted in an appropriate location for measuring exterior light levels.
   a. The sensor shall connect to a separate Photocontrol Module mounted on the DIN rail inside any panel via a single 20/4 shielded conductor with a maximum distance of 500 FT.
   b. The control unit shall connect to the network data line at any panel, and draw power from the data line, so no extra wires are required.
2. The Photocontrol Module shall be designed to integrate seamlessly with either the Network Clock or the BMS Interface module.
   a. Replacing the astronomic control function on the clock, the Photocontrol module shall measure the actual exterior light level.
   b. Each of the eight global channels shall have the ability to be assigned a different trip level.
3. Real time, 2-line LCD display of actual exterior light level up to 200 fc.
4. Channel set points and parameters programmed via the Network Clock or BMS Interface Module.
5. Choice of OPERATE or TEST modes, with simulated light level for testing.
6. Control unit detects and broadcasts "Dark" or "Not Dark" states for each channel to the panels.
7. Automatic dead band and five minute time delay to avoid nuisance switching.
8. LEDs for each channel show RED if dark (actual light level below set point); GREEN if above set point, OFF if not programmed.

G. Accessory Enclosure:
1. Enclosure for intrinsically safe barriers for light switches in hazardous areas.
   a. Control panel per Specification Section 26 09 16.
   b. Intrinsically safe barrier and power supply per the Drawings.

H. Software:
   1. Feature rich lighting control software for documenting, programming and controlling the lighting control system.
   2. Microsoft Windows based.
   3. Comprehensive activity logging and trend analysis.
   4. Real time graphics functions.
   5. Password protected.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a complete and fully-functioning system.

B. Switches and/or photocells shall be mounted as indicated on the Drawings.

C. Each low voltage wire shall be labeled clearly indicating which relay panel it connects to.

D. All relays and switches shall be tested after installation to confirm proper operation, and all connected loads shall be recorded on the relay schedule for each panel.

E. The relay panels shall be mounted in electrical rooms as indicated on the Drawings.
   1. The numbered relays in the panel shall be wired to control the power to each load as indicated on the Lighting Relay Panel Schedules.
   2. All power wiring will be identified with the circuit breaker number controlling the load.
      a. If multiple circuit breaker panels are feeding into a relay panel, wires shall clearly indicate the originating panel's designation.

F. Configuration:
   1. As indicated on the Drawings.
   2. One of the computers provided by Division 13 control system shall be configured with the control software.
      a. Provide technical assistance to the System Integrator as necessary to provide a functioning system.
   3. Configure the computer screens to display all data and trending from all the relay panels.

### 3.2 FIELD QUALITY CONTROL

A. Before installation, a factory authorized technician shall hold a training session with the installing contractor on the proper installation of all components.

B. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all system components.

C. Acceptance Testing: See Specification Section 26 08 13.

### 3.3 TRAINING

A. Manufacturer shall provide factory authorized application engineer to train Owner personnel in the operation and programming of the lighting control system.

## END OF SECTION

# SECTION 26 12 13
## POWER TRANSFORMERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Liquid-filled transformers.
   2. Dry-type transformers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 – Procurement and Contracting Requirements.
   2. Division 01 – General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. Department of Energy (DOE):
      a. 10 CFR 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers.
   3. Institute of Electronic and Electronics Engineers, Inc. (IEEE):
      a. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
      c. TR 1, Transformers, Regulators and Reactors.
   5. Underwriters Laboratories, Inc. (UL).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Technical data including assembly and component ratings.
      b. Nameplate drawing.
      c. Mounting and loading information.
      d. Installation instructions and procedures.
      e. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings:
      a. General arrangement.
      b. Elevation.
      c. Wiring diagrams for all accessories.
   3. Test reports:
      a. Factory tests.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 00 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. ABB.
   2. Eaton.
   3. Howard Industries, Inc.
   4. Siemens.
   5. Square D by Schneider Electric.
   6. WEG.
   7. Maddox.
   8. Or approved equal.

### 2.2 TRANSFORMER - LIQUID FILLED

A. General:
   1. Designed, constructed, and tested in accordance with applicable ANSI, NEMA and IEEE Standards.

B. Type:
   1. Outdoor.
   2. Liquid-filled.
   3. Self-cooled and forced-air cooled type.

C. Ratings:
   1. Operation and application: Step-down operation.
   2. Voltage and kVA ratings: As specified on the Drawings.
   3. Number of phases: 3.
   4. Frequency: 60 Hz.
   5. Polarity: ANSI standard.
   6. Percent impedance: ANSI standard.
   7. High voltage BIL: 95 kV.
   8. Low voltage BIL: 30 kV.
   9. Temperature rise: 55/65 DEGC.
   10. Sound levels: Per NEMA TR 1.
   11. Efficiency (minimum):
      a. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.
      b. 3 PH, 1500 - 2500 kVA: NEMA TP 1.
   12. Connections:
      a. Delta or wye: As indicated on the Drawings.
      b. Primary:
         1) Flange for flexible bus braid or cable connection to load interrupter switchgear.
      c. Secondary:
         1) Flange for flexible bus braid connection to switchboard.
   13. Tap-changer:
      a. De-energized type on H-winding, five total with:
         1) Two 2.5% above and two 2.5% below nominal tap.

D. Components:
   1. Windings: Aluminum or copper.
   2. Insulation system:
      a. Mineral oil liquid.
      b. Permanently affix nameplate to outside of tank stamped "Non PCB."
   3. Tank:
      a. Sealed-tank construction with welded main cover and bolted tamper-resistant handhole.
      b. Steel divider between high-voltage and low-voltage compartments.

c. No exposed screws, bolts, or other fastening devices that are externally removable.
d. No openings through which foreign objects such as sticks, rods, or wires may contact live parts.
e. Lifting hooks and loops.
f. Fill plug.
g. Drain valve with sampling device.
h. Dial type liquid thermometer with alarm contacts.
i. Magnetic liquid level gauge with alarm contacts.
j. Pressure vacuum gauge with alarm contacts.
k. Automatic pressure relief device.
l. Stainless steel NEMA 2-hole ground pads.

4. Cooling equipment:
   a. Radiators.
   b. Forced air package contains all necessary components and wiring for automatically increasing the kVA rating by 25%.
      1) The electronic temperature monitor and fan control unit shall:
         a) Digital readout.
         b) Indicating lights for power on, fan on and high temperature.
         c) Audible alarm with silence pushbutton.
         d) Maximum temperature memory.
         e) Auto/manual fan control switch.
         f) System test switch.
         g) Temperature sensing in all three low voltage coils.
         h) Auxiliary alarm contact for remote indication of alarm.
         i) Control power by control power transformer in secondary equipment.
5. Surge arrestors:
   a. Standards: IEEE C62.11.
   b. MCOV: As indicated on the Drawings.
   c. Metal oxide or zinc oxide type, distribution class.
   d. Installed under oil.
6. Finish:
   a. Manufacturer's standard corrosion protection system.
   b. Light gray.
7. Permanently affix nameplate.

## 2.3 TRANSFORMER - DRY TPYE

A. General:
   1. Designed, constructed and tested in accordance with applicable ANSI, NEMA and IEEE Standards.
   2. UL listed.

B. Type:
   1. Indoor.
   2. Coil assembly Vacuum Pressure Impregnated (VPI) polyester.

C. Ratings:
   1. Operation and application: Step-down operation.
   2. Voltage and kVA ratings: As specified on the Drawings.
   3. Number of phases: 3.
   4. Frequency: 60 Hz.
   5. Polarity: ANSI standard.
   6. Percent impedance: ANSI standard.
   7. High voltage BIL: 95 kV.
   8. Temperature rise: 65 DEGC.
   9. Sound levels: Per NEMA TR 1.
   10. Efficiency (minimum):

a. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.
b. 3 PH, 1500 - 2500 kVA: NEMA TP 1.

11. Connections:
    a. Delta or wye: As indicated on the Drawings.
    b. Primary:
        1) Flange for flexible bus braid or cable connection to load interrupter switchgear.
    c. Secondary:
        1) Flange for flexible bus braid connection to switchboard.
12. Tap-changer:
    a. De-energized type on H-winding, five total with:
        1) Two 2.5% above and two 2.5% below nominal tap.

D. Components:
1. Forced air package contains all necessary components and wiring for automatically increasing the kVA rating by 33%.
2. Electronic temperature monitor and fan control unit with:
    a. Digital readout.
    b. Indicating lights for power on, fan on and high temperature.
    c. Audible alarm with silence pushbutton.
    d. Maximum temperature memory.
    e. Auto/manual fan control switch.
    f. System test switch.
    g. Temperature sensing in all three low voltage coils.
    h. Auxiliary alarm contact for remote indication of alarm.
    i. Control power by separate external power source.
3. Insulation system:
    a. Inorganic material.
    b. Class H material for a fully rated 220 DEGC system.
4. Temperature rise: 115 DEGC at rated kVA.
5. Windings: Aluminum or copper.
6. Surge arrestors
    a. Standards: IEEE C62.11.
    b. kV Class: As indicated on the Drawings.
    c. Metal oxide type, distribution class.
7. Enclosure:
    a. NEMA 3R.
    b. Heavy gauge sheet steel with removable panels for access to the core and coils on the front and rear.
    c. Ventilated openings per NEMA standards.
    d. Provisions for rolling, skidding, lifting and jacking for installation.
8. Finish:
    a. Manufacturer's standard corrosion protection system.
    b. Light gray.
9. Permanently affix nameplate to outside of enclosure.
10. Accessories: Two ground pads.

## 2.4 SOURCE QUALITY CONTROL

A. Transformer factory tests in accordance with ANSI and IEEE standards:
1. No-load losses.
2. Excitation current.
3. Resistance measurement.
4. Ratio test.
5. Polarity and phase relations tests.
6. Impedance and load-loss.
7. Applied potential test.

8. Induced potential test.

### 2.5 MAINTENANCE MATERIALS

A. Touch-up paint.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Arrange as shown on the Drawings.

### 3.2 FIELD QUALITY CONTROL

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Acceptance tests: See Specification Section 26 08 13.

### 3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 4 HRS of on-site training in the operation and maintenance of the unit substation and its components.

**END OF SECTION**

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# SECTION 26 12 19
DISTRIBUTION TRANSFORMERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Distribution pad-mounted transformers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 – Procurement and Contracting Requirements.
   2. Division 01 – General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. Institute of Electronic and Electronics Engineers, Inc. (IEEE):
      a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
      b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
      c. C57.12.28, Standard for Pad-Mounted Equipment - Enclosure Integrity.
      d. C57.12.34, Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVa and Smaller) - High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below.
      e. C57.12.70, Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers.
      f. C57.12.80, Standard Terminology for Power and Distribution Transformers.
      g. C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
      h. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products including subcomponents specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings.
      a. Outline Drawing including dimensions, weight and identification of all components and features.
      b. Nameplate Drawing.
   4. Certifications:
      a. Letter stating compliance with current Department of Energy efficiency requirements.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Content of Operation and Maintenance Manual:
   1) Instruction and maintenance manual.
   2) Product technical data provided in the submittal.
   3) Outline drawing updated for as-built conditions.
   4) Nameplate Drawing updated for as-built conditions.
   5) Actual impedance data.
   6) Factory test report.
   7) Acceptance testing report.

C. Informational Submittals:
   1. Factory test report.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. ABB.
   2. Eaton.
   3. Howard Industries, Inc.
   4. Square D by Schneider Electric.
   5. WEG.
   6. Maddox.
   7. Or approved equal.

### 2.2 THREE-PHASE TRANSFORMER

A. General:
   1. Transformer to be designed and constructed in accordance with:
      a. IEEE C57.12.00, IEEE C57.12.28, C57.12.29 IEEE C57.12.34, IEEE C57.12.70, IEEE C57.12.80.

B. Ratings and Configurations:
   1. Type: Outdoor, pad-mounted, liquid-immersed, self-cooled, compartmental type.
   2. Operation and application: Step-down operation.
   3. Configuration:
      a. Dead-front, loop-feed primary.
   4. Voltage and kVA Ratings: As specified on the Drawings.
   5. Number of phases: Three.
   6. Frequency: 60 Hz.
   7. Polarity: ANSI standard.
   8. Percent impedance: ANSI standard.
   9. Basic impulse level (BIL):
      a. Primary: 95 kV.
      b. Secondary: 30kV.
   10. Temperature rise: 65/75 DEGC.
   11. Efficiency: Meet all current Department of Energy rules.
   12. Connections:
      a. Delta or Wye: As indicated on the Drawings.
      b. Primary: 200 ampere bushing wells and insert for loadbreak elbows.
      c. Secondary (480/277V):

1) Less than 500 kVA: Four-hole, tin plated, spade-type minimum or as required.
2) 750 - 1500 kVA: Six-hole, tin plated, spade-type minimum or as required.
3) 2000 kVA and greater: Twelve -hole, tin-plated, spade-type minimum or as required.
4) Removable ground strap on neutral terminal.

13. Tap-changer: De-energized type on H-winding, five total with:
    a. Two 2.5% above and two 2.5% below nominal tap.
14. Sectionalizing oil immersed load break primary switch:
    a. Rating: 200A.
    b. Two position, with the switch positions labeled:
        1) "XFMR OPEN" when the coil is de-energized.
        2) "XFMR CLOSED" when the coil is energized.
    c. Four (4) position, 'V' blade, with the switch positions labeled:
        1) "SOURCE A" (Loop is open and the coil is energized by Source A).
        2) "SOURCE B" (Loop is open and the coil is energized by Source B).
        3) "SOURCE A & B" (Loop is closed and the coil is energized by both sources).
        4) "LOOP & XFMR OPEN" (Loop is open and the coil is de-energized).
    d. Four position, 'T' blade, with the switch positions labeled:
        1) "SOURCE A" (Loop is open and the coil is energized by Source A).
        2) "SOURCE B" (Loop is open and the coil is energized by Source B).
        3) "SOURCE A & B" (Loop is closed and the coil is energized by both sources).
        4) "LOOP CLOSED & XFMR OPEN" (Loop is closed and the coil is de-energized).

C. Components:
1. Core and Coil:
    a. Coil material: Aluminum or copper.
    b. Windings designed to reduce losses.
    c. Insulating materials rated for 120 DEGC class.
    d. Core material: High-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses.
        1) Magnetic flux densities are to be kept well below saturation to allow for a minimum 10% overvoltage excitation.
        2) Properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.
    e. Core frame:
        1) Designed to provide maximum support for the core and coil assembly.
        2) Welded or bolted to ensure maximum short-circuit strength.
    f. Designed and manufactured to meet the short circuit requirements of ANSI C57.12.90.
    g. Vacuum processed and energized or baked in an oven prior to tanking to set the epoxy coating on the insulating paper and remove moisture from the insulation prior to vacuum filing.
2. Tank and Terminal Cabinet Enclosure:
    a. Carbon steel reinforced with external, internal or sidewall braces, with all seams and joints continuously welded.
    b. Design the tank and attached components to withstand pressures greater than the required operating design value without permanent deformation.
    c. Sealed-tank construction:
        1) 1000kVA and below: Bolted main tank cover.
        2) 1500kVA and above: Welded main cover and bolted tamper-resistant handhole.
    d. Lifting lugs welded to tank.
    e. Steel divider between high-voltage (right side) and low-voltage (left side) compartments.
    f. No exposed screws, bolts, or other fastening devices that are externally removable.
    g. Tamper resistant per IEEE C57.12.28.
    h. Cabinet depth: IEEE standard or 20 IN minimum.

i. 1 IN upper fill plug.
j. 1 IN drain valve with sampling device mounted in an enclosure outside of the main terminal cabinet.
k. Automatic pressure relief device.
l. Ground pad(s):
    1) 500kVA and below: Two steel pads with one hole.
    2) Above 500kVA: Two stainless steel pads with two holes.
m. Door:
    1) Each compartment will have removable, three-point latching hinged doors equipped for latching in the open position.
    2) The high-voltage compartment door will have a fastening device that is accessible only through the low-voltage compartment.
    3) The hinge assemblies made of corrosion-resistant material.
        a) Provide stainless-steel hinge pins of 3/8 IN minimum diameter.
    4) Both compartment doors capable of securing with a single padlock having a maximum 1/2 IN DIA shackle.
    5) Door secured with a hex-head bolt.
    6) Provisions for mounting fault indicator.

3. Overcurrent protection:
    a. Internal protective link
    b. Provide full range protection two fuse system.
    c. Partial-range current limiting backup fuse.
        1) Interrupting rating: 50,000A.
        2) Under oil, non-filed replaceable.
    d. Current sensing, expulsion-type, bay-O-Net fuse.
4. Finish:
    a. Manufacturer's standard corrosion protection system in accordance with IEEE C57.12.28.
    b. Dark "padmount" green.
5. Dielectric Fluid:
    a. Tested for compatibility with the transformer.
    b. Less-flammable, natural or synthetic ester, biodegradable per US EPA OPPTS 835.3100 and certified to comply with US EPA Environmental Technology Verification requirements.
        1) Envirotemp FR3 or approved equal.
    c. Permanently affix nameplate stamped "Non PCB".
6. Accessories:
    a. Liquid level gage with auxiliary contacts.
    b. Dial-type thermometer gage with auxiliary contacts.
    c. Pressure vacuum gage with auxiliary contacts.
    d. Gages to be mounted in a separate enclosure and not in the main terminal cabinet.
    e. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacturer and mounted on exterior of transformer.
    f. Cable parking stands, one per bushing.

## 2.3 SURGE ARRESTORS

A. Standards: IEEE 386 and IEEE C62.11.

B. MOV gapless elbow type.

C. Elbow Connector:
1. One-piece design, comprised of an insulation layer and outer shield constructed of EPDM rubber.
2. 200A, dead front, load break type with hot stick pulling eye and grounding tab.

D. Voltage Class: As indicated on the Drawings.

E. Arrestor MCOV Rating: As indicated on the Drawings.

### 2.4 SOURCE QUALITY CONTROL

A. Factory Tests: At a minimum, provide all routine tests as specified in IEEE C57.12.00 IN accordance with IEEE C57.12.90.

### 2.5 MAINTENANCE MATERIALS

A. Touch-up paint, two separate one quart containers.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install on pad as detailed on the Drawings and in accordance with NFPA 70 and manufacturer's instructions.

B. Transformer locations as shown on the Drawings are intended to be used as a guide.
   1. Field conditions may affect actual transformer location.
   2. Coordinate final location with Owner.

C. Install three-phase transformers on concrete pad per detail on the Drawings.

### 3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

**END OF SECTION**

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# SECTION 26 22 13
## DRY-TYPE TRANSFORMERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Dry-type transformers, 1000 kVA and less.
   2. Transformers mounted in motor control centers.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 26 - Grounding.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Department of Energy (DOE):
      a. 10 CFR 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry Type Transformers for General Applications.
   4. Underwriters Laboratories, Inc. (UL):
      a. 506, Standard for Specialty Transformers.
      b. 1561, Standard for Dry-Type General Purpose and Power Transformers.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Nameplate drawing.
   4. Certifications:
      a. Sound level certifications.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Eaton.
2. General Electric.
3. Square D by Schneider Electric.
4. Siemens.
5. SolaHD by Emerson Electric Co.
6. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two winding type.

B. Cores:
1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:
1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
2. Drip-proof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as follows:
1. 1 PH, 2 kVA and below: None.
2. 1 PH, 3 to 25 kVA: Two, 5 PCT FCBN.
3. 1 PH, 25 kVA and above: Two, 2.5 PCT FCAN and four, 2.5 PCT FCBN.
4. 3 PH, 3 to 15 kVA: Two, 5 PCT FCBN.
5. 3 PH, 15 kVA and above: Two, 2.5 PCT FCAN and four, 2.5 PCT FCBN.

F. Sound Levels:
1. Manufacturer shall guarantee not to exceed the following:
   a. Up to 9 kVA: 40 dB.
   b. 10 to 50 kVA: 45 dB.
   c. 51 to 150 kVA: 50 dB.
   d. 151 to 300 kVA: 55 dB.

G. Efficiency (minimum):
1. Ventilated:
   a. 1 PH, 15 - 333 kVA: DOE 2016 Efficiency.
   b. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.

H. Insulating Material (600 V and below):
1. 3 to 15 kVA units: 185 DEGC insulation system with a 115 DEGC rise.
2. 15 kVA and above units: 220 DEGC insulation system with a 150 DEGC rise.

I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

K. Standards: IEEE C57.96, NEMA ST 20, UL 506, UL 1561.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.
   2. Provide non-ventilated type for 9 kVA units and below and were indicated on the Drawings.
   3. Mount 9 kVA units and below on wall.
   4. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 26 05 00.
   5. Provide rubber vibrations isolation pads.

C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.

D. Ground in accordance with Section 26 05 26.

**END OF SECTION**

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# SECTION 26 24 13.20
## SWITCHBOARDS – LOW VOLTAGE (POW-R-LINE XPERT- MICROGRID)

## PART 1 - GENERAL

### 1.1 SCOPE

A. The Contractor shall furnish and install, where indicated, a free-standing, dead-front type low voltage distribution switchboard, utilizing group mounted circuit protective devices, metering and relaying and control components as specified herein, and as shown on the contract drawings.

### 1.2 RELATED SECTIONS

A. Specification Section 26 28 00 – OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

B. Specification Section 26 09 13 – ELECTRICAL METERING DEVICES

C. Specification Section 26 37 19 – MICROGRID CONTROLLER – POWER XPERT MICROGRID CONTROLLER 3000

D. Specification Section 26 43 13 – LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

### 1.3 REFERENCES

A. The low voltage distribution switchboards and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:
1. UL Standard 891 - Switchboards
2. UL Standard 50 – Enclosures for Electrical Equipment
3. NEMA PB-2 Switchboards
4. UL Standard 489 – Circuit Breakers
5. UL Standard 1449 – Surge Protective Devices
6. UL Standard 508 – Industrial Control Equipment

### 1.4 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
1. Front view and plan view of the assembly
2. Floor plan
3. Top view
4. Single line diagrams
5. Schematic diagram
6. Nameplate schedule
7. Component list
8. Conduit space locations within the assembly
9. Assembly ratings including:
   a. Short-circuit rating
   b. Voltage
   c. Continuous current rating
10. Major component ratings including:
    a. Voltage
    b. Continuous current rating
    c. Interrupting ratings
11. Cable terminal sizes
12. Product data sheets
13. Provide system architecture documentation

14. Provide a sequence of operation for the Microgrid Controller

B. Where applicable, the following additional information shall be submitted to the Engineer:
   1. Busway connection
   2. Connection details, composite front view, and plan view of close-coupled assemblies
   3. Key interlock scheme drawing and sequence of operations
   4. Automatic transfer scheme sequence of operation. Microgrid controller control scheme.
   5. Microgrid controller information.
   6. HMI information.
   7. Mimic bus size and color

## 1.5 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:
   1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
   2. Wiring diagrams
   3. Certified production test reports
   4. Installation information
   5. Seismic certification with equipment anchorage details and center of gravity as specified
   6. Coordination Drawings if required: Floor plans, drawn to scale, showing dimensioned layout upon which the following items are shown and coordinated with each other, using input from installers of the items involved:
      a. Required working clearances and required area above and around Switchboard.
      b. Show Switchboard layout and relationships between electrical components and adjacent structural and mechanical elements.

## 1.6 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The Switchboard manufacturer shall have the Environment Certification ISO 14001.

D. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

E. Where noted in the contract documents provide seismic qualified equipment.

## 1.7 REGULATORY REQUIREMENTS

A. The low-voltage switchboard shall be UL labeled.

## 1.8 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

## 1.9 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

A. Eaton (Basis of Design)

1. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.
2. The switchboard shall be equal to Eaton type Pow-R-Line Xpert utilizing the components herein specified and as shown on the drawings.
3. Other acceptable manufactures are Siemens MIS and Square D. Other manufactures will be considered if they meet the specification requirements herein.

### 2.2 RATINGS

A. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 42,000 amperes symmetrical at rated voltage or as shown on the contract documents.

B. Bus voltage and current rating to be standard at 480V, 3-phase, 3-wire. Provide a neutral point for connection to ground.

### 2.3 CONSTRUCTION

A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.

B. All sections of the switchboard shall be front and rear aligned with depth(s) shown on the drawings.

C. The assembly shall be provided with adequate lifting means.

D. The switchboard shall be suitable for use as service entrance equipment and provisions for utility metering sections when indicated on Contract Documents and be labeled in accordance with UL requirements. Switchboard shall be EUSERC rated, NEMA 1, with provisions for Utility pull section and metering.

E. Provide metering section compatible with Ashland Electric Utility. Provide remote metering option where required by Utility. A conduit to be provided from metering section to a junction box mounted outside.

### 2.4 BUS

A. All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria.

B. Provide a full capacity neutral connection lug for bonding to ground,.

C. A 1/4 x 2-inch copper ground bus (minimum) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

E. All bussing shall be fully-rated for the entire length of the switchboard lineup. Tapered bus is not acceptable.

## 2.5 WIRING/TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Mechanical-type terminals shall be provided for all line and load terminations. Terminals shall be suitable for copper or aluminum conductors rated per 75 degrees C for the size as shown on the drawings. 90 degrees C conductor is permissible but must be sized in accordance with 75 degrees C rated conductor tables.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

D. All control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall first be connected to conveniently accessible short-circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

## 2.6 MAIN, TIE AND DISTRIBUTED ENERGY RESOURCE PROTECTIVE DEVICES

A. INSULATED CASE MAIN, TIE AND DER PROTECTIVE DEVICES

1. Protective devices shall be fixed mounted, insulated case, low-voltage circuit breakers, Power Defense RF or approved equal. All breakers shall be UL listed for continuous application in their intended enclosures for 100% of their continuous ampere rating.
2. Main, solar, BESS and generator breakers shall be true two-step stored energy devices and shall be electronically operated unless otherwise indicated on contract documents.
3. All circuit breakers shall have a minimum symmetrical interrupting capacity of 42,000 amperes. All circuit breakers shall have 3 cycle short-time withstand ratings.
4. All insulated case circuit breakers shall be UL489 listed.
5. All insulated case circuit breakers shall have a nameplate clearly marking any electrical accessories that are mounted in the breaker at the time of sale. The accessory shall have a label that will indicate its function and voltage. All accessories shall be modular, plug and lock type, and UL listed for easy field installation.
6. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is attempted to be tripped or opened.
7. Each insulated case circuit breaker shall be equipped with a true RMS sensing, solid-state PXR25 trip unit consisting of at least three current sensors microprocessor-based trip device and trip actuator. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection.
8. Provide trip units with integral arc flash reduction mode (ARMS) for 1200A frame and above to meet NEC Article 240.87. The use of ZSI to satisfy NEC 240.87 does not meet the intent of these specifications and will not be acceptable as a substitution.
9. Where noted on the contract documents, provide zone selective interlocking between trip units.
10. System coordination shall be provided by adjusting rotary switches for the following microprocessor-based time-current curve shaping adjustments:

a. Adjustable long-delay pick-up setting with minimum of 10 settings
b. Adjustable long-delay time - 0.5 to 24 seconds
c. Adjustable short-delay pick-up setting – 1.5x to Max allowable by frame
d. Adjustable short-delay time 0.0 sec up to 0.5 sec depending on frame with selectable flat or I2t curve shaping
e. Adjustable instantaneous setting 2x to Max allowable by frame
f. Where indicated, adjustable ground fault current pickup (0.2 – 1.0 x In in 0.10x increments) and time (0.1 – 1.0 sec in 0.10sec increments), with selectable flat or I2t curve shaping. Provide switch selectable options for GF OFF, GF alarm, or GF trip.

## 2.7 FEEDER PROTECTIVE DEVICES

A. All feeder protective devices shall be Eaton type Power Defense or approved equal molded case circuit breakers with inverse time tripping characteristics unless otherwise noted.

B. Any feeder protective devices noted as electrically operated on the contract drawings are to be insulated case protective devices as specified in Section 2.06. Electrically operated breakers are shown on drawings with dashed lines connected to the microgrid controller.

C. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.

D. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the contract documents.

E. Circuit breakers to be fixed mounted.

F. Breaker model to be Power Defense MCCB, minimum symmetrical interrupting capacity of 42,000 amperes, for up to 1200 amperes breakers.

G. Circuit breakers shall have microprocessor-based rms sensing trip units as specified below:
1. All molded case circuit breakers shall be equipped with the no less than a PXR-20 trip unit, a true RMS sensing, solid-state tripping system consisting of at least three current sensors microprocessor-based trip device and trip actuator. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection.
2. Provide trip units with integral arc flash reduction mode for 1200A frame and above. The use of zone selective interlocking to emulate this feature does not meet the intent of these specifications and will not be allowed.
3. System coordination shall be provided by adjusting rotary switches for the following microprocessor-based time-current curve shaping adjustments:
   a. Adjustable long-delay pick-up setting with minimum of 10 settings
   b. Adjustable long-delay time - 0.5 to 24 seconds
   c. Adjustable short-delay pick-up setting – 1.5x to Max allowable by frame
   d. Adjustable short-delay time 0.0 sec up to 0.5 sec depending on frame with selectable flat or I2t curve shaping
   e. Adjustable instantaneous setting 2x to Max allowable by frame
   f. Where indicated, adjustable ground fault current pickup (0.2 – 1.0 x In in 0.10x increments) and time (0.1 – 1.0 sec in 0.10sec increments), with selectable flat or I2t curve shaping. Provide switch selectable options for GF OFF, GF alarm, or GF trip.
4. Where indicated provide 100% rated UL listed circuit breakers. At a minimum, main breakers shall be 100% rated.
5. Trip units shall be capable of metering phase, neutral, and ground current with an accuracy of +/- 2.0% of the reading.

6. Trip units shall have an integral, high-resolution liquid-crystal display (LCD) capable of displaying the trip unit programming, status, and monitoring information including bar graph display.
7. Trip units shall include embedded Modbus RTU communication capability. Breaker status and all monitored parameters shall be available.
8. Trip units shall collect and store pertinent information to the trip unit and circuit breaker health and event history. The trip unit shall also include diagnostic features to allow the user to investigate events and dynamically monitor the health of the trip unit and the breaker.
    a. Number of operations (load and no-load)
    b. Number of trips (overload trips, short circuit trips)
    c. Run time
    d. Breaker ambient temperature.
    e. Breaker remaining life - The trip unit shall utilize an algorithm that applies a weighted value to monitored information to determine the remaining life of the breaker. The remaining life of the breaker shall be displayed or communicated in calculated percentage of life remaining.
    f. All breaker health information shall be accessible via micro-USB port on front of trip unit and via embedded communications
9. Trip unit shall perform a waveform capture on trip, alarm, or user-initiated events.
    a. Any breaker trip event shall capture a 10-cycle waveform. The trip unit shall store the most recent trip event waveform.
    b. Any alarm event or user-initiated waveforms shall capture a 1-cycle waveform.
    c. Waveform events shall capture and store all phase, neutral and ground currents.

## 2.8 ACCESSORIES

A. Provide shunt trips, bell alarms and auxiliary switches as shown on the contract drawings.

B. Provide HMI on Microgrid controller section for control and status of the microgrid.

C. Provide the arc flash maintenance mode breakers with a blue light and switch for mode status. Provide alarm to SCADA for in maintenance mode selection.

## 2.9 MISCELLANEOUS DEVICES

A. Electrical interlocks shall be provided as indicated on the drawings.

B. Control power transformers with primary and secondary protection shall be provided, as indicated on the drawings, or as required for proper operation of the equipment.

C. Provide current transformers and voltage transformers as indicated on the drawings. If revenue current transformers are required, then additional space will be necessary.

D. Provide Eaton EDR5000, or similar, multi-function relay on main breaker..

E. Provide other protective relaying and control devices as indicated on drawings.

## 2.10 UTILITY METERING

A. Where indicated on the drawings, furnish a barrier to separate the utility metering compartment complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers, or potential taps as required by the utility company.

B. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements.

C. In the case of remote metering requirements, a conduit shall be provided from metering section to the outside of the building.

## 2.11 SURGE PROTECTIVE DEVICE

A. SPD shall comply with ANSI/UL 1449 4th Edition or later listing by Underwriters Laboratories (UL).

B. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

C. The SPD shall be of the same manufacturer as the switchboard.

D. The SPD shall be factory installed integral to the switchboard by the original equipment manufacturer.

E. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

F. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located within immediate proximity to the SPD.

G. All monitoring and diagnostic features shall be visible from the front of the equipment.

H. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

I. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

J. Electrical Noise Filter – Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

K. Type 2 units with filtering shall conform to UL 1283 5th Edition

L. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.

M. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered and hardwired with connections utilizing low impedance conductors.

N. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   1. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
   2. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
   3. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes
   4. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other

phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

5. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
6. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

O. Electrical Requirements:
1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Units with end of life short-circuit mode are not acceptable.
4. Unit shall operate without the need for an external overcurrent protection device (OCPD) and be listed by UL as such. Unit must not require external OCPD or replaceable internal OCPD for the UL Listing.
5. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

| | **Protection Modes** | | | |
|---|---|---|---|---|
| Configuration | L-N | L-G | L-L | N-G |
| Wye | • | • | • | • |
| Delta | N/A | • | • | N/A |
| Single Split Phase | • | • | • | • |
| High Leg Delta | • | • | • | • |

6. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
7. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

| **Modes** | **208Y/120** | **480Y/277** | **600Y/347** |
|---|---|---|---|
| L-N; L-G; N-G | 700 | 1200 | 1500 |
| L-L | 1200 | 2000 | 3000 |

## 2.12 CUSTOMER METERING

A. Where indicated on the drawings, provide a separate customer metering compartment with a front facing hinged door and a UL listed microprocessor-based multifunction power meter equal to Eaton PXM3000 or approved equal. Include current transformers wired to shorting-type terminal blocks for each meter. Provide fused potential taps as the potential source for metering as shown on the drawings.

B. The meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems. The Meter shall support 3-Element Wye, 2 Element Delta, 4 wire Delta systems.

C. Meter surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6KV)

D. The meter shall have an accuracy of +/- 0.2% or better for volts and amps, and 0.2% for power and energy functions. The meter shall meet the accuracy requirements of IEC62053-22 (class 0.2S) and ANSI C 12.20 (Class 0.2).
   1. The meter shall sample the current and voltage inputs at 512 samples per cycle for high accuracy metering.
   2. The meter shall sample the current and voltage inputs at 512 samples per cycle for high accuracy metering:
      a. Volts (phase to phase and phase to neutral; per phase and average)
      b. Amps (per phase, neutral, and average)
      c. KW (per phase, and total)
      d. KVAR (per phase and total)
      e. KVA (per phase and total)
      f. PF (apparent power factor)
      g. Frequency
   3. The meter shall provide the following measurements with a 1 s update rate:
      a. kWh (forward, reverse, total, net)
      b. kVARh , (forward, reverse, total, net)
      c. kVAh (total)
      d. kWh per phase (forward, reverse)
      e. kVARh per phase (forward, reverse)
      f. kVAh per phase (total)
      g. % THD (Total Harmonic Distortion) monitoring to the 63rd harmonic order for currents and L-N voltage in 4 wire wye and L-L voltage in 3 Wire Delta

E. The meter shall provide the following advanced analysis features:
   1. Calculation of harmonic magnitudes for each phase voltage and current through the 63rd harmonic.
   2. Minimum and Maximum values for the following parameters:
      a. Voltage L-L and L-N
      b. Current per phase
      c. Apparent Power Factor
      d. Real, Reactive, and Apparent total power
      e. %THD voltage L-N
      f. %THD Current per phase
      g. Frequency

F. The WEB server shall provide the user with remote WEB access to metered information including basic metering data, energy, harmonics, sequence components, Max/Min, Alarm Log, I/O status.

G. The meter shall have a real-time clock with the added capability to synchronize with a network time server to maintain time accuracy.

H. Meter shall be mounted on the switchboard such that it can be read without the need for a ladder. Do not mount power meter in the top sections.

I. Connect power meter to the microgrid controller as required.

J. Connect power meter to SCADA or verify that microgrid controller will relay same power information to SCADA.

## 2.13 MICROGRID CONTROLLER INTEGRATION

A. Provide a Power Xpert Microgrid Controller and HMI factory-installed within the switchboard. The Controller shall consist of required user interfaces, communication interfaces and control functionality to operate two or more Distributed Energy Resources (DERs) as specified in the Power Xpert Microgrid Controller Specification 233713.

B. The Microgrid Controller and associated components will be installed within a dedicated section or compartment within the switchboard assembly.

C. The Microgrid Controller installation will be coordinated with all features from the power distribution equipment, power monitoring and control components that interface with the controller to form an integrated, operational system.

D. The HMI used with the Microgrid Controller shall be an industrial panel PC with fanless design, 15.6" TFT touchscreen display, quad-core processor, 4 GB RAM, 32 GB SSD, 24Vdc power supply (XP-504-15).

E. The HMI shall be mounted in the door of the controller compartment at a convenient viewing height.

F. The Microgrid Controller and HMI shall be connected to a UPS capable of operating for a minimum of 5 minutes if power is lost.

G. Microgrid controller shall be programmed by manufacturer and coordinated with generator manufacturer, solar and BESS controllers.

### 2.14 ENCLOSURES

A. NEMA 1 Enclosure

### 2.15 NAMEPLATES

A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

B. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

### 2.16 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 light gray.

## PART 3 - EXECUTION

### 3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
   1. The switchboard shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 volts for one (1) minute between live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one (1) minute between live parts and ground.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

C. Factory to connect and set up ethernet gateways and/or data aggregation processors (such as Eaton PXG900 or Power Xpert Dashboard Lite) included in switchboard assemblies. Factory

testing should also include confirmation that the processor and display communicate with each other and that every device connected to the processor is communicating with the processor. Addresses for the communicating devices in these networks will be indicated on factory supplied communication drawings.

## 3.2 MANUFACTURER'S CERTIFICATION

A. A certified test report of all standard production tests shall be available to the Engineer upon request.

## 3.3 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 2 normal workdays at a job site location determined by the owner.

B. A manufacturer's qualified representative shall conduct the training session. The training program shall consist of instruction on operation of the assembly, circuit breakers, fused switches, and major components within the assembly.

## 3.4 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills provided the floor is level to 1/8 inch per 3-foot distance in any direction. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

## 3.5 FIELD ADJUSTMENTS

A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study and protective device coordination study.

B. Necessary field settings of devices, adjustments, and minor modifications to equipment to accomplish conformance with an approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

**END OF SECTION**

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# SECTION 26 24 16
PANELBOARDS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Branch circuit panelboards.
   2. Distribution panelboards.
   3. Panelboards mounted in motor control centers and integrated switchboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   6. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017.
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

### 1.3 DEFINITIONS

A. Branch Circuit Panelboard: Bus rating of 400A and less or where labeled as Branch Circuit Panelboard on the Drawings.

B. Distribution Panelboard: Bus rating of 600A and greater or where labeled as Distribution Panelboard on the Drawings.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Panelboard schedules with as-built conditions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. ABB/GE.
   3. Square D by Schneider Electric.
   4. Siemens Corporation.
   5. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. PDP-101 and PDP-601 were designed based on Eaton distribution panelboard Pow-R-Line 4X. Provide Eaton or similar style and layout for these power distribution panels.

### 2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
      a. Series rating is not acceptable.
      b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
      c. Minimum SCCR ratings:
         1) Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating.
         2) Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.
   4. Provide with circuit breaker slots as shown on panelboard schedules. Sizes shown are minimums.

D. Bus Bars:
   1. Main bus bars:
      a. Tin plated aluminum or tin plated copper sized to limit temperature rise to a maximum of 65 DEGC above an ambient temperature of 40 DEGC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100 PCT rated or 200 PCT rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.
   2. Branch overcurrent protective devices:
      a. Bolt-on molded case circuit breaker.
   3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
   4. Factory installed.

F. Integral surge protective device:

1. Provide for each panelboard.
2. Provide Type 3 SPD.
3. See Specification Section 26 43 13.

G. Enclosure:
1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Branch circuit panelboard:
a. Trims supplied with hinged door-in-door construction.
1) Outer door:
a) Allows access to the interior of the enclosure.
b) Hinged to the enclosure.
c) Opened by removal of screws or by operating a mechanical latch located behind the inner door.
2) Inner door:
a) Allows access to breakers (non-live parts).
b) Hinged to outer door.
c) Opened by operation of a keyed corrosion resistant chrome-plated combination lock and catch. Locks for all branch circuit panelboards keyed alike.
b. Trims for surface mounted panelboards, same size as box.
c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
d. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
e. Clear plastic cover for directory card mounted on the inside of each door.
f. Where NEMA 3R or NEMA 12 rating is indicated: Door gasketed.
g. Where NEMA 4X is indicated: Stainless Steel.
4. Distribution panelboard:
a. Trims cover all live parts with switching device handles accessible.
b. Minimum 8 IN deep and less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
c. Clear plastic cover for directory card mounted in front of enclosure.
d. Where NEMA 3R or NEMA 12 rating is indicated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike, or provisions for padlocks.
e. Where NEMA 4X is indicated: 316 Stainless Steel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

C. Provide NEMA rated enclosure as indicated on the Drawings. Where enclosure type is not indicated, provide enclosure rating suitable for the atmosphere where equipment is installed.

D. Field identification:
1. Provide all required tagging and markings per NFPA 70 and Specification Section 10 14 00.

E. Service Equipment Marking and Documentation:
1. Provide service rated equipment with available fault current and arc-flash hazard warning labels as required by NFPA 70 and other applicable codes.
2. Provide documentation of the calculations made for compliance with the marking requirements.

3. Provide labels in accordance with Specification Section 10 14 00.

F. Provide each panelboard with a typed directory:
   1. Identify all circuit locations in each panelboard with the load type and location served.
   2. Use Owner-furnished mechanical equipment designation if different than designation indicated on the Drawings.
   3. Use final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.
   4. Identify spare overcurrent devices.

**END OF SECTION**

# SECTION 26 24 19
## MOTOR CONTROL EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Motor control centers.
   2. Separately mounted motor starters (including those supplied with equipment).
   3. Manual motor starters.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.
   5. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
   6. Section 26 36 00 - Transfer Switches.
   7. Section 26 24 13 - Switchboard.
   8. Section 26 24 16 - Panelboards.
   9. Section 26 22 13 - Dry-Type Transformers.
   10. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   11. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).
   12. Section 26 09 13 - Electrical Metering Devices.
   13. Section 26 09 16 - Control Equipment Accessories.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. International Electrotechnical Commission (IEC).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
      b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
      c. ICS 18, Motor Control Centers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 845, Motor Control Centers.

B. Miscellaneous:
   1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
   2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Motor control center:
         1) Bill of Materials (BOM).

2) Manufacturer data sheets for integrated components.
3) Elevation drawing with overall dimensions and vertical bus ratings.
4) Power flow schematic.
5) Starter and component schedule.
6) Identification of units and their location in the MCC.
7) Location of incoming line terminals.
8) Mounting dimensions.
9) Available conduit entrance areas.
10) Nameplate schedule.
11) Assembly ratings (amps, volts, short circuit, etc.).
12) Unit ladder logic wiring for each unit depicting electrical interlocking and wiring between units (NEMA ICS 18 Class II) and identification of terminals where field devices or remote control signals are to be terminated (NEMA ICS 18 Class II-S) including industry standard symbology of the field devices as indicated on the Drawings, product specification and/or loop descriptions. Drawings indicate basic control functionality, provide diagrams for the manufacturer's product(s) meeting the required functionality.

b. Separately mounted combination starters:
1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated including industry standard symbology of the field devices as indicated on the Drawings, specification and/or loop descriptions. Drawings indicate basic control functionality, provide diagrams for the manufacturer's product(s) meeting the required functionality.
2) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Fabrication and/or layout drawings updated with as-built conditions.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Service equipment marking and documentation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Allen-Bradley by Rockwell Automation, Inc.
2. Eaton.
3. Square D by Schneider Electric.
4. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MOTOR CONTROL CENTERS

A. Ratings:
1. 600 V class, 3 PH, 60 Hz with operating voltage and number of wires as indicated on the Drawings.
2. Assembly short circuit current and interrupting device rating as indicated on the Drawings, minimum of 65 KAIC.

3. Service Entrance Equipment rated when indicated on the Drawings.

B. Construction:
   1. Drawout stabs to allow disconnection of the bucket prior to removal.
   2. Standards: UL 845.
   3. Totally enclosed, dead front, free standing assemblies, bolted together to form a single assembly.
   4. Fabricate of not less than 14 GA steel with 16 GA steel doors in standardized units.
   5. Nominal size per section: 20 IN wide, 20 or 21 IN deep, and 90 IN high.
   6. Enclosure:
      a. NEMA 12 gasketed.
   7. Horizontal wireways:
      a. At the top, isolated from the main bus.
      b. At the bottom.
      c. Easily accessible.
      d. Full length of the MCC.
   8. Vertical wireway:
      a. Located in each MCC section that accepts plug-in units.
      b. Connect to top and bottom wireways.
      c. Isolated from the unit interiors.
      d. Accessible through a separate hinged door.
      e. Cable tie supports to hold wiring in place.
   9. Unit doors:
      a. Formed round corners and rolled edges.
      b. Minimum of two heavy-duty hinges or continuous piano hinge.
      c. Held closed by means of captive fasteners.
      d. Fabricate to be a part of the structure and not part of the starter.
   10. Unit cubicles:
      a. Draw-out type for motor starters through NEMA Size 5.
      b. Guide rails for supporting and aligning starters.
      c. Operating handle:
         1) With the unit stabs engaged and door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
         2) Circuit breaker and MCP operators includes a separate TRIPPED position.
         3) Mechanical interlock to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism.
         4) Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism.
         5) Non-defeatable interlock to prevent the installation or removal of a unit unless the disconnect is in the OFF position.
         6) Pad-lockable in the OFF position.
      d. Control panel:
         1) Provide control devices (selector switch, indicating devices, etc.) as indicated on the Drawings per Specification Section 26 09 16.
      e. Control power:
         1) Control power transformer:
            a) 120 V secondary.
            b) Fused on primary and secondary side.
            c) Sized for 140 PCT of required load.
      f. Minimum of one full size space unit (12 IN) for any combination magnetic motor starter or starter without overload relay.
      g. One-half full size space unit (6 IN) for circuit breakers 100 A and less.
      h. Effectively baffled to isolate any ionized gases which may occur within unit starter.
   11. Externally mounted overload relay pushbutton.

12. Assemblies effectively ventilated to allow relocation of starters and other components:
    a. Within the assembly and with the same load.
    b. Without having to compensate for changes in location.
13. Finish: Rust inhibited primer and manufacturer's standard paint inside and out.
14. Provide ample unrestricted space for conduit entry from the bottom.
15. Wiring: NEMA ICS 18 Class II, Type B-D.

C. Buses:
    1. Material: Tin-plated copper.
    2. Main horizontal bus:
        a. 800 A unless otherwise indicated on the Drawings.
        b. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
    3. Vertical buses:
        a. 300 A minimum.
        b. Securely bolted to the horizontal main bus with joint easily accessible for maintenance.
        c. Completely isolated and insulated by means of a barrier.
        d. Extended full length of vertical section to distribute incoming power to each circuit breaker and starter in structure.
            1) Starters NEMA Size 5 and larger and certain other components may be cable connected to the main bus with the approval of the Engineer.
        e. Extend Vertical bus to spaces provided for future equipment.
    4. Ground bus:
        a. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
        b. 300 A tin-plated copper.
        c. Solidly grounded to each structure.
        d. Locate near bottom of structure.
        e. Provide for lug connection of equipment ground wires.

D. Overcurrent and Short Circuit Protective Devices:
    1. Main device:
        a. Molded case circuit breaker.
        b. Fusible switch.
    2. Feeder devices:
        a. Molded case circuit breaker.
        b. Fusible switch.
    3. Motor protection with full voltage starters:
        a. Motor circuit protector.
    4. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
    5. Factory installed.

E. Motor Starters: See requirements within this Specification Section.

F. Panelboards: Integrally mounted, see Specification Section 26 24 16.

G. Transformers: Integrally mounted, see Specification Section 26 22 13.

H. Integral surge protective device:
    1. Provide for each Motor Control Center.
    2. Provide Type 1 SPD.
    3. See Specification Section 26 43 13.

I. Power Monitor Metering:
    1. Separate compartment.
    2. See Specification Section 26 09 13 for meter requirements.

J. Miscellaneous:

1. See Drawings for items provided by other but factory installed (e.g., submersible motor temperature/leak controller, control system gateways or switches).

## 2.3 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 4 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 4X rated:
      a. Body and cover: Type 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   3. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:
   1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
   2. Circuit breaker and MCP operators includes a separate TRIPPED position.
   3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
   4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
   5. Pad-lockable in the OFF position.

D. External mounted overload relay pushbutton.

E. Control Devices:
   1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
   2. Devices will be accessible with the door closed.

F. Control Power Transformer:
   1. 120V secondary.
   2. Fused on primary and secondary side.
   3. Sized for 140 PCT of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
   1. Motor circuit protector.
   2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
   3. Factory installed.

## 2.4 MOTOR STARTERS

A. Standards:
   1. NEMA ICS 2.
   2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
   1. NEMA full size rated contactor.

a. NEMA half sizes and IEC contactors are not permitted.
2. Double-break silver alloy contacts.
3. Overload relays:
   a. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.
4. Interlock and auxiliary contacts, wired to terminal blocks:
   a. Holding circuit contact, normally open.
   b. Overload alarm contact, normally open.
   c. Normally open auxiliary contact, for remote run status.
   d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation and Control (Elementary) Diagram.
   e. Two additional normally open spare field replaceable auxiliary contacts.
   f. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.
5. Interlock and auxiliary contacts, wired to terminal blocks:
   a. Holding circuit contact, normally open.
   b. Overload alarm contact, normally open.
   c. Normally open auxiliary contact, for remote run status.
   d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
   e. Two additional normally open spare field replaceable auxiliary contacts.

C. Variable Frequency Drives: See Specification Section 26 29 23.

### 2.5 MANUAL MOTOR STARTERS

A. Standards:
1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
1. Horsepower rated, for ON/OFF control and thermal overload protection.
   a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
1. NEMA 4 rated:
   a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
   b. No knockouts, external mounting flanges.
2. NEMA 4X rated:
   a. Type 316 stainless steel.
   b. No knockouts, external mounting flanges.
3. NEMA 12 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
   b. No knockouts, external mounting flanges.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.

C. Mount MCC on 4 IN high concrete pad:
   1. Install two, 4 IN wide channel sills flush in pads to support and maintain alignment of the MCC.
   2. Align front of MCC with top edge of pad chamfer.

D. Service Equipment Marking and Documentation:
   1. Provide service rated equipment with available fault current and arc-flash hazard warning labels as required by NFPA 70 and other applicable codes.
   2. Provide documentation of the calculations made for compliance with the marking requirements.
   3. Provide labels in accordance with Section 10 14 00.

E. Provide separately mounted combination starters with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
   1. Determine the SCCR rating by one of the following methods:
      a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
      b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
      c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
   2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
   3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

F. Overload Relays:
   1. Calibrate for actual motor full load current of the connected motor.

G. Combination and Manual Starter Enclosures:
   1. Permitted uses of enclosure types:
      See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.

H. Provide all spare and space locations with equipped spaces. At a minimum, provide white back pan for future installation points.

## 3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

**END OF SECTION**

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# SECTION 26 27 26
WIRING DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Wall switches.
      b. Receptacles.
      c. Device wallplates and coverplates.
      d. Plug-in strips.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 33 - Raceways and Boxes.
   5. Section 26 24 19 - Motor Control Equipment.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.
      f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
      g. 1310, Standard for Class 2 Power Units.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wall switches and receptacles:
      a. Bryant Electric.

b. Cooper Wiring Devices by Eaton.
c. Hubbell Incorporated Wiring Device-Kellems.
d. Leviton Manufacturing Company.
e. Legrand/Pass & Seymour.
f. Eaton Crouse-Hinds.
g. Appleton Electric Co.
h. Hubbell Killark.

2. Plug-in strip:
a. Wiremold/Legrand.
b. Walker.

## 2.2 WALL SWITCHES

A. Basic requirements unless modified in specific requirements paragraph of switches per designated areas or types:
1. Industrial Specification Grade.
2. Quiet action, snap switch.
3. Self-grounding with grounding terminal.
4. Back and side wired.
5. Solid silver cadmium oxide contacts.
6. Rugged thermoplastic and/or nylon housing and one-piece switch arm.
7. Ratings: 20 A, 120/277 VAC.
8. Switch handle type: Toggle.
9. Switch handle color: Ivory.
10. Types as indicated on the Drawings:
a. Single-pole.
b. Double-pole.
c. 3-way.
d. 4-way.
e. Momentary contact.
11. Standards: UL 20, UL 514A, NEMA WD 1, NEMA WD 6.

B. Architecturally Finished Area Specific Requirements:
1. Commercial Specification Grade.
2. Quiet action, snap switch.
3. Ratings: 15A, 120/277V.
4. Switch handle type: Decorator rocker or paddle.
5. Switch handle color: Ivory.
6. Wallplate:
a. 302 or 304 brushed finish stainless steel.
b. Single or multiple gang as required.

C. Dry Non-architecturally Finished Area Specific Requirements:
1. Coverplate for use on surface mounted outlet boxes:
a. Cast iron alloy, galvanized and factory painted finish.
b. Cast aluminum, natural, lacquer, or factory painted finish.
c. Sheet steel, galvanized.
d. Sheet aluminum.
e. 302 or 304 brushed finish stainless steel.
f. Single or multiple gang as required.
2. Wallplate for use on recessed outlet boxes:
a. 302 or 304 brushed finish stainless steel.
b. Single or multiple gang as required.

D. Dry and Dusty Non-Architecturally Finished Area Specific Requirements:
1. Coverplate:

a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
b. Operator type:
   1) Side mounted rocker type handle to operate snap switch.
   2) Front mounted lever type handle to operate snap switch.
   3) Push/pull operator to operate snap switch.
   4) Spring type door to cover snap switch.
c. Single or multiple gang as required.

E. Wet or Damp Non-Architecturally Finished or Exterior Area Specific Requirements:
1. Coverplate:
   a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
   b. Operator type:
      1) Side mounted rocker type handle to operate snap switch.
      2) Front mounted lever type handle to operate snap switch.
      3) Push/pull operator to operate snap switch.
      4) Spring type door to cover snap switch.
   c. Wet location rated.
   d. Single or multiple gang as required.

F. Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on metallic outlet boxes:
   a. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
   b. Operator type:
      1) Front mounted lever to operate snap switch.
      2) Push/pull operator to operate snap switch.
      3) Spring type door to cover snap switch.
   c. Wet location rated.
   d. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
   a. High impact thermoplastic, gasketed, stainless steel screws.
      1) Front mounted lever to operate snap switch.
      2) Spring type door to cover snap switch.
   b. Wet location rated.
   c. Single or multiple gang as required.

G. Highly Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on PVC coated metallic outlet boxes:
   a. PVC coated galvanized iron alloy, gasketed, stainless steel hardware.
   b. PVC coated aluminum, gasketed, stainless steel hardware.
   c. Operator Type:
      1) Front mounted lever to operated snap switch.
      2) Push/pull operator to operate snap switch.
      3) Spring type door to cover snap switch.
   d. Wet location rated.
   e. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
   a. High impact thermoplastic, gasketed, stainless steel hardware.
      1) Front mounted lever to operate snap switch.
      2) Spring type door to cover snap switch.
   b. Wet location rated.
   c. Single or multiple gang as required.

## 2.3 RECEPTACLES

A. Basic requirements unless modified in specific requirements paragraph of receptacles and per designated areas:
   1. Industrial Specification Grade.
   2. Straight blade.
   3. Brass triple wipe line contacts.
   4. One-piece grounding system with double wipe brass grounding contacts and self-grounding strap with grounding terminal.
   5. Back and side wired.
   6. Rating: 20 A, 125 VAC.
   7. High impact nylon body.
   8. Receptacle body color:
      a. Normal power: Ivory.
   9. Duplex or simplex as indicated on the Drawings.
   10. Configuration: NEMA 5-20R.
   11. Standards: UL 498, UL 514A, NEMA WD 1, NEMA WD 6.

B. Receptacle Type Specific Requirements:
   1. Basic receptacles:
      a. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
         1) Identification: Letters "WR" on face of receptacle.
   2. Ground Fault Circuit Interrupter (GFCI):
      a. Specification Grade.
      b. Class A protection.
      c. Feed through type.
      d. Test and reset buttons.
      e. Self-testing.
      f. Visual indicator light.
      g. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
         1) Identification: Letters "WR" on face of receptacle.
      h. Additional standards: UL 943.
   3. Plug load (PL) control receptacle.
      a. Commercial Specification Grade.
      b. Dual controlled (PLD) or half controlled (PLH) as indicated on the Drawings.
      c. Identification: NEMA approved controlled receptacle marking on face of receptacle.

C. Architecturally Finished Areas Specific Requirements:
   1. Wallplate:
      a. Single or multiple gang as required.

D. Dry Non-Architecturally Finished Areas Specific Requirements:
   1. Coverplate for use on surface mounted outlet boxes:
      a. Cast iron alloy, galvanized and factory painted finish.
      b. Cast aluminum, natural, lacquer or factory painted finish.
      c. Sheet steel, galvanized.
      d. Sheet aluminum.
      e. 302 or 304 brushed finish stainless steel.
      f. Single or multiple gang as required.
   2. Wallplate for use on recessed outlet boxes:
      a. 302 or 304 brushed finish stainless steel.
      b. Single or multiple gang as required.

E. Dry and Dusty Non-Architecturally Finished Areas Specific Requirements:
   1. Coverplate:

a. Cast iron alloy, gasketed, self-closing cover, stainless steel hardware, galvanized and factory painted finish.
b. Cast aluminum, gasketed, self-closing cover, stainless steel hardware, natural, lacquer or factory painted finish.
c. Single or multiple gang, as required.

F. Damp Non-Architecturally Finished Areas Specific Requirements:
1. Coverplate:
a. Cast iron alloy, gasketed, self-closing cover, stainless steel hardware, galvanized and factory painted finish.
b. Cast aluminum, gasketed, self-closing cover, stainless steel hardware, natural, lacquer or factory painted finish.
c. Weatherproof when receptacle is covered.
d. Single or multiple gang as required.

G. Wet Non-architecturally Finished Areas Specific Requirements:
1. Coverplate:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cords.

H. Exterior Locations Specific Requirements:
1. Coverplate:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.

I. Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Receptacle body color: Gray.
3. Weather-resistant.
a. Identification: Letters "WR" on face of receptacle.
4. Coverplate for use on metallic outlet boxes:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 IN minimum cover depth for #12 AWG cord.
5. Coverplate for use on non-metallic outlet boxes:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 IN minimum cover depth for #12 AWG cords.

J. Highly Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Receptacle body color: Gray.
3. Weather-resistant.
a. Identification: Letters "WR" on face of receptacle.
4. Coverplate for use on PVC coated metallic outlet boxes:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 IN minimum cover depth for #12 AWG cords.
5. Coverplate for use on non-metallic outlet boxes:
a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 IN minimum cover depth for #12 AWG cords.

K. Special Purpose Receptacles:
1. NEMA configuration as indicated on the Drawings.
2. Coverplate: See requirements per area designations herein.

## 2.4 MISCELLANEOUS WIRING DEVICES

A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 26 24 19.

## 2.5 OCCUPANCY SENSORS

A. Low Voltage Passive Infrared Ceiling Sensor (Type OC per the Drawings:
   1. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
   2. Analog and digital processing to provide immunity to RFI and EMI.
   3. Temperature compensated, dual element sensor and a multi-element lens with a minimum field of view of 110 DEG.
   4. Daylight filter or compensation for short wavelength infrared wave from the sun.
   5. Cover up to 300 SQFT at normal mounting heights.
   6. System voltage: 24 VDC through power pack.
   7. Load ON-OFF control through power pack.
   8. Adjustable time delay set at 30 minutes.
   9. Adjustable sensitivity set at maximum.
   10. Adjustments and mounting hardware under a removable cover.
   11. Parallel wiring of multiple sensors to allow coverage of large areas.

B. Passive Infrared Wall Switch:
   1. Self-contained control system that replaces a standard toggle switch.
      a. Latching air gap relay switching mechanism, compatible with electronic ballasts, compact fluorescent and inductive loads.
   2. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
   3. Analog and digital processing to provide immunity to RFI and EMI.
   4. Temperature compensated, dual element sensor and a multi-element Fresnel lens.
   5. Cover up to 300 SQ FT for walking motion, with a field of view of 180 DEG.
   6. System voltage: 120 VAC or 277 VAC.
   7. No minimum load.
      a. 0 to 500 watts incandescent, 0 to 800 watts fluorescent or 1/6 HP at 120 VAC, 60 Hz.
      b. 0 to 1200 watts fluorescent or 1/3 HP at 277 VAC, 60 Hz.
   8. DIP switch to control the following functions:
      a. Built-in light level feature adjustable from 8 to 180 FT candles.
      b. AUTOMATIC-ON or MANUAL-ON operation.
      c. Time delay adjustable from 30 seconds to 30 minutes.
      d. High/low sensitivity adjustments.
   9. Adjustments and mounting hardware under a removable, tamper resistant cover.
   10. Normal operation: OFF and AUTO.

C. Ultrasonic Ceiling Sensor:
   1. Detection of Doppler shifts in transmitted ultrasound.
   2. Ultrasonic sensing is volumetric in coverage with a frequency of 32 kHz and automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled areas.
   3. Temperature and humidity resistant, 32 kHz tuned ultrasonic receivers.
      a. Receivers have less than a 6 dB shift in the humidity range of 10 PCT to 90 PCT and less than a 10 dB shift in the temperature range of -20 to 60 DEGC.
   4. DIP switch to control the following functions:
      a. Override-ON function for use in the event of failure.
      b. Time delay adjustable from 15 seconds to 30 minutes.
      c. High/low sensitivity adjustments.
   5. Cover 360 DEG and hallway and corridor sensors shall cover up to 90 linear feet.

6. Additional single-pole, double-throw isolated relay with normally open, normally closed, and common outputs rated at 1 amp for 24 VDC.
    a. The isolated relay is for use with HVAC control, data logging and other control options.

D. Power Pack:
    1. Self-contained transformer and relay module.
    2. Dry contacts capable of switching:
        a. 20 amp ballast load, 13 amp incandescent, 1 HP at 120 VAC, 60 Hz.
        b. 20 amp ballast at 277 VAC, 60 Hz.
    3. 24 VDC, 100 mA output.
    4. Capable of parallel wiring without regard to AC phases on primary.
    5. Used as a standalone, low voltage switch or wired to sensor for auto control.
    6. Low voltage Teflon coated leads, rated for 300 V, suitable for use in plenum applications.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.

C. See Specification Section 26 05 33 for device outlet box requirements.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

**END OF SECTION**

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# SECTION 26 28 00
## OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.
   2. Low voltage fuses.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
      b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
      c. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017.
   3. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      b. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
      c. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Ground fault protection system test reports signed by the projects supervising electrical foreman.
   3. Reports:
      a. As-left condition of all circuit breakers that have adjustable settings.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Circuit breakers:
      a. Eaton.
      b. General Electric Company.
      c. Square D Company.
      d. Siemens.
      e. Or approved equal.
   2. Fuses:
      a. Eaton Bussmann, Inc.
      b. Littelfuse, Inc.
      c. Mersen.
      d. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 CIRCUIT BREAKERS

A. Molded Case Type:
   1. General:
      a. Standards: UL 489.
      b. Unit construction.
      c. Over-center, toggle handle operated.
      d. Quick-make, quick-break, independent of toggle handle operation.
      e. Manual and automatic operation.
      f. All poles open and close simultaneously.
      g. Three position handle: On, off and tripped.
      h. Molded-in ON and OFF markings on breaker cover.
      i. One-, two- or three-pole as indicated on the Drawings.
      j. Current and interrupting ratings as indicated on the Drawings.
      k. Bolt on type.
   2. Thermal magnetic type:
      a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
      b. Frame size 150 amp and below:
         1) Non-interchangeable, non-adjustable thermal magnetic trip units.
   3. Solid state trip type:
      a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
      b. Removable and sealable covers over adjustment means.
      c. Frame size 225 amp to 600 amp:
         1) Standard rating.
         2) Interchangeable current sensor or rating plug.
         3) Adjustable long time pick-up setting.
            a) Adjustable from 50 to 100 PCT of the current sensor or rating plug.
         4) Adjustable short time pick-up setting.
         5) Adjustable instantaneous pick-up.
         6) Fixed ground fault pick-up.
      d. Frame size 800 amp and above:
         1) 100 PCT rated.
         2) Interchangeable current sensor or rating plug.
         3) Adjustable long time pick-up setting.
            a) Adjustable from 50 to 100 PCT of the current sensor or rating plug.

4) Adjustable long time delay setting.
5) Adjustable short time pick-up setting.
6) Adjustable instantaneous pick-up setting.
7) Adjustable ground fault pick-up setting.
8) Adjustable ground fault delay setting.

4. Motor circuit protector:
   a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
   b. Sized for the connected motor.

B. Insulated Case Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: UL 489.
3. 100 PCT rated.
4. Manually operated (MO) unless electrically operated (EO) is indicated on the Drawings.
5. Electrically Operated (EO) breakers:
   a. 120 VAC operators.
   b. Close/open pushbuttons.
   c. Red and green indicators to indicated breaker position.
   d. AC source: Control power transformer internal to the switchgear.
6. Motor driven operator for charging mechanism with open, close and charge push button.
7. Draw out construction:
   a. Roll out type operated by removable crank handle and interlocked with the door.
   b. Four positions: Connected, test, disconnected and removed.
   c. Cell switches to short out ground fault relay when main or tie breaker is drawn out.
8. Current and interrupting ratings as indicated on the Drawings.
9. Selective override circuit on breakers with short time settings and without instantaneous settings that allow selectivity up to the breakers RMS symmetrical short time rating.
   a. The selective override circuit shall allow the breaker to ride through a fully offset (asymmetrical) fault equal to its RMS symmetrical short time rating in a system having an X/R ration of 6.6 with a maximum single phase peak current of 2.3 times the RMS symmetrical short time range.
10. Frame size 400 amp and above:
    a. Interchangeable current sensor or rating plug:
    b. Adjustable long time pick-up setting.
       1) Adjustable from 50 to 100 PCT of the current sensor or rating plug.
    c. Adjustable long time delay setting.
    d. Adjustable short time pick-up setting.
    e. Adjustable instantaneous pick-up setting.
    f. Adjustable ground fault pick-up setting, when indicated on the Drawings.
    g. Adjustable ground fault delay setting, when indicated on the Drawings.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:

a. Frame sizes 150 amp and less shall be thermal magnetic type.
b. Frame sizes 225 amp and larger shall be solid state trip type.
c. Frame sizes 1000 amp and above shall include integral ground fault protection, when indicated on the Drawings.
d. Motor circuit protectors sized for the connected motor.

2. Insulated case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
   a. Set current sensor or rating plugs long time pick-up setting so that the indicated trip level is near the 75 PCT trip point.
   b. Frame sizes 1000 amp and above shall include integral ground fault protection, when indicated on the Drawings.

E. Fuses:
1. UL Class RK-5: Use for safety disconnect switches.

## 3.2 FIELD QUALITY CONTROL

A. Adjustable Circuit Breakers:
1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

B. Ground Fault Protection System:
1. Dual source system:
   a. Main-Tie-Main breaker system using the differential sensing method coordinated with individual feeder breakers using the residual sensing method.
   b. Main, tie and feeder breakers: Utilize four individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.
   c. Main, tie and feeder breakers: Coordinate via time delays, so that feeder breakers will clear downstream ground faults before the Main-Tie-Main system.

C. Testing:
1. Acceptance testing: See Specification Section 26 08 13.

**END OF SECTION**

# SECTION 26 28 16
SAFETY SWITCHES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
      c. See Specification Section 26 05 00 for additional requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. General Electric.
   3. Square D by Schneider Electric.
   4. Siemens Corporation.
   5. Appleton by Emerson Electric Co.
   6. Crouse-Hinds by Eaton.
   7. Killark by Hubbell.

### 2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.

4. Switch blades will be fully visible in the OFF position with the enclosure door open.
5. Quick-make/quick-break operating mechanism.
6. Deionizing arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one common component.
8. Clear line shields to prevent accidental contact with line terminals.
9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
    a. Red and easily recognizable.
    b. Pad lockable in the OFF position.
    c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
1. Horsepower rated of connected motor.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Provide the following accessories for each safety switch:
1. Ground lug kits.
2. Auxiliary contact kits:
    a. Opens before main switch.
    b. Rated 10A at 125/250 VAC.
    c. One N.O. and one N.C. contact.

D. Enclosures:
1. NEMA 3R rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
2. NEMA 4X rated (metallic):
    a. Body and cover: Type 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
3. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Operating handle padlockable in the OFF position.
4. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
1. Fuses.
2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
   1. The VFD is to be disabled when the switch is in the open position.

D. Permitted uses of enclosure types:
   1. See Material Application Schedule in Specification Section 26 05 00 and Area Environmental Designation and Classification Schedule on Drawings.

**END OF SECTION**

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# SECTION 26 29 23
## VARIABLE FREQUENCY DRIVES - LOW VOLTAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Variable frequency drives (VFDs) for operation of inverter duty motors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 01 61 03 - Equipment - Basic Requirements.
   6. Section 40 61 96 – Process Control Descriptions.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
      b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   4. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017:
         1) Article 430, Motors Motor Circuits, and Controllers.
   6. Occupational Safety and Health Administration (OSHA).
   7. Underwriters Laboratory, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.

B. Qualifications:
   1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
   2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
   3. VFD Supplier shall maintain an authorized service organization within 300 miles of the Project Site.

C. Coordination:
   1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.

a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.

2. Motor and VFD coordination: See Specification Section 01 61 03 and Specification Section 26 05 09.
3. VFD shall be supplied complete with all required control components.
   a. Provide control as indicated:
      1) On the electrical drawings.
      2) As specified in this Specification Section.
      3) As specified in the process control system loop descriptions.
         a) See Specification Section 40 61 96.
   b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
      1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
   c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.
4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
   a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
   b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

## 1.3 DEFINITIONS

A. Variable Torque (VT):
   1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
   2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Constant Torque (CT):
   1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
   2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

C. Constant Horsepower:
   1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
   2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

E. Standard Motor: An AC induction motor that fails to comply with one or more requirements of NEMA MG 1 Part 31.

F. Low Voltage: 600 VAC or less.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Provide a schedule for each VFD including the following information:
      a. Equipment Tag Number.
      b. VFD Complete Catalog Number.
      c. VFD Amp Frame Size.

d. Variable or Constant Torque Rating Basis.
e. Rated Input Current.
f. Rated Continuous Output Current.
g. Rated Short Circuit Current.
h. VFD cable type specified (shielded or non-shielded).
i. VFD Maximum Motor Lead Length for the type of cable used and voltage limits
j. Schedule that indicates the maximum lead lengths between the VFD to motor to limit voltage spikes to indicated levels.
k. Motor Manufacturer.
l. Motor Frame Size.
m. Motor Full Load Amps.
n. Motor Service Factor.
o. As installed motor Lead Length.
p. VFD options provided to meet harmonic or motor protection specifications.

3. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
4. Product technical data:
   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
   c. Manufacturer's installation instructions.
   d. Manufacturer's programming and operating instructions.
   e. See Specification Section 26 05 00 for additional requirements.
5. Fabrication and/or layout drawings:
   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
   d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
   f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
6. Certifications:
   a. Submit with Shop Drawings:
      1) Identification and location of closest authorized service organization.
      2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
   b. Submit prior to shipment:
      1) Certified factory test reports confirming compliance with specified requirements.
   c. Submit after installation:
      1) Certified field service reports showing:
         a) Each VFD is operational.
         b) Each VFD and its driven equipment motor are compatible.
         c) Each VFD responds correctly to the input control signals.
         d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
         e) Measured harmonic levels per Harmonic Protection Requirements Article.
         f) Measured motor terminal peak voltages per Motor Protection Requirements Article.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Approved copy of VFD schedule per Submittals Article.
   3. Manufacturer's instruction manuals.
   4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
   5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
   6. Recommended spare parts list.
   7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen Bradley, PowerFlex 753.

B. No like, equivalent or "or-equal" item or substitution is permitted.

### 2.2 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. All VFDs shall be ultra low harmonic type VFD, with active front end technology.

C. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
   1. Motor control.
   2. Motor overload protection.
   3. Motor and motor branch circuit short circuit and ground fault protection.
   4. Motor and controller disconnecting means.

D. It is the intent of this Specification that VFDs shall be an "engineered" or "configured" drive package in which the VFD chassis, circuit breaker all input, output and bypass power devices, VFD accessories, filters, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

### 2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:
   1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 PCT of base speed of the driven equipment.
   2. VFDs shall be compatible with:
      a. Inverter duty induction motors.
   3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
      a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
   4. VFDs shall be designed to operate successfully under the following site conditions:
      a. Ambient:

1) Temperature: 0-40 DEGC.
2) 95 PCT non-condensing relative humidity.

b. Elevation: Less than 3,300 FT above MSL.

c. Power supply characteristics:
1) 480Vac, 3 PH, 60 Hz, 3 wire, (±10 PCT).
2) Effectively grounded.

B. Ratings and Performance Specifications:

1. Voltage rating:
a. Nominal: 460 or 480 VAC, 3 PH, 60 Hz.
b. Range for continuous full load operation: ±10 PCT of nominal.
c. Voltage imbalance tolerance for full load operation: 3 PCT minimum.

2. Current ratings:
a. Continuous:
1) As indicated on the Drawings.
a) If not indicated on the Drawings, then equal to or greater than the motor nameplate full load current.

b. Short-term overload:
1) VT: 110 PCT for 1 minute.
2) CT: 150 PCT for 1 minute.
3) Permissible for 1 minute every 10 minutes continuously.

c. Short circuit:
1) 65,000 A RMS SYM, minimum.
2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.

3. Efficiency:
a. 97 PCT, minimum, at full speed and full load.
b. 93 PCT, minimum at 1/2 speed and full load.

4. Displacement power factor:
a. 95 PCT, minimum from 50 PCT to 100 PCT speed and load.

5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.

6. Frequency drift:
a. +0.5 PCT of set frequency.

7. Speed regulation (motor dependent): 3 PCT.

8. Speed range: 10:1.

9. Control type:
a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
1) When operating under voltage boost.
2) At frequencies over 60 Hz.

C. Operational Features:

1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25 PCT of rated voltage, or single phase condition: 4 SEC, minimum.
3. Controls power loss ride-through: 500 MSEC, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
a. Minimum of three settings.

b. Adjustable bandwidth, 1 - 5 Hz.

8. Capable of operating without the motor connected for start-up and troubleshooting.

D. The VFD shall be provided with the following minimum user-programmable parameters:
   1. Carrier frequency.
   2. Independent maximum and minimum speeds for forward and reverse operation.
   3. Start frequency and hold time.
   4. Independent linear acceleration and deceleration time.
   5. Preset "jog" speed.
   6. Three critical frequency bands.
   7. One preset speed selectable by logic input.
   8. Volts/Hertz ratio.
   9. Voltage boost, magnitude and frequency range.
   10. Process controller gain, offset and bias.
   11. Current limit.
   12. Overcurrent pickup.
   13. Overcurrent delay.
   14. Ground fault pickup.
   15. DC injection level and time.

E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
   1. General:
      a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
         1) Input under voltage.
         2) Input over voltage.
         3) Input under frequency.
         4) Input over frequency.
         5) Input Phase loss.
         6) DC Bus under voltage.
      b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
         1) Over temperature.
         2) Blown fuse.
         3) Component failure.
         4) Overload.
         5) Short circuit.
         6) Ground fault.
         7) DC Bus over voltage.
         8) External safety input (e.g., motor thermal protection).
         9) Logic fault.
      c. When automatic shutdown occurs, VFD shall restart immediately upon reset, whether automatic or manual.
      d. VFD shall hold cause of trip data for a minimum of four shutdowns in memory.
         1) Data to be accessible through the keypad, local communication link and remotely.
   2. Input protection:
      a. Input circuit breaker or current-limiting fuses with externally operable disconnect.
         1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
         2) Handle pad lockable in the OFF position.
      b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
      c. Incoming line transient suppression.

1) 6000V peak per IEEE C62.41.
2) Phase-to-phase and phase-to-ground protection.

d. Sustained over voltage trip.

3. Internal protection:
   a. Surge suppression and power device snubbers.
   b. Power devices rated at 2.5 times line voltage.
   c. Instantaneous over current trip.
   d. DC bus over voltage trip.
   e. Power device over temperature trip.
   f. Control logic circuit malfunction trip.
4. Output protection:
   a. Inverse-time overload trip:
      1) UL Class 10 characteristic.
   b. Over voltage trip.
   c. Over frequency trip.
   d. Short circuit trip.
      1) Line to line and line to ground.
   e. Ground fault trip.

## 2.4 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
   1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 VAC or 24 VAC or 24 VDC.
   1. 120 VAC supplied by CPT in the VFD.
      a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
      b. CPT shall have two fuses on the primary side and one fuse on the secondary side.
      c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
   2. 24 VAC or 24 VDC supplied by Class 2 power supply in the VFD.
      a. Power supply shall have minimum additional capacity of 33 PCT greater than that required by control devices.
      b. Provide two current-limiting fuses on the AC supply to the power supply.
      c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
   1. Door mounted sealed keypad, membrane type with LED or LCD display.
      a. Messages shall be in English and engineering units.
      b. Drive operating parameters shall be programmable.
      c. Menu driven.
      d. Password security.
      e. Display fault and diagnostic data.
      f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
      g. Gold plated plug-in contacts.
   2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
      a. Minimum indications:
         1) Run.
         2) Stop.
         3) Ready.
         4) Alarm.

5) Fault.
6) Local control.
7) Remote control.
8) Control source local.
9) Control source remote.
10) Speed indication.

b. Minimum control functions:
1) Local/Remote switch.
2) Stop button.
3) Start button.
4) Reset button.
5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
a. On occurrence of more than one condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:
1. Local portable computer interface via communications port:
a. Capability to:
1) Start-Stop VFD.
2) Control VFD Speed.
3) Access fault and diagnostic data.
2. Analog and discrete inputs:
a. Speed reference (setpoint) signal 4-20 mA DC.
b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mA DC process variable signal.
c. RUN command.
d. JOG; ramp and run at full speed.
3. Analog and discrete outputs:
a. 4-20 mA DC output for remote speed indication, as a function of frequency, calibrated 0 to 100 PCT.
b. Drive FAULT contacts.
c. Drive RUNNING contacts.
d. Drive selector switch in AUTO status contacts.
4. Contacts:
a. Contacts shall be rated 2 A inductive at 120 VAC.
b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
c. For submersible pump/motors incorporate the temperature/leak detection monitor and shut down.
d. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.
6. Network communications capability:
a. Provide VFD with communication card, protocol and required programming for digital communication of all VFD program and operational parameters to plant control system via:
1) EtherNet/IP.

## 2.5 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a "dedicated system" in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from either or both the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
   1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
   2. Current distortion: IEEE 519 Table 10.3 based on $I_{SC}/I_L < 20$.

C. PCC shall be considered:
   1. Building service entrance switchgear, switchboard or MCC.
   2. Each MCC, switchboard, switchgear, or panelboard supplying a VFD branch circuit.

D. The Engineer has performed preliminary calculations based on typical VFD data which indicate that the minimum mitigation measures required to meet the specified harmonic criteria. Provide the following:
   1. 6-pulse rectifier topology with input line reactors or DC link reactors, minimum impedance 3 PCT on drive kVA base.
   2. Active harmonic filter (specified elsewhere) at each PCC.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.
   1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
   2. Power system data for analysis shall be taken from the electrical drawings and equipment submittals.
      a. VFDs provided in a package with equipment specified elsewhere, shall be included in the analysis.

G. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

## 2.6 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.
   1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:
      a. Inverter duty motors: 1280 V.
      b. Rise time shall be greater than or equal to 0.1 microsecond.
      c. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.

D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10 PCT shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

## 2.7 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
   1. Each VFD system shall be factory-assembled for installation in an MCC or in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
      a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
      b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
   2. Reactors and/or filters, where required, shall be mounted within the drive enclosure.
   3. Cooling fans, as required, shall be provided to run when drive is running.
   4. Enclosures for separately mounted VFD's:
      a. NEMA Type 1 for installation in Electrical Rooms.
      b. NEMA Type 12 for installation in other unclassified areas.

B. Wiring:
   1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
      a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
      b. Bases with a self-sticking back will not be allowed.
   2. All plug-in contacts shall be gold-plated.
   3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
      a. Provide terminals for shield continuity where required.
   4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
      a. Non-brittle, interlocking, track-mounted type.
      b. Screw terminals will not be allowed.
      c. A terminal for each conductor of external circuits plus one ground for each shielded cable.
      d. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
      e. Not less than 25 PCT spare terminals shall be provided.
      f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal drawings.
      g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
   5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
      a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
   6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
      a. Markings or color code shall match the manufacturer's drawings.
   7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:

1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10 14 00.
2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

### 2.8 COMPONENTS AND ACCESSORIES

A. Reactors:
1. Impedance: 3 PCT.
2. Continuous current: Not less than drive rating.
3. Current overload: 150 PCT for 1 minute.
4. Insulation temperature rating: 180 DEGC.
5. Copper windings.
6. Saturation current rating: 3.5 to 5 times rated current.
7. Hi-potential rating: 2500 VAC line to ground and line to line, for 1 minute.
8. Noise reduction features:
   a. Epoxy over cast coil.
   b. Extra dips and bakes of varnish over continuous wound coil.

### 2.9 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.

### 2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Provide separately mounted VFD enclosure with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
1. Determine the SCCR rating by one of the following methods:
   a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
   b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
   c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

C. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

D. Provide services of manufacturer's representative to perform start-up services.

E. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
   1. The space available on the Drawings shall not be exceeded.

## 3.2 START UP

A. Pre-start-up Services:
   1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period described in Specification Section 01 75 00.
   2. Shall consist of:
      a. Physical and electrical installation check.
      b. Final adjustments and calibration of drive parameters.
      c. VFD operation from simulated input signals.
   3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:
   1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
      a. For each individual VFD.
      b. For the maximum number of VFDs that will be operational at the same time.
      c. When all loads are at 75 PCT load minimum.
      d. Duration: 1 HR minimum.
   2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
      a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
         1) Time shall be measured in microseconds.
      b. Tests shall be performed at full:
         1) Full voltage and speed.
         2) Loaded to 75 PCT minimum.
         3) Duration: 1 HR minimum.
   3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
   1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
      a. Perform all work in the presence of the Owner's designated representatives.
   2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
   3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
      a. Ensure compatibility of VFD with associated control and instrumentation signals.
   4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's designated personnel:
   1. Minimum of 8 HRS at the jobsite.
   2. Include both field and classroom instruction.
   3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
      a. Lubrication.
      b. Troubleshooting.
      c. Repair and replacement.
      d. Parts inventory.
      e. Maintenance records.

**END OF SECTION**

# SECTION 26 32 14
## ENGINE GENERATOR - DIESEL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Engine generator set and accessories.
   2. Generator enclosure, including platform and stairs.
   3. Generator Load Center.
   4. Generator Control Panel
   5. Diesel fuel tank.
   6. Radiator mounted Load Bank.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 48 - Seismic Bracing Systems.
   5. Section 26 36 00 – Transfer Switches.
   6. Section 40 05 00 - Piping and Pipe Fittings - Basic Requirements.
   7. Section 40 05 51 - Valves: Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. S1.4, Specification for Sound Level Meters.
   2. Environmental Protection Agency (EPA):
      a. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   4. National Fire Protection association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017:
         1) Article 701, Legally Required Standby Systems.
         2) Article 702, Optional Standby Systems.
      b. NFPA 110.
   5. Underwriters Laboratories, Inc. (UL):
      a. 2200, Standard for Stationary Engine Generator Assemblies.

B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and installation of the unit.

### 1.3 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:
   1. Legally required standby power during a utility power outage, NFPA 70, Article 701.

B. Generator to be coordinated with microgrid controller. Generator manufacturer to coordinate with switchboard manufacturer and coordinate with the microgrid controller.

### 1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. See Specification Section 26 05 00 for additional requirements.
    c. Engine/generator performance curves.
3. Fabrication and/or layout drawings.
    a. Dimensional plan and elevation drawings.
    b. Wire interconnection drawings.
4. Weights of entire assembly and individual weights of engine, generator, enclosure, and fuel tank.
5. Catalog information and technical description of the proposed engine generator set. Include proposed materials and dimensions for the block, heads, valves, rings, cylinders, pistons, crankshaft, and major bearings and wear surfaces.
    a. Engine and generator manufacturer's names.
    b. Number of cylinders and configuration.
    c. Bore and stroke/piston at rated rpm.
    d. Displacement.
    e. Brake Mean Effective Pressure (BMEP) at rated capacity.
    f. Generator capacity in kW, kVA, and power factor.
    g. NEMA MG 1-22.40 temperature rise rating of generator stator and rotor insulation.
    h. Automatic voltage regulator manufacturer performance criteria.
    i. Number and type of bearings.
    j. Type of generator exciter.
    k. Certified engine horsepower at the ambient and elevation specified.
6. List of accessories provided.
7. List of spare parts provided.
8. Performance curves showing engine efficiency, gross fuel consumption rate, and kW output at design rated output, one-half load, and one-quarter load. Account for design altitude and temperature corrections and for engine parasitic loads.
9. Generator reactance's and time constants in per unit.
10. Generator output waveform and telephone interference factor (TIF).
11. Electrical schematic and wiring diagrams:
    a. Generator control panel.
    b. Main generator.
    c. Voltage regulator.
    d. Battery charging system.
    e. Governing system.
    f. Interconnection wiring diagram for interface with automatic throwover system.
12. Control panel instrument identification inscriptions.
13. Engine generator set motor starting capability and percent voltage dip curve.
14. Heater sizes and voltages.
15. Certifications:
    a. Seismic.
    b. Letter of Certification which documents that the proposed engine emissions meet State of Oregon emission limits for this project installation and application.
16. Test reports:
    a. Factory test reports.

B. Contract Closeout Information:
    1. Operation and Maintenance Data:
        a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Unit installation, startup and operational statement.
2. Field Quality Control test reports.

### 1.5 SITE CONDITIONS

A. Ambient air temperature:
   1. Minimum: 0 DEGF.
   2. Maximum: 105 DEGF.

B. Altitude: 2,300 FT above sea level.

C. Seismic (Earthquake) forces:
   1. See Specification Section 26 05 48.
   2. Engine generator housing, sub-base fuel tank, engine-generator assembly, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Engine generator unit:
      a. Caterpillar.
      b. Cummins Onan.
      c. Kohler.
      d. MTU.
   2. Silencers:
      a. Maxim.
      b. GT Exhaust Systems.
      c. Nelson.
      d. Cowl.
      e. Hapco.
   3. Battery charger:
      a. Manufacturer's standard.
   4. Governor:
      a. Manufacturer's standard.
   5. Radiator:
      a. Manufacturer's standard.
   6. Vibration isolators:
      a. Caldyne.
      b. Mason Inds.
      c. Ace.
      d. Korfund Dynamics.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 EQUIPMENT

A. Emissions Requirements:
   1. A single units emissions shall meet all Federal, State and Local government requirements, including but not limited to:
      a. Environmental Protection Agencies (EPA) New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart IIII.
      b. Applicable EPA Tier.

B. Performance and Configuration requirements:

1. The Unit shall be capable of providing standby power without over or under loading the Unit.
2. Size the Unit for the following:
   a. Parameters:
      1) Maximum voltage dip: 30%.
      2) Maximum frequency dip: 10%.
   b. Loads:
      1) Load Steps to vary depending on generators sizing calculations. Steps for major equipment to be determined during submittal process. Largest equipment to be placed on separate steps for the generator.
3. Deviations for the indicated size on the drawings based on the manufacturer's calculations shall be brought to the attention of the Engineer.

## 2.3 COMPONENTS

A. Engine Generator Unit General:
   1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.
   2. Mount unit on skid suitable for installation on concrete foundation.
   3. Base rating on operation at rated RPM when equipped with all operating accessories.
   4. Standards: UL 2200.

B. Engine:
   1. Four-cycle, full compression ignition, single acting, solid-injection unit, either vertical or V-type pistons turbo charged with after cooling.
   2. Fuel supply: No. 2 Diesel.
   3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
   4. Capable of operating at idle or light loads for extended periods of time.

C. Injection Pumps and Valves:
   1. Type not requiring adjustment in service, which may be individually removed and replaced.
   2. Individual injection pump and valve for each cylinder.
   3. Fuel injection pumps: Positive action, constant-stroke, actuated by cam driven from engine crankshaft.
   4. Fuel lines between injection pumps and valves: Heavy seamless steel tubing.
   5. Flexible fuel line connectors for supply and return connections at pump.

D. Oil Pump:
   1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
   2. Spray cool and lubricate pistons.
   3. Oil filters so that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
   4. Filter elements accessible and easily removable.
   5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
   6. Equip filter system with spring-loaded by-pass valve.
   7. Oil cooler: Water-cooled, engine-mounted.

E. Fuel System:
   1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump capable of supplying fuel at constant pressure against head of 12 FT.
   2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
   3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
   4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.

F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 PCT of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.

G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

H. Electric Starting System:
   1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
   2. Controls to provide automatic cranking of engine when generator is called to start.
   3. Prevent excessive cranking which could damage cranking motor. Refer to NFPA cranking cycles 6.5.4.2.
   4. Automatic stop controls.
   5. Starter motors with positive-engagement feature.
   6. Start time to comply with NFPA 110 Type 10 system requirements.

I. Cooling System:
   1. Capacity for cooling engine at the specified operating conditions.
   2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
   3. Unit mounted radiator.
      a. Core guard flexible duct adapter.
      b. Site glass at top of unit.
      c. Engine driven blower fan.
      d. Low water level cutoff switch.
   4. Provide fan guards.

J. Heater:
   1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
   2. 208 V, single phase or three phase. Power from load center inside generator.
   3. Thermostatically controlled heater shall be sized and UL rated to insure that genset will start within the specified time period and ambient conditions.

K. Silencer:
   1. Suitable type for critical silencing.
   2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.

L. Engine Instruments and Controls:
   1. Engine-mounted instruments:
      a. Oil pressure gage.
      b. Water temperature gage.
      c. Run time meter.
      d. Battery voltage meter.
   2. Automatic cycle cranking and over-crank protection.
   3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
   4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.
   5. Three NO auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.
      a. Contacts shall close when generator is started.

M. Belly-type Fuel Tank:
   1. Double wall sub-base day tank mounted underneath engine generator unit.

2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.
3. Tank connections: Fuel level gauge, fuel lines to generator, fill, vent, drain and pressure relief.
4. Manual overfill protection.
5. Low level warning with contacts for remote alarm.
   a. Set to alarm at 50 PCT of capacity.
6. Critical low level shutoff with contacts for remote alarm.
7. Leak detection alarm with contacts for remote alarm.
8. Capacity: 24 HRS at full load.
9. Factory installed and piped complying with UL 142 for rectangular tanks.

N. Fuel Tank and Leak Detection Monitoring:
1. Manufacturer standard.
2. Configured inputs (minimum):
   a. As on P&ID and as given below.
3. Configured outputs (minimum):
   a. LSHH: 95 percent.
   b. LSH: 90 percent
   c. Low Fuel (25 percent).
   d. Low Low Fuel (10 percent).
   e. Leak (Tank).
4. Fuel gage.
5. One level monitoring assembly to indicate at the following levels:
   a. LSHH: 95 percent.
   b. LSH: 90 percent
   c. LSL: 25 pecent.
   d. LSLL: 10 percent.
6. Provide Analog level element for fuel tank. Connect to generator control panel to display 0-100% fuel level in fuel tank.
7. Leak sensors:
   a. Installed for indication of leak between inner and outer walls of sub-base fuel tank.
8. Accessories, fittings, etc. as required.
9. Provide complete and fully-functional, configured fuel tank and leak detection monitoring system integrated with the equipment provided.

O. Batteries:
1. Lead acid type.
2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.

P. Battery Charger:
1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 VAC input.
3. Malfunction alarm contacts (minimum): low and high battery voltage, weak battery and charger failure.

Q. Generator:
1. Brushless, 4-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
2. Minimum continuous standby ratings:
   a. As indicated on the Drawings, substantiated by manufacturer's standard published curves and conform to NEMA MG 1 specification.
   b. Special ratings or maximum ratings are acceptable, including 90% sustained.
3. Rated to serve up to 50 PCT non-linear load without exceeding rated temperature rise.

4. Minimum efficiency: 92 PCT at 50 to 110 PCT of nominal standby rating.
5. Suitable for simultaneous operation with other future units connected in parallel.
6. Stator and rotor: 130 DEGC temperature rise with minimum Class H insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
7. Directly connect stator to engine flywheel housing.
8. Drive rotor through semiflexible driving flange to ensure permanent alignment.
9. Self-ventilating with suitable blower, air inlet and outlet openings.
10. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
11. Generator drive free from critical torsional vibration within operating range.
12. Provide generator mounted circuit breakers:
    a. Solid state molded case type, with LSI trip settings.
    b. Ratings as indicated.
    c. Feeder Circuit Breaker.
    d. Load Bank Circuit Breaker.

R. Voltage Regulator:
1. SCR type, to maintain 2 PCT voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 PCT including cross-current compensation to provide maximum of 5 PCT unbalance in kVA load sharing between this unit and possible future generators.
2. Automatic protection against short circuits on system.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of plus or minus 5 PCT from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

S. Generator Instruments and Controls:
1. AC voltmeter.
2. AC ammeter and phase selector switch.
3. Frequency meter.
4. Run-off-auto engine, start-stop control switch.
5. Emergency stop.
6. Run time meter.
7. Governor control rheostat.
8. Voltage level adjustment rheostat.
9. Cool down time delay 0-15 minute adjustable.
10. Cycle cranking control.
11. Minimum red shut down indicating lights as follows:
    a. Overcrank.
    b. Overspeed.
    c. Low lubricating oil pressure.
    d. High engine water temperature.
12. Minimum amber alarm indicator lights as follows:
    a. Control switch not in auto position.
    b. Low engine water temperature (less than 70 DEGF).
    c. Low fuel in day tank.
    d. Day tank leak.
    e. Battery charger malfunctioning.
    f. Low battery voltage.
13. Minimum amber pre-alarm indicator lights as follows:
    a. High engine water temperature.
    b. Low lubricating oil pressure.

14. Common dry contact and audible alarm to indicate when one or more alarm or pre-alarm conditions exist.
15. Dry contacts for each of the following conditions:
    a. Not in Auto.
    b. Running.
    c. Warning.
    d. General Alarm.
    e. Diesel Fuel Level Low.
    f. Diesel Fuel Level Low Low.
    g. Diesel Fuel Tank Leak.
16. Provide data communication cable from microgrid controller to SCADA. Provide additional data, not provided thru dry contacts. Coordinate with microgrid controller manufacturer. At a minimum, provide microgrid status and voltage, power, hz and amps information.

T. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

U. Accessory Load Panel: Provide a 208/120v, 100A, 3-phase load center, factory mounted inside the generator enclosure. Provide panelboard as shown on the contract drawings and provide power for the following:
1. Generator control panel UPS or 24V power supply.
2. Engine block heater.
3. Battery charger.
4. Battery warmer.
5. Oil Heater.
6. Enclosure lights and accessories.
7. Motorized louvers.
8. Enclosure heater.

## 2.4 ACCESSORIES

A. Provide interposing relays (24 VDC to 120 VAC) as required for interfacing with customer's 120 Vac monitoring system.

B. Generator additional E-stop button, mounted at the man-door to the Ozone treatment building. Coordinate in the field for optimal location.

C. Generator control panel with HMI panel:
1. Surface factory mounted NEMA 1 enclosure.
2. Circuits:
    a. 24 VDC powered from starting batteries.
    b. Verify circuit voltage to match battery voltage.
3. Provide signal lamps, buzzer, silencing switch, lamp test switch, relays, solid-state components, and engraved function identifications.
4. HMI functions:
    a. Light "ON" to indicate generator is operating to supply power to load.
    b. Separate light for each shutdown or alarm condition and light for each pre-alarm condition and common buzzer with silence/ acknowledge switch.
    c. Shut down indicating lights as follows:
        1) Overcrank.
        2) Overspeed.
        3) Low lubricating oil pressure.
        4) High engine water temperature.
    d. Alarm indicator lights as follows:
        1) Control switch not in auto position.
        2) Low engine water temperature (less than 70 DEGF).

3) Low fuel in day tank.
4) Fuel in day tank rupture basin.
5) Battery charger malfunctioning.
6) Low battery voltage.

e. Pre-alarm indicator lights as follows:
1) High engine water temperature.
2) Low lubricating oil pressure.

f. Provide Allen-Bradley PLC and controls. Provide standard design for PLC and generator control panel. PLC and controls to communicate with microgrid controller, coordinate with manufacturer.

g. Provide HMI at the generator control panel for access to generator controls and parameters.

h. Provide Ethernet/IP connection to the main SCADA at the plant. Provide all cards required to connect the generator control panel to the plant SCADA.

5. Coordinate the controls for generator with Microgrid controller. Microgrid controller is installed inside the switchboard in the electrical room. Coordinate with switchboard manufacturer to integrate the control and status of the generator with the microgrid controller. Microgrid controller will provide start/stop signal based on programming in the controller.

D. Generator set non-walk-in, sound-attenuating and weather protective enclosure:
1. Sheet steel with side servicing panels, air intake louvers and rear control panel access door.
2. Side servicing panels shall have two locking points; all panels and doors are key lockable.
3. Pitched roof with silencing exhaust muffler mounted outside the enclosure.
4. Completely install enclosure on generator set mounting base.
5. Stainless steel hardware.
6. Non-hydroscopic sound insulation.
7. Rodent barriers.
8. Sound levels: 80 dB(A) at 7 meters under full load operation.
9. Enclosure mounted directly to a sub-base fuel tank.
10. Exterior oil and coolant drains with interior valves.
11. Provide generator enclosure with stairs and platforms as required to reach and read the generator control panel, main breaker and load center. Provide on both sides as required. Platform shall be constructed out of aluminum or steel and be custom made for the generator enclosure. Generator manufacturer shall coordinate with the platform and stairs and ensure that they are built and installed for the generator enclosure. Allow for all access doors to have full range of door operation. Maintain a minimum of 36" in front of the load center and generator control panel. Include the platform and stairs in submittal for owner approval.
12. sound attenuation, airflow and pressure drop through the system.
13. Space for mounting electrical panel for serving loads inside enclosure to include but not be limited to lights, unit heaters, engine block heaters, battery chargers, ventilation fans.
14. Provide on-board active load bank, radiator mounted, rated a minimum of 50% of the generator nameplate rating. Active load bank to be sized and specified by the generator manufacturer. Load bank to allow additional loads to generator when not fully loaded. Load bank shall also allow for monthly testing and running of the generator for maintenance.

## 2.5 SOURCE QUALITY CONTROL

A. Individually test each prime mover.
1. Apply derating factors for the proposed site to test data.
2. Continuously test for a period no less than 2 HRS.
3. Test procedure shall be as follows:
a. Start prime mover and upon reaching rated RPM, pick up 100 PCT of nameplate KW rating at rated power factor in one step.

b. Observe and record the cranking time(s) required to start and run for each prime mover.
c. Observe and record the time required to come up to operating speed for each prime mover.
d. Record voltage and frequency overshoot for each prime mover.
e. Record voltage, frequency and amperes.
f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

### 2.6 MAINTENANCE MATERIALS

A. Spare Parts:
1. Provide manufacturer's recommended spare parts and consumables, including but not limited to the following:

| ITEM | QUANTITY |
|---|---|
| Diesel fuel line filter elements | 3 complete sets |
| Primary and secondary fuel filters | 2 complete sets |
| Antifreeze fluid | 6 gallons |
| Engine oil | 6 gallons |
| V-belts | 1 complete set |
| Lubricating oil filter elements with gasket | 3 complete sets |
| Air cleaner filter element | 2 complete set |
| Spare fuses | 2 complete sets |

2. Accessories:
   a. Universal General Purpose Spill Kit:
      1) Manufacturer:
         a) Interstate Products - Model GPSK30, or equal
      2) Design and Fabrication (minimum requirements):
         a) Absorbent pads: 50
         b) Absorbent socks: 6
         c) Absorbent pillows: 4
         d) Goggles: 1
         e) Gloves: 1
         f) Disposable bag: 1
         g) 30 Gallon poly drum with lid: 1

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions and Specification Section 26 05 48.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DEGF.

C. Provide full fuel tank upon completion of all testing.

D. Install all wiring to engine in conduit.
1. Control wiring on engine may be factory installed in high temperature loom.

E. Mount on concrete pad, see structural drawings for pad detail.

F. Sound attenuating engine generator enclosure:
   1. Field test installation under 100% load and expected site load.
   2. Use precision sound measuring instrument meeting ANSI S1.4 Type 1.

## 3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-startup adjustments and installation checks.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
   5. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.
   6. Provide coordination with switchboard manufacturer and integration with the microgrid controller.

B. Provide two load tests and one cycle crank test.
   1. Tests one and two shall be for continuous period of no less than 2 HRS each.
   2. Engineer and Owner shall be notified seven days prior to testing.
   3. Test number one:
      a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
      b. Observe and record the time delay on engine start.
      c. Observe and record the cranking time(s) required to start and run for each prime mover.
      d. Observe and record the time required to come up to operating speed for each prime mover.
      e. Record voltage and frequency overshoot for each prime mover.
      f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.
      g. Record voltage, frequency and amperes.
      h. Record oil pressure, water temperature where applicable and battery charge rate at 5-minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.
      i. Return normal power to facility, record time delay on retransfer to normal for each switch and cooldown time delay for each prime mover.
   4. Test number two:
      a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100 PCT of nameplate KW rating in one step.
         1) Unity power factor is acceptable for on-site testing
      b. Observe and record the cranking time(s) required to start and run for each prime mover.
      c. Observe and record the time required to come up to operating speed for each prime mover.
      d. Record voltage and frequency overshoot for each prime mover.
      e. Observe and record time required to achieve steady-state condition.
      f. Record voltage, frequency and amperes.
      g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.
   5. Cycle crank test:
      a. Perform test for each prime mover.
         1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.
         2) Put control switch into "run" position to cause prime mover to crank.
      b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.

1) Upon starting and running of the prime mover, further cranking shall cease.
2) Two means of cranking termination shall be utilized so that one will act as a backup to the other to prevent inadvertent starter engagement.
3) Cranking limiter time shall be 75 seconds for cycle crank.

6. Furnish load banks of required ratings necessary for tests.
7. Record engine fuel consumption by means of test equipment.
8. Test all safeties specified for generator instruments and controls and generator remote annunciator panel as recommended by manufacturer and as required to verify proper operation.
9. The Contractor shall be responsible for fuel and all consumables use during the test.
10. When testing complete, refill the fuel tank to full.
11. All testing shall be performed with coordination with the switchboard and microgrid controller manufacturer. Confirm that generator will start and run upon utility outage and run in conjunction with solar at all times.

**END OF SECTION**

# SECTION 26 36 00
TRANSFER SWITCHES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Manual transfer switches.
   2. Automatic transfer switches.

B. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Electrical - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 26 05 00.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Automatic transfer switches:
      a. Automatic Switch Company.
      b. Kohler.
      c. Onan.
      d. ABB Zenith.
   2. Manual transfer switches:
      a. Automatic Switch Company.
      b. Eaton.
      c. Square D Company.
      d. Siemens.
      e. ABB Zenith.

## 2.2 MANUAL TRANSFER SWITCH

A. Double throw load break rated with:
   1. Quick-make/quick-break operating mechanism.
   2. Deionizing arc chutes.
   3. Double-break rotary action shaft and switchblade shall be manufactured as one common component.
   4. Clear line shields to prevent accidental contact with line terminals.

B. Operating handle: Easily recognizable and pad lockable in both positions.

C. Wiring configuration to allow single load to be supplied by a normal or alternate source.

D. Ratings:
   1. Voltage and amperage: As indicated on Drawings.
   2. Short circuit withstand: Equal to or greater than the upstream equipment.

E. Enclosure:
   1. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. With or without knockouts, hinged and lockable door.
   2. NEMA 4X rated:
      a. Body and cover: Type 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

F. Standards: NEMA KS 1, UL 98.

## 2.3 AUTOMATIC TRANSFER SWITCH

A. Construction:
   1. Electrically operated mechanically held, double throw, air-break type.
   2. Silver-surface main contacts and protect by arcing contacts.
   3. Switch shall have provisions for visual inspection of switch blades and contacts.
   4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
   5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.
   6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
   7. Ratings:
      a. Continuous duty in both normal and emergency.
      b. Three-phase, three pole, four-wire.
      c. Voltage and current ratings as indicated on the Drawings.
      d. Short circuit withstand rating equal to or greater than the normal source electrical gear.
   8. Standards: UL 1008.

B. Operation:
   1. Microprocessor based control module.
   2. Open transition.
   3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
   4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
   5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
      a. Normal source voltage sensing.
         1) Adjustable pickup from 85-100% of rated voltage, factory set 90%.

2) Adjustable dropout from 75-98% of pickup setting, factory set 85%.
b. Emergency source voltage and frequency sensing:
1) Adjustable pickup from 85-100% of rated voltage, factory set 90%.
2) Fixed voltage dropout at 85% of pickup setting.
3) Adjustable pickup from 90-100% of rated frequency, factory set 95%.
4) Fixed frequency dropout at 88% of pickup setting.

6. Time delays:
a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
1) Automatically bypassed when emergency source fails and normal source is available.
d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
a. Enable and disable function.
b. Selectable to exercise with or without transferring load.
c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
d. Adjustable day of the week exercise setting, factory set for Monday.
8. Inphase monitor:
a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
b. Inphase transfer accomplished if both sources are within 2 Hz of rated frequency and 70% or more of rated voltage.
9. Provide connections to SCADA for alarms and indications of transfer switch. Connect via Ethernet/IP communications from ATS to SCADA.
10. Provide start/stop signals to generator control panel.

C. Enclosure:
1. NEMA 12 rated or open enclosure for mounting inside the switchboard.
2. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
3. Install inside the main switchboard, SWBD-300. Coordinate with switchboard manufacturer for installation in switchboard section.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in one line diagram.

C. Mounting of automatic transfer switches:
1. Inside switchboard.

D. Manual Transfer Switch Enclosure:
1. Permitted uses of NEMA 1 rated enclosure:
a. Surface mounted in areas designated as dry.
2. Permitted uses of NEMA 4X rated enclosure:
a. Surface mounted in areas designated as wet and/or corrosive.

### 3.2 FIELD QUALITY CONTROL

A. Automatic Transfer Switch Testing:

1. Simulate power outage by opening normal source overcurrent device.
   a. Verify engine generator starts and switch transfers in the specified time.
2. Close normal source overcurrent device to simulate the return of normal power.
   a. Verify the switch retransfers and engine generator shuts down in the specified time.
3. Perform a manual transfer and retransfer.
4. Verify the indicator lights function properly.

**END OF SECTION**

# SECTION 26 37 19

## MICROGRID CONTROLLER – POWER XPERT MICROGRID CONTROLLER 3000

## PART 1 - GENERAL

### 1.1 SCOPE

A. This specification describes the requirements for the Microgrid and Distributed Energy Resources (DER) controller. The microgrid controller shall operate as a standalone controller or integrated into a complete assembly (e.g., switchboard or switchgear).

B. The microgrid controller manufacturer shall coordinate features of distribution equipment directly related to microgrid DER control and monitoring.

C. The microgrid controller shall coordinate and perform basic control functions with the following types of microgrid components: Energy Storage Systems (ESS), Photo Voltaics (PV), generators, and UPS (UPS status and alarms only, no control).

### 1.2 REFERENCES

A. The codes and standards listed below shall be incorporated into this Specification to the context referenced. The edition/revision of each referenced code and/or standard shall be the most current version available as of the date of the Contract Documents, unless explicitly stated otherwise.

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. IEEE 1547-2018, "IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces"
   b. IEEE Std 1613™-2009, IEEE Std 1613a™-2011, and IEEE Std 1613.1™-2013, "IEEE Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations"
   c. IEEE 2030.7, "Standard for the Specification of Microgrid Controllers"
   d. IEEE 2030.8, "Standard for the Testing of Microgrid Controllers"
   e. IEEE C37.90, "IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus"
2. International Organization for Standardization (ISO):
   a. ISO 9001, "Quality Management Systems – Requirements"
3. Underwriters Laboratories, Inc. (UL):
   a. UL 1741, "Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"
   b. UL 1741 SA, "Advanced Inverter Testing"
   c. UL 1741 SB, "Interoperability Conformance Testing"
4. National Fire Protection Agency (NFPA):
   a. NFPA 70, "National Electrical Code"
   b. NFPA 70E, "Standard for Electrical Safety in the Workplace"
5. National Electrical Code (NEC)
6. North American Electric Reliability Corporation Critical Infrastructure Protection standards (NERC CIP)
7. International Electrotechnical Commission (IEC):
   a. IEC 60255-1, "Measuring Relays and Protection Equipment"
   b. IEC 61850-3-ed2, "Power Utility Automation"
8. Federal Communication Commission (FCC)

B. The microgrid controller may comply with other applicable state regulations and local codes not explicitly mentioned here.

C. Information about the microgrid controller shall be provided to help determine compliance to local codes and standards in the jurisdiction of the Owner.

D. Type Tests and Certifications:
   1. The microgrid controller shall be compliant to IEC 61850-3 (minimum) for climatic environmental conditions.
   2. The microgrid controller shall have an operating temperature of -40 to 75 Celsius (-40 to 167 Fahrenheit).
   3. The microgrid controller shall be compliant to IEC 61850-3 (minimum) for mechanical environmental conditions.
   4. The microgrid controller shall be compliant to IEEE Std 1613™-2009, IEEE Std 1613a™-2011, and IEEE Std 1613.1™-2013 standard class 2 for LC optical port (minimum).
   5. The microgrid controller shall have a cTUVus certification.
   6. The microgrid controller shall meet Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulations.
   7. The microgrid controller shall be Restriction of Hazardous Substances (RoHS) compliant.
   8. The microgrid controller shall be Waste Electrical and Electronic Equipment (WEEE) compliant.

## 1.3 RELATED SECTIONS

A. Related sections include, but shall not be limited to, the following:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.
   3. Refer to the following Specifications for additional requirements.
      a. Section 26 24 13.20 Switchboards
      b. Section 26 24 16.33 Panelboards
      c. Section 26 09 13 Electrical Power Management Systems (EPMS)
      d. Section 25 00 10 Intelligent Building Management System (iBMS)

## 1.4 ACRONYMS

| | |
|---|---|
| BESS | Battery Energy Storage System |
| DER | Distributed Energy Resource |
| COTS | Commercial Off the Shelf |
| ESS | Energy Storage System |
| HMI | Human-Machine Interface, generally a graphic workstation |
| MPA | Modular Power Assembly |
| PXMC | Power Xpert™ Microgrid Controller (PXMC) is the Eaton family of microgrid controllers that manage the interfaces, transitions, and optimization of DER assets |
| PV | Solar photovoltaic system |
| RTC | Real-Time Clock |
| SDLC | Secure Development Life Cycle |
| SFP | Small Form-factor Pluggable |
| SNTP | Simple Network Time Protocol |
| SoC | State of Charge |
| SOE | Sequence of Events |
| ToU | Time of Use |
| UPS | Uninterruptable Power Supply |

### 1.5 QUALIFICATIONS

A. The microgrid control system manufacturer of software and firmware shall have been engaged in the manufacture, development, installation, and commissioning of the microgrid systems for a period of at least ten (10) years and can demonstrate that these microgrid controllers have been utilized in satisfactory use in functioning systems for similar applications.

B. The manufacturer of the microgrid controller shall also be the supplier of the power components used within the assembly.

C. The manufacturer of the microgrid controller shall be an ISO 9001 certified manufacturer.

D. The vendor shall have implemented an ISO 9001 certified Quality Management System.

E. Project materials shall be built, tested, and labeled in accordance with applicable NEMA, ANSI and UL standards and installed to meet local regulations and ordinances.

### 1.6 WARRANTY

A. General Warranty: The microgrid controller hardware shall be protected against defects in manufacturing for a period of ten (10) years.

B. Software upgrades shall be included within the warranty for a period of one (1) year after commissioning.

### 1.7 EXTENDED WARRANTY SERVICES

A. Any requirements for extended service contracts, such as may be required for computers and peripherals, etc.

### 1.8 SUBMITTALS

A. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.

B. Submit required microgrid controller data and shop drawings specific to each microgrid controller and accessory proposed. In addition, include the following information:
   1. System Architecture Diagram
   2. Documentation including:
      a. User Guide
      b. Sequence of Operations
      c. Operation and Maintenance Manuals

C. Operation and Maintenance Manuals
   1. The manufacturer of the microgrid controller shall provide one electronic copy of operation and maintenance manuals for all equipment supplied and submitted for approval. After approval of the operation and maintenance manuals, the manufacturer of the microgrid controller shall provide one hard copy of the manuals plus one electronic file copy of the manuals for Owner records.

## PART 2 - MICROGRID CONTROLLERS

### 2.1 MANUFACTURERS

A. Eaton PXMC 3000 (Basis-of-Design)

B. Siemens

C. Square D

D. The listing of specific manufacturers above shall not imply acceptance of their microgrid controllers that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Microgrid controllers in compliance with the specification and manufactured by others not named shall be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

## 2.2 SYSTEM COMPONENTS

A. Installation Configurations
   1. The microgrid controller shall have the following installation configurations:
      a. Standalone (e.g., DIN-rail mounted or shelf-mounted in an enclosure)
      b. Integrated within a switchboard or switchgear.
      c. Integrated within a Modular Power Assembly (MPA)

B. Communication Interfaces – The microgrid controller shall have the following minimum number and types of communication interfaces:
   1. Two independent Ethernet ports for all models.
   2. One (1) Small Form-factor Pluggable-based (SFP) connector at 1Gbit/s.
   3. Two (2) serial ports (RS-232/RS-485).
   4. A USB port on the front panel for maintenance purposes.

C. Storage
   1. The microgrid controller shall have at least 8 GB of non-volatile memory.

D. Inputs/Outputs – The microgrid controller shall have the following minimum number of onboard inputs and outputs:
   1. Two (2) built-in Form C output relays (on controller module).
   2. One (1) built-in binary input 24 Vdc (on controller module).
   3. 24 binary inputs and 12 binary outputs (on digital I/O modules).
   4. Additional IO channels shall be supported using Modbus connected IO modules (e.g., remote IO).

E. Power Supply
   1. Internal Power Supply:
      a. The microgrid controller shall support an internal low voltage (24-48Vdc) power supply.
   2. AC Power Supply:
      a. If AC is required, then an AC/DC 24V power supply shall be provided.
   3. Uninterruptable Power Supply (UPS):
      a. The manufacturer shall include a 15-minute UPS backup for the controller.

F. Environmental Conditions
   1. Operating Temperature:
      a. The microgrid controller shall have an operating temperature of -40° to 75° Celsius (-40° to 167° Fahrenheit).

G. Microgrid Control Capability
   1. Asset Integration:
      a. Vendor Agnostic:
         1) The microgrid controller shall be vendor agnostic. Customers can reduce engineering costs and speed microgrid commissioning time by selecting distributed energy resources for the microgrid system that have been developed and validated by the manufacturer
      b. Device Integration:
         1) Device integration shall support pre-validated asset templates (e.g., with communication maps and control interface logic).
      c. Data Interfaces:
         1) Supported inputs from the DER assets shall include monitoring, status, mode, and alarm/health inputs necessary to control the asset.

2) Control command and setpoints applicable to the DER type including On/Off, local/remote, Run/Stop, and setpoints (including real, reactive power, curtail set point, State of Charge (SoC)).

d. Asset Interfaces:
1) The microgrid controller shall support asset interfaces including Modbus TCP, Modbus RTU, and DNP3 as defined in IEEE 1547.

e. SunSpec Modbus Profiles:
1) The microgrid controller shall support DER assets with SunSpec Modbus profiles.

2. Embedded Control Engine:
a. The microgrid controller shall have an embedded control engine with behavior defined by parameterization/configuration and not direct control code changes (for supported operations).

3. Advanced or Custom Operation:
a. If required for advanced or custom operation, the control logic changes shall be possible.

H. Supported DERs
1. The following number of assets shall be supported:
(1) Bus
(2) Circuit breaker
(3) Meter
(4) PV – Solar controller
(5) BESS Controller (Future)
(6) Generator
(7) Utility

2. Refer to project drawings for specific requirements.

I. Control Modes and Sequence of Operations
1. Control Modes:
a. Automatic and manual control modes shall be supported.
b. While in automatic mode, the microgrid controller shall manage transitions and provide set points.
c. While in manual mode, the microgrid controller shall provide the ability for the user to initiate transitions (e.g., planned island), provide manual setpoints, and manage loads.

2. Sequence of Operations:
a. The microgrid controller shall continuously monitor the state of the power system to provide status information and detect outages and other anomalous conditions (e.g., metering information, breaker trip, loss of utility).
b. The microgrid controller shall support the ability to blackstart all assets. When in automatic control mode, the microgrid controller will transition to the highest priority grid-forming source and sequentially restore power to loads, and other generating assets (e.g., PV, BESS, and/or generator) configured. When in manual mode, the user shall be able to manually blackstart using one of the grid-forming sources.
c. Unplanned Islanding
1) The microgrid controller shall support automatic system islanding detection by monitoring breaker status, utility status indication, or other signals from the surrounding power system protection.
2) The microgrid controller shall support the shedding of all controllable loads and the curtailment of PV generation during an unplanned island condition.
3) The microgrid controller shall support open transition to the next priority grid-forming asset. The customer shall have the ability to specify and change priority of grid-forming assets.
4) The microgrid controller shall sequentially restore power to the controlled loads according to priority:
a) Critical loads first

b) Additional loads (if enough generating capacity is available and by priority)

5) PV and other generating assets (e.g., BESS) shall be connected after a configured delay to support the bus.

6) The microgrid controller shall support automatic transition back to higher priority grid-forming source when available (and when in automatic control mode).

d. Planned Islanding

1) When in manual control mode, the microgrid controller shall support planned (e.g., customer initiated) islanding transition to a specified grid-forming asset. This transition shall be an closed transition.

2) In islanded mode, the microgrid controller shall optimally manage loads, PV, and BESS to maximize renewable energy usage, maintain the desired SoC for BESS, and connect the maximum number of loads while ensuring the stable operation of the islanded microgrid.

e. The microgrid controller shall provide automatic load shedding to maintain system stability. The microgrid controller shall shed controlled load based on the power deficit at one or more power sources (utility intertie connections and/or generators). When a contingency occurs, this scheme will shed controlled loads to balance microgrid load with the remaining available generation capacity, thereby stabilizing the system.

f. The microgrid controller shall continuously monitor system conditions at interval points and determine when it is acceptable to resume real and reactive power flow across these intertie points. The microgrid controller shall close breaker(s) at utility tie point(s) after conditions are satisfied.

g. The microgrid controller shall support PV curtailment in all operation modes, assuming PV inverter supports curtailment as well.

J. Energy Efficiency Optimization Features:

1. Supported Energy Management Functions:

a. The microgrid controller shall support the following energy management functions:

1) Peak shaving/demand charge reduction

2) Time of Use (TOU)

3) PV self-consumption

K. Software Features

1. Protocols and Data Concentration:

a. Data Gathering Protocols:

1) The microgrid controller shall support the following industry standard protocols for gathering data from IEDs:

a) Modbus

b) DNP3 (IEEE Std 1815™-2012 standard)

b. Data Sending Protocols:

1) The microgrid controller shall support the following industry standard protocols for sending data to control centers or enterprise applications:

a) MODBUS

b) DNP3 (IEEE Std 1815™-2012 standard)

c. Open Architecture Integration:

1) The microgrid controller shall support integration with Commercial Off the Shelf (COTS) components into an open architecture and not require or use proprietary or vendor specific protocols.

L. Security

1. Secure Development Life Cycle (SDLC):

a. The microgrid controller shall be developed using a Secure Development Life Cycle that is certified against a third-party standard (e.g., IEC 62443-4-2 or UL 2900).

b. The microgrid controller shall support a full life cycle vulnerability management and response program. The program shall be publicly available and provide options reporting and receiving microgrid controller notifications of vulnerabilities.

2. Firmware Authenticity and Integrity:
    a. The microgrid controller shall provide authenticity and integrity checking of all firmware (e.g., all firmware updates are digitally signed by the manufacturer). The signatures of all updates shall be verified before loading.
3. Cybersecurity Features:
    a. The microgrid controller shall implement cybersecurity features (commonly required by NERC CIP, IEEE Std 1686-2022, and other IED, DER, and Microgrid standards):
        1) Role-based access control.
        2) Applying least privilege to system resources.
        3) Log in management (limit consecutive access attempts and lockout).
        4) Secret based authentication (with minimum length and complexity requirements).
        5) Only necessary ports and services are enabled.
        6) Major functions have associated access level or permissions.
            a) System access management includes system lockup upon failed access attempts.
            b) Password protection shall be enforced.
        7) Supervisory monitoring and control:
            a) Alarms and sequence of events of at least 20,000 entries.
4. Audit Logging Capability:
    a. The microgrid controller shall support audit logging capability to include:
        1) Audit security related and critical change events (login, logout, failed access, configuration change).
        2) A minimum of 2048 cybersecurity events logged.
        3) Audit logs protected from modification or deletion.
        4) System logs shall be retrieved using a standard system such as Syslog.
5. Encryption and Certificates:
    a. The microgrid controller shall support at a minimum TLS 1.2 with AES 256 bits encryption.
    b. The microgrid controller shall support X.509 certificates for authentication and encryption key management for protocols.
6. Integrated Firewall:
    a. The microgrid controller shall have an integrated built-in firewall.

M. Time Synchronization
1. Real-Time Clock (RTC):
    a. The microgrid controller shall have an RTC that maintains accuracy while free running (i.e. when disconnected from the time source) or when the unit is powered off.
2. Synchronization Protocol:
    a. The microgrid controller's RTC shall be synchronized using Simple Network Time Protocol (SNTP).
3. Time Zone Support:
    a. The microgrid controller shall support multiple time zones across client and server protocol instances.
4. Event Logging:
    a. All time events (updates, source change, etc.) shall be logged.

N. Configuration Tools
1. Offline and Online Configuration:
    a. The configuration tool shall allow offline and online configuration of the microgrid controller.
2. Versioning Support:
    a. The configuration toolset shall support versioning.
3. Backward Compatibility:
    a. The configuration toolset shall be backward compatible – it shall allow the configuration of older firmware versions and conversion to newer versions.
4. Configuration Parameter Validation:

a. The configuration tool shall include a configuration parameter validation mechanism.

5. Importing Predefined Asset Integration Templates:
   a. The configuration tool shall be able to import predefined asset integration templates (including communication maps, and mapping to the control interface).

O. Visualization and User Interface
1. Embedded Web Server:
   a. The microgrid controller shall have an embedded web server providing secure remote access to the device without requiring an additional Human-Machine Interface (HMI) configuration.

P. Embedded Web HMI Views:
1. The embedded web HMI shall provide the following views:
   a. Dashboard: displaying aggregated source and consumption.
   b. Alarms and Logs: displaying system alarms and warnings.
   c. Trends: displaying real-time power and BESS data.
   d. Asset Drill Down: displaying a detailed view of the monitoring and status information of each DER on the system.
2. Additional Performance Metrics:
   a. The embedded web HMI shall support viewing additional performance and real-time metric on the system (e.g., hero tags).

Q. Supported States and Transitions
1. IEEE 2030.7-2017 Supported States and Transitions:
   a. The microgrid controller shall support states and transitions as defined in IEEE 2030.7-2017, including:
      1) Planned islanding
      2) Unplanned islanding (utility outages)
      3) Blackstart
2. Grid-Connected Mode:
   a. The microgrid controller shall support a grid-connected mode.

R. Event Recording and Monitoring
1. Sequence of Events (SOE) System:
   a. The microgrid controller shall include a SOE system that allows recording critical transitions, I/O, and other operations into non-volatile memory.

S. Alarm and Event Management
1. Alarm Management System:
   a. The microgrid controller shall include an alarm management system with snooze/clear mechanism.
2. Remote Accessibility:
   a. The alarm management system shall be accessible remotely (via web browser).
3. Alarm History:
   a. The alarm management system shall keep the alarm history in non-volatile memory.

## 2.3 LICENSING AND UPGRADES

A. Licensing:
1. No additional licensing for the controller shall be required.

B. Remote Upgradability:
1. The microgrid controller shall be remotely upgradable.

C. Microgrid controller Upgrades:
1. Microgrid controller upgrades shall be made available.

D. Update Availability:
1. Updates shall be available periodically for major/minor releases and as needed to address security vulnerabilities.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

A. Qualified Installer:
   1. A qualified Installer shall install all microgrid equipment per the manufacturer's recommendations and provided design documents from the manufacturer of the microgrid controller. All programming, startup and commissioning will be supplied by the manufacturer of the microgrid controller.
   2. Startup Personnel Qualifications: Project participants shall engage specially trained personnel who are directly employed by the manufacturer of the microgrid controller and distribution system protective devices.
   3. Installer shall coordinate directly with the generator manufacturer to ensure compatibility and ensure generator works with the microgrid controller.
   4. Manufacturer to provide technician or engineer to be present during testing of the microgrid controller and ensuring transfer scheme works with Utility, solar, BESS and Generator.

B. Securing Hardware:
   1. All necessary hardware to secure the assembly in place shall be provided by the Installer.

### 3.2 OPERATION AND MAINTENANCE

A. Maintenance Programs
   1. Off-Site Maintenance:
      a. The annual maintenance program shall be provided for one (1) year after commissioning, and shall include the following:
         1) Site Visits: One site visit per year to review the operation of the microgrid control system.
         2) Software Updates: Updates to the software to ensure uninterrupted and optimal performance.
         3) Reduced Service Rates: Discounted rates for on-call troubleshooting and checking of wire terminations.
         4) Backup Services: Comprehensive backup services to ensure system reliability.
         5) Provided Reports: Detailed maintenance reports provided to the client via email at the conclusion of each maintenance session, including the date and specifics of updates performed.
   2. Phone Support:
      a. 24-hour emergency phone support with an 8-hour response time shall be made available upon request.
   3. Additional Services:
      a. Additional services that may be requested by City of Ashland.

### 3.3 TRAINING

A. Training Program:
   1. The manufacturer of the microgrid controller will provide a one-day training class for up to five students (unless specified otherwise by the engineer). The course will cover the operation and maintenance of the newly installed microgrid controller.

## END OF SECTION

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# SECTION 26 42 13
## CATHODIC PROTECTION SYSTEM - SACRIFICIAL ANODE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material, design and installation requirements for:
      a. Sacrificial anode cathodic protection system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 26 05 19 - Wire and Cables - 600 Volt and Below.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
   2. ASTM International (ASTM):
      a. B80, Standard Specification for Magnesium-Alloy Sand Castings.
      b. B843, Standard Specification for Magnesium Alloy Anodes for Cathodic Protection.
   3. NACE International (NACE):
      a. RP0169, Standard Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
      b. RP0193, Standard Recommended Practice External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms.
      c. RP0285, Standard Recommended Practice Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.
   4. Code of Federal Regulations (CFR):
      a. 49 CFR 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards.
      b. 49 CFR 195, Transportation of Hazardous Liquids by Pipeline.
      c. 49 CFR 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electric Code (NEC).

B. Qualifications.
   1. Corrosion expert: Accredited or certified by NACE as a NACE Accredited Corrosion Specialist or NACE Certified Cathodic Protection Specialist or registered professional engineer who has certification or licensing that includes education and five years of experience in corrosion control of metallic surfaces of the type under this contract.

### 1.3 SYSTEM DESCRIPTION

A. Obtain the services of a corrosion expert to design, supervise, inspect and test the installation and performance of the cathodic protection system in complete compliance with:
   1. NFPA 70.
   2. All applicable Federal, State and Local regulations.
   3. 49 CFR 192 for gas pipelines.
   4. 49 CFR 195 for hazardous liquid pipelines.
   5. 49 CFR 280 for underground fuel storage tanks.
   6. Minimum requirements of this Specification Section.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products required for the complete system.
   3. Fabrication and/or layout drawings:
      a. System design calculations.
      b. Installation details.
      c. Detailed plan drawings showing locations of all cathodic protection components.
      d. Detailed wiring and connection diagrams.
   4. Certifications:
      a. Corrosion expert qualifications.

B. Operation and Maintenance Manual:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Training course outline.
   3. Certified performance test results with tabulated field test measurements by corrosion expert.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. Anodes shall be stored inside a building.
   1. Damage as a result of improper handling or being exposed to precipitation, shall be resacked and the required backfill added.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cathodic protection system:
      a. Corrpro.
      b. Corr Tech.
      c. De Nora.
      d. Electrochemical Devices.
      e. MASA.
      f. MATCOR.
      g. Southern Cathodic Protection Company.
      h. Tinker-Rasor.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 COMPONENTS

A. Magnesium Anodes:
   1. H-1 Grade B standard potential type:
      a. Conform to ASTM B80, Alloy AZ63.
      b. Open circuit potential: 1.53 to 1.55 V.
      c. Chemical composition:
         1) Aluminum: 5.3 to 6.7 PCT.

2) Zinc: 2.5 to 3.5 PCT.
3) Manganese: 0.15 PCT minimum.
4) Silicon: 0.2 PCT maximum.
5) Copper: 0.05 PCT maximum.
6) Nickel: 0.003 PCT maximum.
7) Iron: 0.003 PCT maximum.
8) Other impurities: 0.2 PCT maximum total.
9) Magnesium: Remainder.

2. High potential type:
   a. Conform to ASTM B843.
   b. Open circuit potential: 1.75 to 1.77 volts.
   c. Chemical composition:
      1) Aluminum: 0.01 PCT maximum.
      2) Manganese: 0.5 to 1.3 PCT.
      3) Silicon: 0.05 PCT maximum.
      4) Copper: 0.02 PCT maximum.
      5) Nickel: 0.001 PCT maximum.
      6) Iron: 0.03 PCT maximum.
      7) Other impurities: 0.05 PCT each maximum or 0.3 PCT maximum total.
      8) Magnesium: Remainder.

B. Packaged Anode:
   1. Anodes shall be provided in package form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack.
      a. Anodes shall be centered by means of spacers in the backfill material.
   2. Chemical composition of backfill material:
      a. Gypsum: 75 PCT.
      b. Bentonite: 20 PCT.
      c. Sodium Sulphate: 5 PCT.

C. Lead Wires:
   1. Factory installed.
   2. Minimum 12 AWG solid copper.
   3. Minimum of 10 FT, unspliced.
   4. NFPA 70 Type TW or RHW.

D. Test Stations:
   1. Flush-curb-box type:
      a. Flared ABS plastic pipe shaft, 5 IN DIA, 18 IN long.
      b. Lid and collar:
         1) Cast iron.
         2) Lockable.
         3) Yellow in color.
         4) "CP TEST" embossed legend.
      c. Insulated terminal block connected to the test head cap.
   2. Insulated terminal block:
      a. Phenolic plastic.
      b. Terminal screws, nuts and lock washers: Nickel plated.
      c. Shunts and variable resistors as required.

E. Miscellaneous Components:
   1. Wire other than lead: Per Specification Section 26 05 19.
   2. Wire connectors: Per Specification Section 26 05 19.
   3. Wire markers: Per Specification Section 26 05 00.

## PART 3 - EXECUTION

### 3.1 DESIGN CRITERIA AND INSTALLATION

A. The corrosion expert shall make at least three visits to the project site:
   1. The first visit shall be fact finding in nature to obtain data for the design of the system (e.g., soil resistivity, pipeline coatings to be used).
   2. The second visit shall include training the contractor on the installation practices and supervising the installation.
   3. The third visit involves testing the installed system and training applicable personnel on proper maintenance techniques.

B. Design and installation standards:
   1. NACE RP0169 for underground metallic piping systems.
   2. NACE RP0193 for on-grade metallic storage tank bottoms.
   3. NACE RP0285 for underground storage tank systems.

C. Provide a complete cathodic protection system on the following metallic structures:
   1. Natural gas pipelines.
   2. Fire hydrants.
   3. Valves.
   4. Connectors or change-of-direction devices.

D. The proposed system shall achieve a minimum metallic surface-to-soil potential of -850mV with reference to a copper-copper sulfate reference cell.
   1. The anode system shall be designed for a life of 25 years of continuous operation.

E. Corrosion expert to ensure that isolating flanges and/or dielectric unions are installed at locations indicated and in the proper manner.

F. Flush-curb-box test stations shall be centered in a 18 IN x 18 IN x 4 IN concrete slab.

G. Conductor color coding:
   1. Anode lead wire: Black.
   2. Structure lead wire: White.
   3. Reference electrode lead wire: Red.

H. Owner's Standards:
   1. Anode size: 17 LBS.
   2. Anode location: 5 FT from and 5 FT below protected pipeline.
   3. Test station at every anode location.

### 3.2 FIELD QUALITY CONTROL

A. Owner shall have the option to witness the installation and testing.
   1. Notify the Owner 14days in advance of the installation and testing.

B. Testing:
   1. Baseline potentials: After backfill of the structure to be protected, a static potential-to-soil of the structure shall be measured.
   2. Isolation testing: Before the anode system is connected to the structure to be protected, each isolating joint of fitting shall be tested to demonstrate that no metallic contact or short circuit exists between the two isolated sections.
   3. Anode output: As the anodes are connected to the protected structure, current output shall be measured with a clamp-on millimeter or calibrated shunt and millivoltmeter.
   4. Reference electrode potential measurements:
      a. Upon completion of the entire system, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a voltmeter.
      b. The locations of the measurements shall be the same as the baseline potentials.
   5. Recorded data: Values measured, date, time and location.

C. Training:
   1. Performed by the Corrosion Expert.
   2. Field instructions of the items listed in the operation and maintenance instructions.
   3. Demonstrations of routine maintenance operations with forms for test data and the tolerances which indicated that the system works.

**END OF SECTION**

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# SECTION 26 42 19
## CATHODIC PROTECTION SYSTEM - ELEVATED STORAGE TANK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Design and installation of cathodic protection system.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 33 16 25 - Welded Steel Water Storage Tank.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Welding Society (AWS).
   2. American Water Works Association (AWWA):
      a. C652, Disinfection of Water-Storage Facilities.
   3. NACE International (NACE):
      a. SP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
      b. SP0388, Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Storage Tanks.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Occupational Safety and Health Administration (OSHA).
   7. Underwriters Laboratories, Inc. (UL):
      a. 467, Standard for Grounding and Bonding Equipment.

B. Qualifications.
   1. Structural inspector:
      a. Registered professional structural engineer licensed in the State of Oregon with five years' experience in the inspection of water storage tanks.

### 1.3 DEFINITIONS

A. Confined Space: As defined by OSHA.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products required for the complete system.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
      c. Manufacturer's application instructions.
      d. Cathodic protection system for each tank for Engineer's review, including:
         1) Power unit (rectifier, transformers, automatic voltage controller).
         2) Anodes.
         3) Floats.
         4) Lightning surge arrestors.
      e. Anode and rectifier sizing calculations.

f. Spare parts data.

3. Fabrication and/or layout drawings:
   a. Anode arrangement and tank dimensions showing both plans and sectional views.
   b. Anode size and quantity.
   c. Anode suspension and floatation details.
   d. Rectifier and controller size and location.
   e. Wiring and connection diagrams.
4. Certifications:
   a. AWS certification of welders.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Performance test results with tabulated field test measurements and final position of controls.

D. Prior to expiration of the Correction Period, the tank(s) will be drained by Owner to facilitate a walk-through inspection by the Contractor, Contractor's cathodic protection installer, Owner and Engineer.
   1. Provide certificate of insurance in amounts and coverages equal to the construction period, labor and equipment necessary to remove any standing water and sediment from the floor of the tank prior to the walk-through to ensure that any defects in the coating are readily visible, and all lighting and ventilation necessary for the walk-through inspection.
   2. In the event that defects are detected, submit to the Engineer his proposed repair method along with a completion schedule.
      a. Complete the repair work within the scheduled time period.
   3. Upon completion of the repair work to the satisfaction of the Engineer, or if no repairs were necessary, The Contractor shall be responsible for disinfection of the tank in accordance with AWWA C652 prior to its being returned to service.

## 1.5 MAINTENANCE SERVICE AGREEMENT

A. Cathodic Protection System Maintenance Contract:
   1. Manufacturer shall make quarterly site visits to all systems installed under this Contract to ensure that equipment is properly adjusted and functioning.
      a. At the end of the warranty period, the manufacturer or his agent shall perform a full inspection of the tanks and cathodic protection systems installed.
      b. The inspections shall include potential profiles as described herein, all necessary adjustments, and final evaluation reports.
      c. Inspection shall be coordinated with other work.
   2. Cathodic protection manufacturer shall agree to enter into contract with the Owner, to furnish maintenance, testing and repair services for the cathodic protection systems installed under this Contract, for an initial period of one year following the end of the warranty period.
      a. Thereafter, the Owner shall have the option to renew these contracts on a yearly basis.
      b. During the maintenance contract period, no repairs will be initiated without submission of a quotation and subsequent approval by the Engineer, or Owner, in the form of a written purchase order.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cathodic protection system:
      a. Corrpro.
      b. Harco.
      c. Wallace and Tiernan, Pennwalt Corporation.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 CATHODIC PROTECTION SYSTEM

A. Provide complete automatic impressed current-type cathodic protection system designed to prevent corrosion on the interior submerged surfaces of potable water storage tanks and standpipes.

B. Work shall include systems designed, manufactured and installed by same manufacturer.

C. Cathodic protection supplier shall have a minimum of five years continuous experience in the design, fabrication and installation of systems with similar scope.
   1. System shall be designed, fabricated and installed in accordance with NACE SP0388 under the direct supervision of a licensed professional engineer authorized to practice in the state where the project is located, with specific experience in similar cathodic protection or in collaboration with a individual with NACE certification who has minimum five years' experience in water tank cathodic protection design.

D. The Contractor shall be responsible for disassembly of existing cathodic protection system.
   1. All removed equipment shall be returned to Owner.

E. Design Data:
   1. The following data shall be used as a basis for design.

| NAME | LOCATION | SIZE | INTERIOR COATING |
|---|---|---|---|
| | | | See Section 33 16 25 |

   2. Water analysis (average):
      a. Total hardness (CaCO3): 35 MG/L maximum, 13 MG/L minimum.
      b. Total alkalinity: 38 MG/L maximum, 22 MG/L minimum.
      c. pH: 6.8 to 7.9.
   3. Designed to maintain an adequate level of protection in accordance with criteria for steel or stipulated in NACE SP0169 and shall as a minimum provide:
      a. Negative (cathodic) voltage of at least 0.85 V as measured between structure surface and a saturated copper-copper sulfate half-cell contacting the electrolyte.
         1) Determination of this voltage shall be made with cathodic protection system in operation and shall be free of "IR" drop error.
      b. Negative (cathode) voltage not to exceed 1.1 V (to mitigate disbonding of interior tank protective coating) as measured between structure surface and a saturated copper-copper sulfate half-cell reference electrode located between 0.65 and 1.25 centimeters from the steel surface but not touching it.
   4. Consist of non-icing, suspended anodes in concentric ring configuration with number of rings, anodes and anode length as determined by cathodic protection system design.

F. Materials and Manufactured Units:
   1. Rectifier unit:
      a. Shall be of solid state circuitry, air-cooled and consist of the necessary potential control circuitry.

1) It shall be equipped with a selenium or silicon rectifier, a unit voltmeter, a separate ammeter for each output circuit, meter wiring, circuit breaker, terminal and appurtenances of adequate capacity to meet the requirements of the system.
2) It shall have provisions for manually adjusting the voltage output of 20 or more equal steps from 0-100 PCT of rated capacity.

b. The power unit shall have the following features:
1) Designed to operate on 115 V, 1 PH, 60 cycle AC input.
2) Capable of continuously providing a minimum direct current output of 15 A at maximum of 45 V.
3) Auto-restart after power outage.
4) Short circuit and surge protection.
5) Dead front panel.
6) Accept all standard reference electrodes.
7) Adjustable current limit.
8) Display potential for any operating mode continuously or on demand.
9) Automatic temperature compensating circuit.
10) Clock circuit.
11) Able to be field serviceable.

2. Automatic controller:
a. The controller shall be housed integrally with the rectifier unit.
b. The automatic controller shall be of completely solid state design, having no moving parts, equipped with a calibrated voltmeter, and shall be capable of automatically regulating the protective current as required to maintain the tank-to-water potential at (-) 900 mV with respect to a copper-copper sulfate reference electrode within an accuracy of 25 mV.
c. The tank-to-water potential measured and maintained by the controller shall be free of "IR" drop error.

3. Rectifier controller enclosure combination shall be capable of supplying full rated output at an ambient temperature of 112 DEGF in full sunlight with expected life of not less than 10 years.

4. Mode of operation:
a. The power unit shall have, as a minimum, the following operating modes, the selection of which, can be made on the front panel without the use of additional equipment or tools:
b. Manual mode:
1) The power unit shall operate as a conventional rectifier continuously delivering preselected current to the anodes.
2) In this mode, the automatic control shall be locked out without affecting the pre-programmed settings for other modes of operation.
3) The output of the power unit shall be regulated from 0-100 PCT of rated capacity.
c. Auto mode:
1) In this mode, the controller shall automatically and continuously monitor the potential and make the necessary adjustments in the current output to maintain the potential at the preselected value.
2) A single reference electrode placed within 1 to 2 CM from the submerged steel tank surface and at some distance from the tank wall shall be used to measure the potential and control the operation of the power unit.
3) The measured potential shall be free of "IR" error.

5. Anodes:
a. Anodes shall be supported from the roof and attached to the bottom of the tank by means of brackets and porcelain insulators.
b. They shall be placed in a vertical position for optimum current distribution to all submerged surfaces of the tank which is consistent with accepted industry practices.
1) Installation shall not require wall penetrations below the high water line or the use of pressure fittings.

c. Any welding on the tank shall be done by AWS certified welders and shall be approved by the Engineer.
d. Anodes shall be 14.5 PCT silicon alloy cast iron, Duriron, at least 1 IN DIA by 9 IN long.
e. Multiple segments shall be assembled onto individual continuous insulated copper cables to provide minimum 15 year design life.
f. Anode wire supporting fixture shall be of an electrical insulating material.

6. Reference electrode:
   a. Copper-copper electrodes shall be used to measure the level or protection on the submerged steel surfaces.
   b. The electrodes shall be constructed so that a super-saturated solution of copper sulfate is in continuous contact with an electrolytically pure copper slug.
   c. The electrodes shall be constructed for extended usage (permanent-type) and remain stable for a minimum of five years.
   d. Reference electrode shall be suspended in the same manner as the anodes.
7. Wiring:
   a. Unless noted otherwise, all wiring shall be insulated stranded copper and shall be sized in accordance with NFPA 70 for allowable current capacity but not smaller the #12 AWG.
   b. Control signal wires shall be insulted copper not smaller than #22 AWG suitable for the mechanical and environmental exposure anticipated.
   c. The wires to connect the components of the power unit shall be stranded or solid copper.
   d. The direct current output terminals shall be conveniently located and shall be of the solderless pressure-type sized to accommodate wires as required for safe operation of the cathodic protection system.
   e. Anode and anode header and distribution wire shall be stranded copper wire #8 AWG minimum with Type CP high molecular weight polyethylene 600 V insulation.
   f. Cable-to-anode contact resistance shall be 0.003 ohms maximum.
   g. Where split bolts are used, a minimum of two split bolts shall be used per connection.
   h. All under-roof electric wire splices shall be made above the high waterline and sealed watertight.
   i. Provisions for connecting alternating current power shall be made available in the form of insulated pigtails or terminal blocks.
8. Conduit: The wiring between the rectifier unit and the under-roof anode feeders shall be run in rigid galvanized steel electrical grade conduit of a type and size conforming to NFPA 70 and all other applicable codes.
9. The entire power unit shall be housed in a NEMA 3R (minimum) metal cabinet suitable for outdoor use with provisions for locking.
10. Handholes:
    a. Tank handholes may conform to either of the following configurations:
       1) A gasketed cover plate clamped or bolted in place.
       2) A pipe stub welded to the tank surface, with a cap plate over it.
          a) Existing handhole components shall be replaced.
       3) Handholes having a minimum diameter of 6 IN shall be provided in tank roof for each anode string to permit replacement inspection of anode.
11. The grounding system for grounding rectifier cabinets shall have a resistance to earth of not more than 25 ohms.
    a. Grounding provisions shall conform to NFPA 70 and UL 467, including a ground terminal in the cabinet.
    b. The grounding conductor from the terminal to earth grounding system shall be solid or stranded copper not smaller than #6 AWG.
    c. The earth grounding system shall consist of one or more 3/4 IN DIA copper-clad steel rods 10 FT long, minimum.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Confined Space Procedures:
   1. Tanks identified under the Contract may be designated as a "confined space" in accordance with OSHA.
      a. As such, conform to all applicable requirements regarding work in tanks.

### 3.2 FIELD QUALITY CONTROL

A. Cleaning:
   1. Remove surplus materials, scaffolding, and debris.
   2. Leave areas broom clean.

B. Disinfection:
   1. The Contractor shall be responsible for tank disinfection after completion of all interior tank work.
   2. Tank shall be disinfected in accordance with AWWA C652 Chlorination Method 2.
   3. Tests shall be conducted by Owner to determine water quality:
      a. Coliform test results shall be negative.
         1) If results indicate active bacteria, tank shall be drained, disinfected again and retested until negative test results are obtained.
      b. Heterotrophic plate count (HPC) testing shall be done.
         1) Test results indicating 500 colonies per milliliter (500/ML) or less shall be acceptable.
         2) If tests indicate more than 500/ML colonies, the Owner reserves the right to require redisinfection of tank until acceptable limits are obtained.
      c. Contractor responsible for all work and associated costs including re-testing costs if initial disinfection is ineffective.
      d. Tank fill-water failing disinfection testing shall be drained or pumped to sanitary sewer system.

C. Start-up and Testing:
   1. A trained representative of the manufacturer shall energize the system and make adjustments for optimum operation.
   2. After the unit is adjusted, measurements of tank-to-water potential shall be taken as recommended in NACE SP0388, using a copper-copper sulfate half-cell as a reference electrode.
   3. In addition, to verify that the cathodic protection system is operating within the specified range, an independent potential profile shall be made with a test reference electrode and a 10 mega-ohm or greater input impedance meter.
   4. When making the measurements, the test cell shall be placed within 1-2 CM of the submerged steel tank surface midway between anodes.
   5. All measurements shall be taken with protective current "ON" at intervals of approximately 3 FT across the tank floor and shell.
   6. A report shall be submitted to the Engineer which includes all of the test results obtained.

### 3.3 TRAINING

A. Provide 8 HRS on site orientation and training of Owner's personnel.

**END OF SECTION**

# SECTION 26 43 13
## LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Type 1 SPD - High exposure locations (switchboard or motor control center), integrally mounted.
   2. Type 3 SPD - Medium exposure locations (panelboard), integrally mounted.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017.
   4. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Surge Protective Devices.

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

### 1.3 DEFINITIONS

A. Clamping Voltage:
   1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 DEG phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 PCT deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer's qualifications.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Testing procedures and testing equipment data.
      e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
         1) Data in the Product Data Sheet heading:
            a) SPD Type Number per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
            c) Name of the nationally recognized testing laboratory that preformed the tests.
            d) Warranty information.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
         4) Date of signature.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of the Operation and Maintenance Manuals.

2. Warranty.

### 1.5 WARRANTY

A. Minimum of a five year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, MIL-STD 220B, UL 1283, UL 1449.

### 2.2 TYPE 1 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number to which SPD is connected to.
   2. Integrally mounted in switchboards or MCCs.
   3. Hybrid solid-state high performance suppression system.
      a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   4. Do not connect multiple SPD modules in series to achieve the specified performance.
   5. Designed for parallel connection.
   6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   7. Device monitor:
      a. Long-life, solid state, externally visible indicators and Loss of Protection Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2-pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 PCT deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

| System Voltage | Test Mode | IEEE C62.41 | | UL 1449 |
|---|---|---|---|---|
| | | C High V & I Wave | B Combination Wave | |
| L-L < 250 V<br>L-N < 150 V | L-L | 1470 V | 1000 V | 800 V |
| | L-N | 850 V | 600 V | 500 V |
| | L-G | 1150 V | 800 V | 600 V |
| | N-G | 1150 V | 800 V | 600 V |
| L-L > 250 V<br>L-N > 150 V | L-L | 2700 V | 2000 V | 1800 V |
| | L-N | 1500 V | 1150 V | 1000 V |
| | L-G | 2000 V | 1550 V | 1200 V |
| | N-G | 2000 V | 1550 V | 1200 V |

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

## 2.3 TYPE 3 SPD

A. Product:
   1. Integrally mounted in a switchboard, panelboards or motor control centers.
   2. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   3. Do not connect multiple SPD modules in series to achieve the specified performance.
   4. Designed for parallel connection.
   5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   6. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 PCT of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 160,000 A per phase, 80,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 PCT deviation of the clamping voltage.

I. SPD Protection:

1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 DEG phase angle including 6 IN lead length and measured from the zero voltage reference:

| System Voltage | Test Mode | IEEE C62.41 | | UL 1449 |
|---|---|---|---|---|
| | | B Comb. Wave | B3 Ring Wave | |
| L-L < 250 V<br>L-N < 150 V | L-L | 1000 V | 700 V | 800 V |
| | L-N | 600 V | 400 V | 500 V |
| | L-G | 800 V | 550 V | 600 V |
| | N-G | 800 V | 550 V | 600 V |
| L-L > 250 V<br>L-N > 150 V | L-L | 2000 V | 1400 V | 1800 V |
| | L-N | 1150 V | 800 V | 1000 V |
| | L-G | 1550 V | 1000 V | 1200 V |
| | N-G | 1550 V | 1000 V | 1200 V |

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

### 2.4 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
1. Integral unit level and/or component level fusing.
2. Neutral and ground shall not be bonded during testing.
3. 6 IN lead lengths.
4. Integral disconnect switch when provided.

C. The "as installed" SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
2. Single pulse surge current capacity test.
3. Repetitive surge current capacity testing.
4. Spectrum analysis for EMI-RFI noise rejection.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type 1 and 3 SPD:
1. Connected in parallel to the equipment.
2. Integrate into the equipment enclosure of the equipment which it is to protect.
3. Provide leads that are as short and straight as possible.
4. Maximum lead length: 12 IN.

5. Minimum lead size: #2 stranded AWG or bus bar.
6. Connect leads to the equipment to be protected by one of the following means:
   a. Provide a circuit breaker disconnect mounted in the equipment.
   b. Use manufacturer recommended circuit breaker size.
   c. Circuit breaker to be operable from the equipment exterior or from behind a hinged door.

**END OF SECTION**

# SECTION 26 50 00
## INTERIOR AND EXTERIOR LIGHTING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building and exterior building mounted luminaires.
      b. Exterior and site luminaires.
      c. LEDs.
      d. Drivers.
      e. Light poles.
      f. Lighting control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 03 - Concrete.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   6. Section 26 09 16 - Control Equipment Accessories.
   7. Section 26 09 43 - Low Voltage Lighting Control System.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C78.377, Specification for the Chromaticity of Solid State Lighting Products.
   2. Federal Communications Commission (FCC):
      a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   4. Illuminating Engineering Society of North America (IESNA):
      a. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
      b. LM-80, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
      c. LE 4, Recessed Luminaires, Ceiling Compatibility.
   6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. SSL 1, Electronic Drivers for LED Devices, Arrays or Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC) - 2017.
      b. 101, Life Safety Code.
   8. Underwriters Laboratories, Inc. (UL):
      a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
      b. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
      c. 924, Standard for Emergency Lighting and Power Equipment.
      d. 1012, Power Units Other Than Class 2.

e. 1310, Standard for Class 2 Power Units.
f. 1598, Luminaires.
g. 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

9. United States Department of Energy (USDOE):
   a. EPAct, the National Energy Policy Act.

## 1.3 DEFINITIONS

A. Useful Life for LED luminaire light sources:
   1. The operating hours before reaching 70 PCT of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
   2. This is also known as 70 PCT "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Identify luminaire by Luminaire Schedule designation.
      c. Luminaire data sheet:
         1) Name of manufacturer.
         2) Complete order information (catalog number).
         3) Description of construction and optics.
         4) Total input wattage.
         5) Luminous efficacy (lumens/Watt).
         6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
         7) Dimensional size.
         8) Weight.
         9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
         10) Effective Projected Areas (EPA) for pole mounted luminaires.
         11) Lumens.
      d. Solid state Luminaire additional data:
         1) Voltage.
         2) Initial and IES L70 lumens.
         3) Luminous efficacy (lumens/Watt).
         4) Correlated Color Temperature (CCT).
         5) Color Rendering Index (CRI).
         6) Total Harmonic Distortion (THD).
         7) Lamp life.
         8) Driver manufacturer and model number.
         9) Driver life.
         10) Driver type (0-10V, constant voltage, constant current).
         11) Dimming range and control device compatibility.
         12) Remote driver: Maximum wire length to luminaire.
         13) Emergency battery driver:
            a) Compatibility with lighting module.
            b) Lumen output of lighting module in emergency operation.
            c) Battery life.
            d) Description of testing.
            e) Ambient operating temperature.
         14) Toxicity Characteristic Leaching Procedure (TCLP) compliance.

15) DesignLights Consortium (DLC) Listing.
16) Warranty information.

e. Luminaire lamp data sheet:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Wattage.
4) Initial and mean lumens.
5) Luminous efficacy (lumens/Watt).
6) Correlated Color Temperature (CCT).
7) Color Rendering Index (CRI).
8) Lamp life.
9) Base configuration.
10) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
11) Warranty information.

f. Pole data sheet:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Description of construction.
4) Length, shaft size and thickness.
5) Wind loading (available luminaire EPA per wind speed).
6) Anchor bolt template.
7) Bolt size and material.

g. Photometric calculation for manufacturers not listed in the Luminaire Schedule demonstrating equivalent illumination:

h. See Specification Section 26 05 00 for additional requirements.

3. Test Reports:
a. IESNA LM-79 Test Report for Solid-State Luminaire.
b. IESNA LM-80 Test Report Solid-State Light Source.

4. Certifications: Solid-state Luminaire Useful Life Certificate.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Submittal data for each component covered by warranty.
c. Warranty.

### 1.5 WARRANTY

A. Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15 PCT of the individual light emitting diodes fail to illuminate.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Luminaires: Per Luminaire Schedule.
2. Solid State Light Sources:
a. Cree.
b. Xicato.
c. Luminaire manufacturer's proprietary system.
3. LED Driver: Luminaire manufacturer's standard.
4. Emergency ballasts:

a. Iota Engineering.
b. Philips Bodine.

5. Emergency transfer devices: Philips Bodine.
6. Poles: Luminaire manufacturer's standard.

## 2.2 GENERAL REQUIREMENTS

A. Luminaires complete with LED modules and drivers.

B. Rated for area classification as indicated on the Drawings.
1. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and lamp or LED combination shall not exceed the auto-ignition temperature of the atmosphere in which the Luminaire is used.

C. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
1. Provide recessed luminaires with trim gaskets cemented in proper position.

D. Provide standard plaster frame for all recessed luminaires installed in plaster walls or ceilings.
1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

E. Coordinate luminaire mounting where recessed into building canopies prior to Submitting Shop Drawings. Confirm clearances and luminaire flange compatibility with construction.

F. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.

G. No live parts normally exposed to contact.

H. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

I. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

## 2.3 LUMINAIRES

A. Standards and Listings:
1. DesignLights Consortium (DLC).
2. UL 1598.
3. UL 844 for hazardous locations.
4. NEMA LE 4 for recessed locations.

B. Housings:
1. As indicated in the Luminaire Schedule and the following:
a. Troffer luminaires:
1) Minimum 22 gage sheet steel.
2) Integral end plates and trim flanges to suit ceiling construction.
3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
b. Down Light luminaires:
1) Minimum 22 gage sheet steel, or minimum 16 gage sheet aluminum, unless noted otherwise.
2) Auxiliary junction box secured to mounting frame.
c. Extruded aluminum housings, where scheduled, shall be at least 1/8 IN thick.
d. Punch and form housings prior to finishing (post-paint).

C. Trim (Recessed Mounted):
1. As indicated in the Luminaire Schedule and the following:
a. For square and rectangular luminaires, miter and continuously weld corners.
b. Miter perimeter inverted T-Bar angles at corners.
c. Do not butt or overlap squared ends.
d. Finish joints smooth.

D. Castings:
   1. As indicated in the Luminaire Schedule and the following:
      a. Uniform quality, free from imperfections affecting strength and appearance.
      b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.

E. Fasteners:
   1. As indicated in the Luminaire Schedule and the following:
      a. Aluminum or steel luminaires: Cadmium-plated or an equivalent.
      b. Stainless steel luminaires: Stainless steel.
      c. Bronze luminaires: Bronze or stainless steel.
      d. Non-metallic luminaires: Stainless steel.

F. Finishes:
   1. As indicated in the Luminaire Schedule and the following:
      a. Painted surfaces:
         1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish; acrylic, alkyd, epoxy, polyester or polyurethane.
         2) White finishes shall have minimum 85 PCT reflectance.
      b. Unpainted surfaces:
         1) Interior: Clear anodic coating, satin finish.
         2) Exterior: Clear anodic coating.

G. Lens/Louver Frames:
   1. As indicated in the Luminaire Schedule and the following:
      a. Extruded aluminum with mitered corners.
      b. Hinging or other normal motion shall not cause lens or louver to drop out.
      c. No light leak between frame and housing.

H. Lenses:
   1. As Indicated in the Luminaire Schedule and the Following:
      a. 100 PCT virgin, UV stabilized acrylic.
      b. Linear fluorescent luminaires: Male conical prismatic, minimum thickness 0.150 IN, size as required.
      c. Held securely in place but must also be removable for cleaning and relamping.
      d. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
      e. No light leaks between the lens and the luminaire.

I. Reflectors:
   1. As Indicated in the Luminaire Schedule and the Following:
      a. Linear fluorescent luminaires: High-purity #12 aluminum reflector sheet, 0.047 IN (15 GA) or heavier, free from fabrication or assembly damages. No exposed rivets, springs or other hardware after installation. Shape reflectors in modified elliptical or parabolic contour to produce no apparent brightness. Lamp image or any part of lamp shall not be visible in 45 DEG zone.
      b. Down Light Reflector and Baffle Finishes: First-quality "Alzak" anodized specular finish.
      c. Troffer reflector finish: Integral reflectors shall be painted white after fabrication with a minimum reflectance value of 90 PCT.

J. Gaskets:
   1. As Indicated in the Luminaire Schedule and the Following:
      a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and which allow interior access.
      b. Moisture seal gaskets at exterior locations and in other designated wet areas.

c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

K. Ventilation:
1. Ventilation openings of adequate size and quantity to permit operation of lamps and ballast without affecting rated output or life expectancy. Include wire mesh screens.

L. Wiring:
1. Factory-wired to be compatible with the project electrical and controls systems.
2. Long tube fluorescent luminaires shall comply with NEC requirements and be supplied with a quick disconnect accessible to qualified persons before servicing or maintaining the ballast.
3. Thermally protect halogen and HID luminaires.

M. Mounting Accessories:
1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during relamping or cleaning.
3. Recessed Luminaires:
   a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
   b. Baffles and Gaskets: As required to prevent light leakage.
   c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
4. Luminaire Suspension Material:
   a. Unfinished Spaces:
      1) 1/2 IN minimum diameter swivel stem, unless otherwise noted.
      2) Safety chain on high bay type.
   b. Finished Spaces: Unless otherwise noted.
      1) Manufactured cable or stem and outlet box canopy.
         a) Contemporary design with swivel self-aligning features.
         b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.
         c) Finish to match luminaire.
      2) Coordinate pendant location with ceiling tiles/ceiling grid.
         a) Submit coordinated mounting accessories as part of Shop Drawing submission.
      3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.
      4) For high intensity discharge lamps:
         a) Use stems suspended from swivel shock-absorbing fittings.

## 2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:
1. IESNA LM-79, IESNA LM-80.
2. NEMA SSL 1.
3. UL 1012, 1310, and 8750.
4. UL 844 for hazardous locations.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:
1. Uniform color temperature of 4000K unless otherwise noted on the Luminaire schedule.

a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
2. Minimum color rendering index (CRI) of 80.
3. LED module light output and efficacy: Measured in accordance with IESNA LM-79 standards.
4. LED useful life and lumen maintenance: Measured in accordance with IESNA LM-80 standards.
5. Driver and LED module: Minimum useful life of 50,000 HRS (L70).
6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:
1. Compatible with solid-state modules and control devices specified.
2. Operate from 60 Hz input source of 120V through 277V with sustained variations of ±10 PCT (voltage and frequency).
3. Input current Total Harmonic Distortion (THD): Less than 20 PCT when operated at nominal line voltage.
4. Power Factor: Greater than 0.90.
5. Avoid interference with infrared devices and eliminate visible flicker.
6. Comply with ANSI C62.41 Category A for Transient protection.
7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
8. Dimmable drivers capable of continuous dimming over a range of 100 PCT to 1 PCT of rated lumen output. Dimming controlled by a 0 - 10 VDC signal, unless otherwise specified in Luminaire Schedule.
9. Control device must be compatible with type of driver and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.
10. Remote-mounting:
a. Provide maximum allowable distances for secondary wire runs to luminaires.
b. Provide remote mounting hardware and enclosures as required.
11. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:
1. UL 924.
2. Confirm compatibility with LED modules utilized.
3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry.
4. A solid state charging indicator light to monitor the charger and battery.
5. Single-pole test switch.
6. The following product family shall be selected based on coordination with LED lamp type:
a. Philips Bodine "BSL23C": can operate up to 4.5W at 410mA.
b. Philips Bodine "BSL26C": can operate up to 5.1W at 265mA.
c. Philips Bodine "BSL722 IN: can operate up to 23W at 770mA.
d. Philips Bodine "BSL23C": can operate up to 23W at 770mA in operating conditions ranging from -20 DEGC (-4 DEGF) to 60 DEGC (140 DEGF).
e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
1. Provide ambient operating temperature range for which product is warrantied.

## 2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:

1. UL 924.
2. NFPA 101.
3. Local State or City requirements.

B. Exit Signs:
1. Housing and finish: As indicated in the Luminaire Schedule.
2. LED illuminated with integral driver.
3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
4. Battery powered units:
   a. Battery type: As indicated in the Luminaire Schedule.
   b. Self-testing/self-diagnostic.
      1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
   c. Consist of batter, charger and electronic circuitry.
   d. Solid state charging indicator light to monitor the charger and battery.
   e. Single-pole test switch.
   f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

C. Emergency Lighting Units:
1. Housing: As indicated in the Luminaire Schedule.
2. Lamps: As indicated in the Luminaire Schedule.
3. Battery type: As indicated in the Luminaire Schedule.
4. Self-testing/self-diagnostic.
   a. Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
5. Consist of batter, charger and electronic circuitry.
6. Solid state charging indicator light to monitor the charger and battery.
7. Single-pole test switch.
8. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

D. Emergency Circuit Transfer Device:
1. Transfer device permits emergency lights to be switched under normal conditions and automatically transfers to unswitched emergency circuit upon power interruption.
2. Multiple luminaire switching:
   a. Up to 20A.
   b. Mounting as indicated on the Drawings.
   c. Acceptable product family:
      1) Philips Bodine GTD20A or equal.
3. Individual luminaire switching:
   a. Mount on top of luminaire or in ballast channel.
   b. Acceptable product family:
      1) Philips Bodine GTD or equal.

## 2.6 POLES

A. As Indicated in the Luminaire Schedule and the Following:
1. Designed for attached luminaire EPA with a 100 MPH maximum wind velocity at the base with a 1.3 wind gust factor.
2. Additional features:
   a. Handhole near base of pole.
   b. Grounding lug accessible at handhole.
   c. Galvanized anchor bolts.
   d. Anchor bolt covers.
   e. Vibration dampers

B. Metal Poles:

1. Material: Steel.
2. Shaft shape: Straight.
3. Pole cross section: Square.
4. Designed for attached luminaire EPA with a 100 MPG maximum wind velocity at the base with a 1.3 wind gust factor.
5. Additional features:
   a. Luminaire mounting provisions.
   b. Handhole near base of pole.
   c. Grounding lug accessible at handhole.
   d. Galvanized anchor bolts.
   e. Anchor bolt covers.
   f. Vibration dampers.
6. Steel pole finish: Black

### 2.7 MAINTENANCE MATERIALS

A. Furnish a minimum of 10 PCT of total of each type and amperage of fuses for fixtures indicated to be fused.

B. Spare parts are to be stored in a box clearly labeled as to its contents.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:
   1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.
   1. Do not support luminaire from conduit system.
   2. When luminaire is supported from outlet boxes, install per NFPA 70.
   3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.
   1. Luminaires up to 4 FT wide and 4 FT long: A minimum of four supporting points, one at each corner.
   2. Luminaires 8 FT long: A minimum of five support points, one at center of luminaire and one at each corner.
   3. Luminaires smaller than 2 FT in length: A minimum of two supporting points.

E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.
   1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
   2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.
   3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.
      a. Chain or cable to prevent luminaire from falling more than 3 IN before the luminaire is caught by the chain or cable.

F. Pendant Mounted, Open, Industrial Luminaire:
   1. Not in continuous rows:
      a. Supported by conduit or by approved chains or cable:
      b. Hardwired to ceiling mounted junction box.

2. In continuous rows:
    a. Supported rigidly with conduit and fasten luminaire to each other or mount on continuous metal channel per Specification Section 26 05 00.
    b. Hardwired to ceiling mounted junction box.
    c. Provide reflector alignment clips.

G. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
    1. Locate luminaires in accordance with reflected ceiling plans.

H. Locate luminaire in exact center of ceiling tile unless otherwise indicated.
    1. Relocate misinstalled luminaire and replace damaged ceiling materials.

I. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

J. Install exterior luminaires so that water cannot enter or accumulate in the wiring compartment.

K. Where indicated, provide two-level control of three and/or four lamp fluorescent luminaires.
    1. Provide two ballasts per luminaire and control inside lamp(s) in each luminaire by one switch or set of switches and the outside two lamps by a second switch or group of switches.

L. Emergency Battery Ballasts:
    1. Where emergency battery ballasts are shown controlled via switching device, wire ballast so lamps will not operate when normal power is available and switching device turns lights off. Lamps will operate in emergency mode regardless of switch position.
    2. Luminaire manufacturer to supply the emergency battery ballasts with luminaire.

M. Ground luminaire and ballasts.

## 3.2 POLE INSTALLATION

A. Drawings Indicate the Intended Location of Light Pole:
    1. Field conditions may affect actual location.
    2. Coordinate location with all existing or new utilities and pavement.

B. Anchor Base Plated Poles:
    1. Mounted on cast-in-place foundations, as detailed on the Drawings.
        a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.
        b. Concrete:
            1) Minimum compressive strength: 4000 PSI at 28 days.
            2) Concrete work in accordance with ACI 301.
        c. Reinforcing steel:
            1) ASTM A615/A615M, Grade 60.
    2. Protect pole finish during installation.
        a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:
    1. See Specification Section 26 05 19 for required underground conductors.
    2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #12 AWG minimum.

## 3.3 LIGHTING CONTROL

A. See Specification Section 26 09 16 and 26 09 43 for lighting control equipment.

B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

## 3.4 ADJUST AND CLEAN

A. See Specification Section 01 74 00.

B. Replace all inoperable luminaire with new luminaires prior to final acceptance.

C. Aim all emergency lighting units, such that, the path of egress is illuminated.

**END OF SECTION**

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# SECTION 26 99 00
PHOTOVOLTAIC MODULES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for equipment, materials and installation of photovoltaic modules.
   2. Contractor shall provide PV modules to attain the nominal maximum power rating (Pmax) DC capacity specified as determined by Contractor's module selection and the requirements in the Project Drawings.
   3. The PV system design is based on the Canadian Solar BiHiKu7 585Wp module. Alternate, equivalent panels are acceptable per Owner's approval. Alternate modules may require system re-design, and require Engineer's approval.
   4. All proposed equipment shall work together to form a fully functioning system without adjustments, derates, or field modification.
   5. Contractor shall propose a recommended quantity of spare modules in excess of proposed project installed DC capacity.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ACC Global Compliance:
      a. CE Mark of Conformity.
   2. ETL Testing Laboratories (ETL).
   3. International Electrotechnical Commission (IEC):
      a. 61215, Crystalline Silicon Terrestrial Photovoltaic (PV) Modules.
      b. 61646, Thin-Film Terrestrial Photovoltaic (PV) Modules.
      c. 61730, Photovoltaic (PV) Module Safety Qualification.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories of Canadian (C-UL).
   6. Underwriters Laboratories, Inc. (UL):
      a. 790, Standard Test Methods for Fire Tests of Roof Coverings.
      b. 1703, Standard for Safety of Flat-Plate Photovoltaic Modules and Panels.

B. Miscellaneous:
   1. Install per manufacturer guidelines and applicable NEC requirements for compliant installation, for the listed purpose.
   2. Component is installed as part of the project completion and workmanship review.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See other Specification Sections for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's specifications, certifications, and installation instructions.
      c. Module flash data and other pertinent electrical data for design confirmation.
      d. All modules shall come with appropriate label listing information and attach to each module.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Ratings:
   1. All PV Products for delivery to the United States shall meet the following specifications:
      a. Certified to UL 1703 and listed by an OSHA recognized NRTL, including the Class C Fire Rating pursuant to UL 790 and UL 1703.
      b. IEC 61215 (for crystalline modules) or IEC 61646 (for thin film modules).
      c. IEC 61730.
      d. UL 790, Class C.
      e. All applicable NEC requirements, including, without limitation, series fuse rating requirements.
      f. CEC approved and listed.
   2. CE Mark of Conformity.
   3. PV modules shall be supplied with a copy of UL and IEC certification reports indicating compliance for the model numbers used and indicating the certification is in force as of the dates of module manufacture.

C. PV modules shall be new and certified to IEC 61730 - Photovoltaic (PV) module safety qualification and IEC 61215, shall be UL listed and shall meet any certifications / listings as required by the authority/(ies) having jurisdiction.

D. PV modules shall be supplied with documentation confirming that the PV modules have been manufactured in accordance with the manufacturer's specifications. PV modules must be of the same manufacturer and model number and consistent sub-components.

E. PV module supplier shall be certified to ISO9001:2000 and ISO140001:2004.

F. PV modules and ancillary materials shall be rated to withstand and be capable of continuous operation for the full range of "Ambient Temperature Rating Range" design conditions as listed in the Drawings and Specifications.

G. The module /module framing shall have load ratings that are compatible with the site design conditions including wind and snow loads.

H. Wire leads and connectors shall be factory-installed with lengths appropriate for the module connection scheme. Connectors shall be locking, Amphenol or equivalent, and consistent throughout the design. Provide USE-2 or RHH or RHW-2 wire, and sunlight-resistant wire when exposed to sunlight.

I. PV modules shall be bifacial, crystalline silicon. Modules shall incorporate anti-reflective coated (ARC) glass with an aluminum frame, bypass diodes and connectors.

J. Loading:
   1. Frames capable of withstanding loads of not less than 50 PSI (2400Pa) in a variety of mounting methods.
   2. Frames capable of meeting IEC extended snow load requirements of not less than 112 PSF (5400 Pa) when using traditional mounting at the bolt holes.

K. PV modules shall have a power tolerance of +5W/-0W.

L. PV module binning and ratings shall be clearly marked on packaging to facilitate Owner's efforts of matching PV module bin class rating within strings to minimize mismatch losses for the project.

M. PV manufacturer shall provide factory flash test results in accordance with IEC 61853-1, and temperature coefficients at: STC, nominal operating cell temperature (NOTC), low irradiance conditions (LIC), high temperature conditions (HTC), and low temperature conditions (LTC).

N. PV modules shall have a minimum rating of 1,000V DC.

O. PV modules shall be rated as a Top Performer according to the latest PVEL Reliability Scorecard, or shall be tested in accordance with the full PVEL PQP testing program and receive Top Performer ratings, or other Owner approved equivalent testing and certification program. Supplied PV modules shall be manufactured to the PVEL tested Bill of Materials (BOM) specification to ensure performance, durability, and reliability match that of the tested modules.

P. Contractor shall be responsible for the performance of all inspection and testing activities as set forth in, and as required to demonstrate compliance with, the drawings, specifications, referenced standards, applicable codes and industry practices.

Q. PV modules shall not utilize top or back sheet coatings made from fluoropolymers such as per- and polyfluoroalkyl substances (PFAS) or GenX. PV module manufacturer to provide evidence that PFAS, GenX, or similar chemicals are not used in the module manufacturing process. Letter confirmation from the module manufacturer is sufficient.

R. PV modules shall have a minimum 10-year manufacturer's warranty covering defect and workmanship.

S. PV modules shall have a minimum 25-year manufacturer's warranty covering product performance that incorporates a degradation guarantee with peak power rating at year 25 not less than 84.3% of the original peak power rating identified on the product nameplate.

T. The contractor shall provide information from the PV module manufacturer identifying the loading basis in accordance with IEC 61215.

U. PV modules will be installed on a fixed-tilt, ground-mount system.

V. Grounding of PV modules will be performed by use of WEEB system or a self-grounding racking system that meets the applicable requirements of UL 3703 and UL 2703 and their referenced requirements for grounding. PV module design offered shall be compatible with this grounding method.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Module installation shall be in accordance with manufacturer's recommendations.

B. Contractor shall be responsible for the performance of all inspection and testing activities to demonstrate compliance with the drawings, specifications, referenced standards, applicable codes, and industry practices.

C. Ensure wire bending radius for all conductors meets NEC requirements from the modules.

D. Electrical installation is secured and properly grounded.

E. Bolted connections are torqued per manufacturer and NEC requirements.

F. Source circuit wires should be organized and bent in a uniform manner.

**END OF SECTION**

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# SECTION 26 99 03
INVERTERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Requirements for equipment, materials and installation of PV inverters.
2. Contractor shall provide PV inverters to attain the nominal AC capacity specified as determined by Contractor's inverter selection and the requirements in the Project Drawings.
3. The PV system design is based on the CPS America SCA50KTL-DO-US 50 kW inverter. Alternate, equivalent inverters are acceptable per Owner's approval. Alternate inverters may require system re-design and require Engineer's approval.
4. All proposed equipment shall work together to form a fully functioning system without adjustments, derates, or field modification.
5. The PV system is intended to operate in parallel with the utility service provider. Contractor shall coordinate with the Power Company to ensure system compliance.
6. This system is intended to connect to the existing Plant electrical system at one point, the point of common coupling (POCC). This connection shall be in compliance with the Power Company standards.

### 1.2 QUALTIY ASSURANCE

A. Referenced Standards:
1. Electrical Safety Authority (ESA).
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.
   b. National Electrical Safety Code (NESC).
3. International Organization for Standardization (ISO):
   a. 9000, Quality Management Systems -- Fundamentals and Vocabulary.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
      1) 110.26, Installation Requirements: Basics of Load Center.
6. Underwriters Laboratories, Inc. (UL):
   a. 1741, Inverters, Converts, Controllers and Interconnection System Requirements for Use with Distributed Energy Resources.

B. Miscellaneous:
1. On-site installation guidelines to meet applicable NEC, NESC, Utility, or other local Authority Having Jurisdiction code.
2. Product shall be listed for its intended use. Listing must be to a UL standard, tested and certified by an OSHA recognized NRTL.
3. Design manuals for system engineering and planning purposes.
4. Appropriate packing for delivery and procedures for equipment un-packaging and event reporting.

### 1.3 SUBMITTALS

A. Shop Drawings:
1. See other Specification Sections for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.

3. Supplier to provide the following information:
   a. Manufacturer's specifications sheets.
   b. Design or planning documentation.
   c. Installation and un-packing/handling instructions.
   d. Typical Shop Drawings for inverter units.
   e. Typical Shop Drawings for pre-packaged solutions.
   f. Manufacturing quality control documentation.
   g. Explanation of advanced grid support features.
   h. SCADA systems offered/explanation of compatibility with Owner SCADA system.
   i. Applicable value engineering documentation.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Inverters shall be compliant with IEEE 929-2000 and IEEE-1547-2003 and IEEE 519.

C. All same-sized inverters supplied must be of the same manufacturer and model number.

D. Provide inverter utilizing a wall-mount or support structure mounting system.

E. Provide inverter with anti-islanding protection to prevent back-feeding inverter generated power to the grid in the event of a utility outage. Anti-islanding protection must be listed to UL 1741.

F. Overcurrent protection and ground-fault protection must comply with the requirements of NFPA 70.

G. Provide inverter with self-diagnostics routines, and remote and local display of operating status and remote monitoring capabilities.

H. Inverters shall have network capability.

I. Provide inverter with integrated monitoring system and metering system.

J. Ratings:
   1. Capacity: As required to meet the project capacity requirements.
   2. Phase: 3

K. Voltage: Inverter output 480 Vac.

L. Match inverter DC input to the design of the PV module array outputs and account for the following:
   1. The inverter low voltage is 50% of the maximum system voltage, to account for 25 year degradation.
   2. Voltage decrease due to high temperatures at project site.

M. Array-to-inverter kW ratio must not exceed manufacturer limitations.

N. Frequency: 60 Hz.

O. Power factor: Capable of 0.90 leading or lagging.

P. Efficiency: CEC efficiency as verified by CEC SAND2007-5036 to have a weighted average inverter power conversion efficiency of 98% or greater.

Q. Full power operating temperature range: -40 DegC to 50 DegC.
   1. If other, specify operating range.

R. Integrated DC and AC voltage surge protection.

S. AC interface: specify maximum number of conductors and size per phase.

1. All terminations to be crimp on conductors and bolt on to inverter bus.
2. All terminations rated 90 DegC for copper or aluminum.
3. Specify neutral/grounding requirements if any.

T. Enclosure (inverter specific):
1. NEMA 4X rated for outdoor equipment.
2. If other, specify rating.

U. Specify maximum operating elevation at full power.
1. Specify derate curve for higher elevations.

V. Assembly and all components listed for use with max 1000 Vdc and continuous duty.

W. Specify MPPT operating range.

X. Integrated fused DC input combiner.
1. Specify maximum number of inputs.
2. Specify maximum fuse size.
3. Specify maximum conductor size.
4. All terminations preferred to be crimp on conductors and bolt on inverter bus.
5. All terminations rated for 90 DegC for copper or aluminum.

Y. Array ground configuration: ungrounded.

Z. DC input monitoring for voltage and current at each fused DC input.

AA. DC conduit entry: Bottom entry only.

BB. Communications protocol: Ethernet/IP to coordinate with Plant SCADA system.

CC. Certifications:
1. Listed to UL 1741 standards.
2. Inverters operating at 1000VDC and with advanced grid support features such as voltage and frequency ride-through and VAR support.
3. IEEE 1547 compliant.
4. Comply with the latest applicable ANSI and FCC standards and addenda, and inspected before commissioning, testing, and operation of the system. Submit documentation validating system performance requirements.
5. Inverter must be approved by FCC Part 15, Class A as an unintentional radiator.

DD. Where a circuit grounding connection is not designed to be automatically interrupted as part of the ground-fault protection system required by Article 690.5, a switch or circuit breaker used as a disconnecting means shall not have a pole in the grounded conductor.

EE. Means shall be provided to disconnect equipment such as inverters, batteries, charge controllers, and the like from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.

FF. The Inverters shall have a minimum 5-year manufacturer's warranty covering defects and workmanship that provides for all parts and labor required to replace or repair warranty-eligible failures.

GG. Materials, equipment and parts comprising the units specified herein shall be new and unused, of current manufacture, of highest grade, and assembled in a workmanlike manner.

HH. The inverter for the proposed solar electric system shall be identified for use in solar photovoltaic systems. All equipment shall be UL approved or equivalent.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, State and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Contractor shall inspect all packages for damage upon delivery. Any damaged packages shall be opened so the inverter and equipment can be inspected. Any damage to the packaging or equipment shall be documented and reported to the owner immediately. Inverters to be stored shall be properly replaced in the packaging for storage.

C. Inverters shall be stored in a secure and clean location per the manufacturer's recommendations and documentation. Inverters shall be protected from the harsh environment such as excessive heat, cold, moisture, dust, snow, etc.

D. Inverters shall be handled and installed in accordance with the manufacturer's recommendations and documentation. All instructions and reference documents shall be reviewed and understood by the contractor prior to handling and unpacking the equipment.
   1. Reference the manufacturer's instructions for unpacking the equipment. Inverters shall be transported by means outlined in the manufacturer's documentation only.

E. Contractor is to obtain all electrical approvals by the authorities having jurisdiction, approval from the utility company, and approval from the Owner prior to energizing any inverters.

F. Commissioning, inspection, and testing of the inverter shall be properly documented and submitted to the Owner prior to energizing the inverter.

G. PV array DC grounding configurations may vary by manufacturer and technology.

H. The grounding configuration shall be noted by the Contractor for safety and proper installation.

I. Warning and safety labels properly placed.

J. Inverter is labeled and identified to match the naming convention shown on the plans.

K. Provide sufficient service access and equipment setbacks per NEC 110.26. Ensure enclosure doors are able to swing a full 180 degrees at installed location.

L. The contractor is to ensure that working clearances meet the requirements of all applicable codes and the manufacturer's requirements. Any discrepancies shall be reported to the owner immediately.

M. Inverters shall be installed on a level surface. The inverter shall be secured to the foundation utilizing all of the provided mounting points. Reference the manufacturer's documentation for location and size of mounting points.

N. All disconnect switches shall be in the open position during installation and shall remain in the open position until proper testing, inspection, and commissioning has been completed.

O. Do not open the inverters electrical cabinets when it is raining or when humidity exceeds 95%.

P. All fasteners shall be torqued per the manufacturer's documentation.

Q. It is prohibited to modify the inverter or install equipment not explicitly recommended by the manufacturer. Do not store documents, instructions, plans, or any other foreign material not intended to be part of the system inside the inverters cabinets.

R. Components of the inverters may be damaged by electrostatic discharge (ESD). When handling the electrical components observe all ESD safety regulations.

S. All conductors shall be connected to the inverter per the manufacturer's recommendations and documentation making note of recommended terminations, torque values, and bolt stack up

details if provided. All buss bars, conductors, and terminations shall be clean prior to making, the connection.

**END OF SECTION**

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# SECTION 26 99 04
## METEOROLOGY STATION SYSTEM DESCRIPTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pre-package meteorological station for the ground-mount photovoltaic system.

B. Related Sections include but are not necessarily limited to:
   1. Refer to all Division 26 for requirements.

### 1.2 QUALTIY ASSURANCE

A. Referenced Standards:
   1. Electrical Safety Authority (ESA).
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems.
      b. National Electrical Safety Code (NESC).
   3. International Organization for Standardization (ISO):
      a. 9000, Quality Management Systems -- Fundamentals and Vocabulary.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) 110.26, Installation Requirements: Basics of Load Center.
   6. Underwriters Laboratories, Inc. (UL):
      a. 1741, Inverters, Converts, Controllers and Interconnection System Requirements for Use with Distributed Energy Resources.

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of meteorology stations for the PV system for a period of 3 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Supplier to provide the following information:
      a. Manufacturer's specifications sheets.
      b. Design or planning documentation.
      c. Installation and un-packing/handling instructions.
      d. Typical Shop Drawings for pre-packaged solutions.
      e. Manufacturing quality control documentation.
      f. SCADA interface with Owner SCADA system.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. NorCal
   2. Campbell Scientific
   3. Kippzonen
   4. Or approved equal.

### 2.2 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. MET Components:
   1. Self-supporting weather station tower, rack-mounted.
   2. Wind speed and direction sensors.
   3. Temperature and relative humidity probe.
   4. Barometric pressure.
   5. Precipitation for rain gauge.
   6. Global Horizontal Irradiance (GHI) pyranometer.
   7. Plane-Of-Array Irradiance (POA) pyranometer.
   8. Soiling station.
   9. Data logger with 24VDC power supply.
   10. SCADA interface for connection to the SCADA system.
   11. PV module temperature sensors.
   12. All sensor and power cables as required for connection to the sensors.
      a. Sensor and communication cable splices are not allowed.
   13. All associated hardware, crossarm and brackets for installation of all devices.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, State and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. All sensors are installed on the weather tower structure except the following sensors which are installed at the nearest PV array:
   1. POA pyranometers.
   2. PV module temperature sensors.
   3. Soiling station.
   4. All associated cables to the data logger.

D. Contractor to provide hardware for mounting the POA, soiling station and wire supports as required at the nearest PV array rack per design drawings.

E. Contractor shall be responsible for designing the tower support connection to the equipment rack.

F. Contractor to design and provide (1) 20A, 1P, 120VAC power supply to the MET tower.

G. Commissioning, inspection, and testing shall be properly documented and submitted to the Owner.

H. Contractor shall inspect all packages for damage upon delivery. Any damage to the packaging or equipment shall be documented and reported to the owner immediately.

I. All conductors shall be connected to the inverter per the manufacturer's recommendations and documentation making note of recommended terminations, torque values, and bolt stack up details if provided. All buss bars, conductors, and terminations shall be clean prior to making the connection.

**END OF SECTION**

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# DIVISION 27

**COMMUNICATIONS**

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# SECTION 27 05 01
## COMMON WORK RESULTS FOR COMMUNICATIONS SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. All labor, materials, tools, equipment, and services for Basic Materials and Methods for Communications Systems, as indicated, in accordance with provisions of Contract Documents to provide a full and operating communications system as described within Division 27 documents.

B. Related Requirements: Include but are not necessarily limited to:
   1. Division 03 – Concrete
   2. Section 07 84 00 – Fire Stopping
   3. Section 10 14 00 – Identifications Devices
   4. Section 26 05 19 – Wire and Cable – 600 Volt and Below
   5. Section 26 05 33 – Raceways and Boxes
   6. Section 26 05 43 – Electrical – Exterior Underground
   7. Section 26 05 48 – Electrical Seismic Restraint Systems
   8. Section 26 08 13 – Acceptance Testing
   9. Section 26 09 16 – Control Equipment Accessories
   10. Section 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Circuits
   11. Section 27 10 00 – Structured Cabling

### 1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
   1. AMP NETCONNECT
      a. Design Installer Agreement (ND&I).
   2. ASTM International:
      a. A36/A36M - Standard Specification for Carbon Structural Steel.
   3. BICSI®
      a. Telecommunications Distribution Methods Manual (TDMM).
   4. Code of Federal Regulations
      a. Title 47 – Telecommunication.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
      a. C2 – National Electrical Safety Code (NESC).
   6. ISO/IEC
      a. 11801 Generic Cabling for Customer Premises.
   7. National Fire Protection Association® (NFPA)
      a. 70 – National Electrical Code (NEC).
   8. TIA - Telecommunications Industry Association.
      a. 526 - Standard Test Procedures for Fiber Optic Systems.
      b. 526-7-A - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fiber-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement568.0 - Generic Telecommunications Cabling For Customer Premises.
      c. 568.1 - Commercial Building Telecommunications Infrastructure Standard.
      d. 568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
      e. 568.3 - Optical Fiber Cabling and Components Standard.

f. 569 – Telecommunications Pathways and Spaces.
g. 606 - Administration Standard for Telecommunications Infrastructure.
h. 607 - Generic Telecommunications Bonding & Grounding (Earthing) for Customer Premises.

9. UL Solutions (UL).
   a. 1863 - UL Standard for Safety Communications-Circuit Accessories.

## 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Build-out of all telecommunications areas, entrance facility, building distribution, floor distribution and data/telecommunication outlets meeting the requirements of TIA.
2. Adherence to the design guidelines for installation of cabling in pathways and spaces as defined by TIA 569
3. All material, labor, tool, apparatus, and equipment to furnish completely working telecommunication cabling system.
4. Horizontal cables, backbone cables, cross connects, patch cords and data/telecommunication outlets.
5. Complete bonding of all systems components and cabinets to the telecommunications primary busbar and secondary busbar(s) in compliance with TIA 607.
6. Cable identification tags and system labeling shall match owners labeling conventions.
7. Coordination of the entire installation with all other divisions.

## 1.4 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturers:
   a. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
   b. Products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:
      1) Incoming inspection of raw materials.
      2) In-process inspection and final inspection of the cable product.
      3) Calibration procedures of test equipment to be used in the qualifications of the product.
      4) Recall procedures in the event that out of calibration equipment is identified.
      5) Conform to government standards on quality assurance for applications within these specifications.
   c. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
   d. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.
2. Installers:
   a. The intent of these specifications is to ensure the systems described in this division are provided and installed by a technically experienced installer and, further, that the work is fully coordinated between the various systems by a single installer who is technically qualified as described herein.
   b. Company specializing in installation of structured data/telecom cabling systems networks for a minimum of five years. Experience shall include the following:
      1) List at least 10 facilities of equal size, complexity and technical requirements utilizing the equipment submitted.
      2) For each facility, list:
         a) Name and location of facility.
         b) Date of occupancy by Owner.

c) Owner's representative to contact and telephone number.
d) Construction Manager or General Contractor.
e) Architect.

c. The successful cabling contractor must meet the following requirement:
1) Must have a BICSI® certified RCDD review the drawings and meet with the Engineer and Owner representatives to discuss the project and to ensure that a structured cabling system is installed that provides a comprehensive telecommunications infrastructure.

d. Where the installer is a branch office or other division of a larger organization, the qualifications of the branch office or other division shall meet the requirements of the Contract Documents. The installer incorporated under the same name, shall have successfully completed a minimum of three similar communications construction projects, both in scope and system types.

e. The work of this division shall be managed and supervised by a full-time site communications superintendent who shall have the following qualifications:
1) Experience in the applications engineering, installation, and supervision of similar construction projects both in scope and system type for a minimum of five years.
2) Full time employee of the installer.
3) Have a working knowledge of all systems installed under this division.

f. Project superintendent shall be on site full time through duration of construction.

## 1.5 SUBMITTALS

A. General:
1. Provide complete submittal package (shop drawings/product data) per individual Division 27 specification section. Information contained within each submittal package shall only pertain to the referenced specification section.
2. All submittal documents shall be submitted as pdf files. Drawings shall be produced on 30 inch x 42 inch format and product data shall be produced on 8.5 inch x 11 inch format.

B. Action Submittals: Submit the following:
1. Shop Drawings:
a. General:
1) Drawing comparison:
a) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.

b. Equipment enclosure wiring diagrams:
1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet.
2) Show the device nomenclatures exactly as shown on the single-line diagrams.
3) Show the terminations including the wire numbers as shown on the single-line diagrams.
4) Show wire colors for each terminal.
5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.

c. Custom assembly diagrams:
1) For each custom assembly such as a receptacle assembly, control panel or the like, provide an assembly drawing illustrating the appearance of the assembled device including dimensions, assembly components and functional attributes.

d. Drawing comparison:
1) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.

C. Product Data:
1. Cover page: Each product shall have a cover page with the following information:
a. Submitting Contractor's Logo.
b. Specification Section.
c. Specification Reference.

d. Manufacturer Name.
e. Manufacturer Part Number.
f. Brief Description.

2. Product Information: Include manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) to clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by highlighting, arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in Division 27. Include relevant products that will be provided, which are not listed in the specifications.
   a. Do not include sheets that are not relevant to the product data or the project.
3. Specification comparison:
   a. Copy of specification annotated on a line-by-line basis where proposed product or system differs from specified product or system. Any differences to be explained.
4. Product list for Division 27 equipment per specified system.
5. Description of system operation indicating overall system operation and purpose and capabilities of each component within system.
6. Cross reference data sheets to components shown on shop drawings.
7. Samples:
   a. As indicated in each Division 27 section.
8. Testing Plans, Procedures, and Testing Limitations:
   1) Testing procedure, apparatus, and limitations of apparatus and procedure, for:
      a) Source quality control activities indicated in each Division 27 section.
      b) Field quality control activities indicated in each Division 27 section.

D. Informational Submittals: Submit the following:
1. Certificates.
2. Manufacturer Instructions:
   a. Serial numbers of items furnished, equipment nameplate information, and similar information for all items furnished.
   b. Instructions for handling, installation, startup.

E. Qualifications Statements:
1. Manufacturer.
2. Installer.

F. Contract closeout information:
1. As indicated in each Division 27 section.
2. Operation and Maintenance Data
   a. Contract closeout information:
      1) Refer to Section 01 33 04 - Operation and Maintenance Manuals.

G. Maintenance Material Submittals: Furnish the items and submit documentation of delivery to and acceptance of such items by Owner or facility manager (as applicable) as defined in each Division 27 section.

H. Record Drawings: Refer to Section 01 78 39 - Project Record Documents.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 01 65 50 - Product Delivery, Storage, and Handling Requirements.

## 1.7 WARRANTY

A. Manufacturer's Special or Extended Warranty:

1. In addition to manufacturer's general, standard printed warranty, furnish any manufacturer's special warranty coverage. Special warranty shall remain in effect as indicated commencing on the date of Substantial Completion for the associated Work.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Acceptable manufacturers:
   1. As noted in each Division 27 section.

B. Use UL labeled electrical materials where listing has been established for materials or devices in question.

C. Structural steel for supports: ASTM-A36/A36M.
   1. Stainless steel members installed in all corrosive areas, including locations less than 10 miles from a saltwater source.
   2. Galvanize members installed in areas of high humidity or condensation.
   3. Furnish other members with shop coat of rust inhibiting primer.
   4. Shop fabricate for field assembly using bolts.
   5. Minimize field welding.
   6. Retouch primer and galvanizing after field welding.

### 2.2 EXTRA MATERIALS

A. Furnish spare parts required in each Division 27 section.

B. All spare parts shall be new and in original packaging from manufacturer.

C. Ensure parts are packaged to protect from damage and to allow for easy storage.

D. Provide inventory of all spare parts.

### 2.3 EQUIPMENT ENCLOSURE RATING

A. Use equipment enclosures suitable for the environment.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF COMMUNICATIONS INFRASTRUCTURE

A. Provide access panels in any area where equipment is located which requires accessibility for service and/or maintenance.

B. Do not change indicated sizes or configuration without written approval of Engineer.

C. Conduit verification:
   1. Verify that all conduit is clear of foreign matter and substances prior to pulling of wire or cable.
   2. Apply a chemically inert conduit lubricant to all wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer. Under no circumstances shall wire or cable be attached to any mechanical pulling device which exerts excessive force, shear or tensile.
   3. Secure all wire and cable runs vertically in conduit for continuous distances greater than thirty (30) feet at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular or other wire conforming, non-metallic bushings shall be provided for all other cables.

D. Structured cabling systems shall not occupy the same conduit/raceway with any other system or power cables.

E. Provide installation, including electrical connections, cable pulling, testing and interfacing of systems.

F. Deliver materials and equipment to project and store in original containers or cartons, properly protected from elements.

G. Execute all work described in this specification and shown on drawings and all work dependent upon, and necessary to, complete finish of the work so described or shown, in a skillful manner using materials best adapted to purposes where such work or material is not specifically mentioned.

H. Labeling:
   1. All labeling shall be in accordance with TIA-606-D requirements and Owner's labeling convention.

## 3.2 INSTALLATION OF EQUIPMENT

A. Install all equipment and infrastructure in accord with manufacturer's recommendations.

B. Provide all necessary anchoring devices and supports.
   1. Use structural supports suitable for equipment.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.

C. Verify that equipment will fit support layouts indicated.
   1. Where substitute equipment is used, revise indicated supports to fit at no additional expense.

D. Arrange for necessary openings to allow entry of equipment.
   1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.

E. Installation of communications equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
   1. Temperature and humidity are controlled.
   2. Finished ceiling is installed.
   3. Walls are finish coated with final paint treatment.
   4. Floors are finished and sealed.
   5. Millwork is completely installed, approved and signed off.

F. Equipment installed in areas where the previously described conditions have not been met and maintained after equipment installation shall be removed and either cleaned or replaced at the Engineer's discretion.

G. Install equipment to permit easy access for normal maintenance.
   1. Maintain easy access to switches, pull boxes, panels, receptacles, etc.
   2. Relocate items which interfere with access.

## 3.3 CUTTING AND PATCHING

A. Refer to section 01 73 29 - Cutting and Patching.

## 3.4 COORDINATION

A. General:
   1. Coordinate the work with the other trades to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.
   2. Verify all field conditions.
   3. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Architect or Owner without additional expense.
   4. Interface Devices: Provide all items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Owner without any additional expense.

## 3.5 FINISHES (SEE DIVISION 09)

## 3.6 WIRING

A. All cable and wire:
   1. Standard type available from more than one cable manufacturer.
   2. Manufacturer and installer are responsible for system performance.

B. All cabling, wiring, conduits/raceways and equipment housings: In strict accordance with recommendations of equipment manufacturer; finish and color of all face plates as directed by Engineer.

C. Furnish and install all wiring and cable for communications systems and perform all connections and equipment terminations.
   1. Check each cabling system run thoroughly for opens, shorts, faults, and other discontinuities.
   2. Test each system receptacle for continuity, ground condition, and voltage level prior to allowing plug-in of system equipment.
   3. All conductors from outgoing terminal blocks in control consoles, panels and/or systems equipment cabinets to devices controlled to be continuous.
      a. No splicing of cabling allowed.
   4. Field device terminations to be per manufacturer's requirements.
      a. Conductor to conductor connections to be fully insulated crimp on male/female tab type or pin and sleeve type.
      b. No conical spring connectors to be used.

D. Install communications systems cable in conduit 1 inch minimum, unless otherwise indicated.

E. Boxes: Provide a 6-inch loop for all wire and cable routed through pull boxes or distribution panels. Cable loops and bends shall not be at a radius smaller than that recommended by the manufacturer. Enlarge pull boxes as necessary to accommodate this requirement.

## 3.7 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
   1. Conduct tests in presence of Engineer, Owner and, if required inspectors of agencies having jurisdiction.
   2. Arrange date of tests in advance with Engineer, manufacturer and installer.
   3. Give minimum of 1 week notice to all inspectors.
   4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.

B. Repair or replace equipment and systems found inoperative or defective and retest.
   1. If equipment or system fails retest, replace it with products conforming to Contract Documents.
   2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

## 3.8 SYSTEMS OPERATIONAL TESTS

A. Prior to the time of substantial completion, an operational test, witnessed by a representative of the Engineer and Owner, shall be held of each system comprising the total communications systems to determine full compliance with the contract drawings. Provide all personnel, equipment, instrumentation, and communication equipment and include all costs of testing in the contract.

B. The installer shall certify in writing that the systems are installed in compliance with the manufacturer's recommendations, Refer to the requirements of the contract documents and are operating correctly. These written certifications shall be submitted to the Engineer and shall

signify that the total communications system is operationally tested and ready for final acceptance testing by the Engineer.

C. Final acceptance tests of the total communications systems shall be conducted as directed by the Engineer.

D. It shall be the responsibility of the Installer to submit for the Engineer's approval, a proposed systems check list for use in final acceptance testing. This checklist shall consist of a list of individual tasks on a device-by-device basis, organized into logical groups per system being supplied. The checklist shall be submitted not later than 90 days prior to the scheduled start of acceptance testing. Acceptance testing may not begin until the Engineer has approved the form and content of the acceptance checklist.

## 3.9 ADJUST AND CLEAN

A. Inspect all equipment and put in good working order.

B. Clean all exposed and concealed items.

C. All equipment shall be clean and dust free.

## 3.10 PUTTING SYSTEMS IN OPERATION - START UP

A. All systems shall be in satisfactory operation prior to final acceptance, at time agreed to by Owner and Engineer.

B. Operate all systems in good working order for period of 10 working days prior to final acceptance testing.

## 3.11 DEVICE MOUNTING

A. Dimensions are to center of device unless otherwise indicated.

**END OF SECTION**

# SECTION 27 10 00
STRUCTURED CABLING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for the structural cabling system such as:
      a. Service entrance protection.
      b. Cabinets, racks, frames and enclosures.
      c. Termination blocks and patch panels.
      d. Cable management and cable pathways.
      e. Rack mounted power protection and power strips.
      f. Backbone cabling.
      g. Horizontal cabling.
      h. Patch cords.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 84 00 - Firestopping.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 05 26 - Grounding and Bonding.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 26 05 36 - Cable Tray.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Building Industry Consulting Service International (BICSI).
   2. Electronics Components Industry Association (ECA):
      a. 310, Cabinets, Racks, Panels and Associated Equipment.
   3. National Electrical Manufacturers Association (NEMA):
      a. WC 66, Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With Or Without An Overall Shield) For Use In LAN Communication Wiring Systems.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 526-7, Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant.
      b. 526-14, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
      c. 568-C.0, Generic Telecommunications Cabling for Customer Premises.
      d. 568-C.1, Commercial Building Telecommunications Cabling Standard.
      e. 568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
      f. 568-C.3, Optical Fiber Cabling Components Standard.
      g. 568-C.4, Broadband Coaxial Cabling and Components Standard.
      h. 569-C, Telecommunications Pathways and Spaces.
      i. 598-D, Optical Fiber Cable Color Coding.
      j. 606-B, Administration Standard for Telecommunications Infrastructure.
      k. 607-B, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

B. Qualifications:

1. Telecommunications Contractor:
    a. Shall be regularly and professionally engaged in the business of the applications, installation, and testing of telecommunications systems and equipment.
    b. Include three references of similar scope jobs completed in the last two years.
    c. Supervisors and installers shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level.
2. Manufacturer:
    a. Company specializing in manufacturing products specified in this Section with minimum 10 years documented experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

## 1.3 SYSTEM DESCRIPTION

A. The building telecommunications cabling and pathway system shall include:
    1. All permanently installed backbone and horizontal cabling.
    2. Horizontal and backbone pathways.
    3. Service entrance facilities.
    4. Work area pathways.
    5. Telecommunications outlet assemblies.
    6. Racks.
    7. Cabinets.
    8. Enclosures.
    9. Conduit.
    10. Raceway.
    11. Patch panels.
    12. Fiber enclosures and hardware for splicing.
    13. Terminating and interconnecting cabling necessary to transport voice and data between equipment items in a building.

B. All components required for the above shall be provided for a fully tested operational system per the latest TIA/EIA/ANSI Standards.

C. Provide and install all components per this Specification for the Structured Cabling System.

D. Active equipment including switched hubs, routers, data switch(es) for fiber/copper shall be provided by others under a separate contract.

E. Patch cords connected to active equipment shall be installed by others.

## 1.4 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration for the submittal process.
    2. Provide product technical data including:
        a. Submittal data for all products specified in PART 2 of this Specification.
        b. See Specification Section 26 05 00 for additional requirements.
    3. Fabrication and/or layout drawings, sealed and approved by a registered communications distribution designer (RCDD):
        a. Layout of complete building per floor:
            1) Building area boundaries, backbone systems and horizontal pathways.
        b. Building area drawings:
            1) Drop locations and cable identifications in accordance with TIA-606.
        c. Telecommunications space drawings:
            1) Telecommunication rooms plan views, pathway layout, mechanical/electrical layout, and cabinet, rack, backboard and wall elevations.
        d. Typical detail drawings:
            1) Faceplate labeling, faceplate types, and firestopping.

4. Certificates:
    a. Telecommunications Contractor and Installers qualifications.
    b. Key Personnel qualifications.
    c. Manufacturer qualifications.
5. Test reports:
    a. Testing plan and procedures.
    b. Telecommunications cabling test results.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least one year prior to installation.
    1. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.
    2. Components shall be UL or third-party certified.

### 2.2 EQUIPMENT RACKS

A. Floor mounted 2-post equipment racks shall be welded steel or aluminum relay racks with uprights to mount industry standard 19 IN components and equipment.
    1. Uprights shall be 3 IN deep channel, 1-1/4 IN wide, drilled and tapped 12 - 24 IN standard EIA pattern.
    2. Racks shall be provided with a standard top cross member, and predrilled base plate to allow floor fastening.
    3. Open frame equipment racks shall be 7 FT tall, 45U capacity.
    4. Equipment racks shall be black powder coated.

B. Cable Management:
    1. Cable management shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally across 19 IN equipment racks.
    2. Cable management shall be specifically manufactured for the purpose of routing cables, wires and patch cords vertically adjacent to equipment racks.
    3. Cable management shall consist of ring or bracket-like devices with removable covers.
    4. Cable management shall mount to racks by screws and/or nuts and lockwashers.

### 2.3 TELEPHONE TERMINAL CABINETS

A. Factory painted or galvanized steel NEMA 3R enclosure with hinged door.
    1. Used to house building entrance protector and terminal blocks.

### 2.4 TELECOMMUNICATIONS OUTLET BOXES

A. Electrical boxes for telecommunication outlets shall be 4-11/16 IN square by 2-1/8 IN deep with minimum 3/8 IN deep single or two gang plaster ring as required.
    1. Provide a minimum 1 IN conduit.

### 2.5 TELECOMMUNICATIONS CABLE TRAYS

A. Provide cable trays with width and side heights as shown on drawings.
    1. Provide additional details for cable tray as necessary.

### 2.6 TELECOMMUNICATIONS CABLE RUNWAY

A. Provide cable runways with widths as shown on Drawings.
    1. Materials:
        a. Steel:
            1) Side stringers: 3/8 IN wide by 1-1/2 IN high tubular steel with 0.065 IN wall thickness.

2) Cross members: 1 IN wide by 1/2 IN high tubular steel with 0.065 IN wall thickness, spaced 9 IN apart on center. There will be a maximum of 8 IN open space between each cross member.
3) Black powder coat finish.

## 2.7 EQUIPMENT MOUNTING BACKBOARD

A. Plywood backboards shall be provided on three adjacent walls of telecommunications spaces.
   1. Void-free, interior grade A-C fire-rated plywood, A-side mounted facing out, 3/4 IN thick, 4 FT x 8FT sheets.
   2. Paint applied shall be UL 723 fire retardant paint, white or off-white in color. Plywood fire-retardant UL label shall remain visible after painting.

## 2.8 PATCH PANELS

A. Patch panels mounted in equipment racks with sufficient ports to accommodate all installed cable plus 25 PCT spare:
   1. Copper Patch Panel:
      a. 48-port modular jack (2U maximum), with rear mounted type 110 insulation displacement connectors.
      b. Panel shall have incoming cable strain relief and cable management guides.
      c. Jack pin/pair configuration shall be T568B.
      d. Jacks shall be unkeyed.
   2. Fiber Optic Patch Panel:
      a. Panel shall accommodate 12 duplex connectors (1U maximum).
      b. Panel shall have cable management tray, incoming cable strain relief and cable management guides.
      c. Connectors shall be duplex LC.
      d. Connectors shall be unkeyed.
      e. Provide dust covers for unused connectors.
   3. Fiber Optic Distribution Panel:
      a. Panel shall accommodate 72 duplex connectors (4U maximum).
      b. Panel shall have cable management tray(s), incoming cable strain relief and cable management guides.
      c. Connectors shall be duplex LC.
      d. Connectors shall be unkeyed.
      e. Provide dust covers for unused connectors.

## 2.9 TERMINATION BLOCKS

A. Terminal blocks:
   1. Wall mounted or rack mounted wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings.
      a. Blocks shall be type 110 which meet the requirements for Category 6 or as shown.
   2. Blocks shall be mounted on standoffs and shall include cable management hardware.
   3. Provide space for the number of horizontal and backbone cables terminated on the blocks plus 25 PCT spare.

## 2.10 BACKBONE CABLING SYSTEM

A. Outside Plant Cable:
   1. Same as horizontal cabling System except gel filled with UV resistant jacketed suitable for installation underground.

B. Backbone Fiber Cable:
   1. Singlemode, 9um/125um OS2 rated cable, formed into 12-strand color coded groups.
   2. Multimode, 50um/125um OM4 rated cable, formed into 12-strand color coded groups.
   3. Cable shall be label-verified.

4. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
5. Cable shall be rated CMP per NFPA 70.

## 2.11 HORIZONTAL CABLING SYSTEM

A. Horizontal Copper Cable:
1. Category 6.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Conductors shall be solid untinned copper 24 AWG.
5. Cable shall be rated CMP per NFPA 70.

B. Horizontal Fiber Cable:
1. Singlemode, 9um/125um OS2 rated cable.
2. Multimode, 50um/125um OM4 rated cable.
3. Cable shall be label-verified.
4. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
5. Cable shall be rated CMP per NFPA 70.

C. Telecommunications Outlets:
1. General wall and desk outlet plates shall come equipped with two modular jacks and two blank spaces.
2. Wall telephone outlet plates shall come equipped with one modular jack type.
3. Modular jacks shall be the same category as the cable they terminate.
4. Modular copper jack pin/pair configuration shall be T568B.
5. Modular jacks shall be unkeyed.
6. Wallplates:
   a. High impact thermoplastic or nylon.
   b. Color: TBD.
7. Outlet assemblies used in the premises distribution system shall consist of modular jacks in outlet assemblies mounted in single or double gang covers as specified in this Section and as indicated on the Drawings.

## 2.12 PATCH CORDS

A. Supply patch cords equal to 1.1 times the number of cables terminated in the communication room(s).
1. Provide for installed copper and fiber-optic systems.
2. 10 FT cords.

B. Patch Cords, Copper:
1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
5. Patch cords shall be unkeyed.
6. Patch cords shall be factory assembled.
7. Patch cords shall match the color of the installed system.

C. Patch Cords, Singlemode Fiber:
1. Assemblies consisting of flexible, 9um/125um OS2 rated cable with duplex LC connectors at each end.
2. Cable shall be label-verified.

3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Patch cords shall have crossover orientation.
5. Patch cords shall be unkeyed.
6. Patch cords shall be factory assembled.
7. Patch cords shall be yellow.

D. Patch Cords, Multimode Fiber:
1. Assemblies consisting of flexible, 50um/125um OM4 rated cable with duplex LC connectors at each end.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Patch cords shall have crossover orientation.
5. Patch cords shall be unkeyed.
6. Patch cords shall be factory assembled.
7. Patch cords shall be orange.

## 2.13 DEVICE CABLES

A. Supply Device cables equal to 1.1 times the number of jacks installed.
1. Provide for installed copper and fiber-optic systems.
2. 10 FT cords.

B. Device Cables, Copper:
1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Device cables shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
5. Device cables shall be unkeyed.
6. Device cables shall be factory assembled.
7. Device cables shall match the color of the installed system.

C. Device Cables, Singlemode Fiber:
1. Assemblies consisting of flexible, 9um/125um OS2 rated cable with duplex LC connectors at each end.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Device cables shall be unkeyed.
5. Device cables shall be factory assembled.
6. Device cables shall be yellow.

D. Device Cables, Multimode Fiber:
1. Assemblies consisting of flexible, 50um/125um OM4 rated cable with duplex LC connectors at each end.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Device cables shall be unkeyed.
5. Device cables shall be factory assembled.
6. Device cables shall be orange.

## 2.14 LABELING AND COLOR CODING

A. Labels shall be developed by the contractor and approved by the Owner.

1. Labels shall be machine printed on opaque or clear tape, stenciled onto adhesive labels.
2. Handwritten labeling is unacceptable.

B. Cable and Jacks:
1. Voice: White.
2. Data: Blue.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown.

B. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be coordinated with the local communications provider(s).

C. Components shall be labeled in accordance with TIA/EIA/ANSI 606.

D. Penetrations in fire-rated construction shall be firestopped.

E. Wiring shall be installed in accordance with TIA/EIA/ANSI Standards.
1. Wiring, and terminal blocks and outlets shall be marked in accordance with TIA/EIA/ANSI 606.

F. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with AC power cables.

G. Equipment Racks:
1. Open frame equipment racks shall be bolted to the floor.
2. Cable guides shall be bolted or screwed to racks.
3. Racks shall be installed level.
4. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

H. Rack Mounted Equipment: Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

I. Terminal Blocks:
1. Terminal blocks shall be mounted in orderly rows and columns.
2. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks.
3. Industry standard wire routing guides shall be utilized.

J. Pathway System:
1. Provide in accordance with TIA 569 and NFPA 70.
2. Provide conduits in accordance with 26 05 33 - Raceways and Boxes.
3. Provide grounding of raceways and cable tray in accordance with TIA 607 and NFPA 70.

K. Unshielded Twisted Pair Patch Panels:
1. Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 25 PCT spares.
2. Cable guides shall be provided above, below and between each panel.

L. Fiber Optic Patch Panels:
1. Patch panels shall be mounted in equipment racks with sufficient connectors to accommodate the installed cable plant plus 25 PCT spares.
2. Cable guides shall be provided above, below and between each panel.

M. Backbone and Horizontal Distribution Cable:
1. Cable pulling tension shall not be exceeded.

a. 110N (25 LBF) for copper cabling.
2. Cable shall not be stressed such that twisting, stretching or kinking occurs.
3. Cable shall not be spliced.
4. All backbone cable shall be installed in conduit or cable tray.
5. All horizontal cable shall be installed in an appropriate telecommunications pathway.
6. Cable shall not be run through structural members or in contact with conduits, pipes, ducts, or other potentially damaging items.
7. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 IN shall be maintained when such placement cannot be avoided.
8. Cables shall be terminated; no cable shall contain unterminated elements.
9. Minimum bending radius shall not be exceeded during installation or once installed.
10. Only fabric hook and loop fasteners shall be used to wrap cables, 1/2 IN width minimum. Plastic or nylon cable ties shall not be used.

N. Telecommunications Outlets:
1. Faceplates: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.
2. Cables:
a. Unshielded twisted pair cables shall have a minimum of 12 IN of slack cable loosely coiled into the telecommunications outlet boxes.
b. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

## 3.2 TERMINATION

A. Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles.
1. Manufacturer's minimum bending radius shall not be exceeded.
2. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.
3. Unshielded Twisted Pair Cable:
a. Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels.
b. No cable shall be unterminated or contain unterminated elements.
c. Pairs shall remain twisted together to within the proper distance from the termination as specified in the TIA/EIA/ANSI 568B Series.
d. Conductors shall not be damaged when removing insulation.
e. Wire insulation shall not be damaged when removing outer jacket.
4. Fiber Optic Cable:
a. Each pair shall be terminated with appropriate connectors.
b. No cable shall be unterminated or contain unterminated elements.

## 3.3 GROUNDING

A. Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with TIA/EIA/ANSI J-STD-607.
1. Equipment racks shall be connected to the electrical safety ground.

## 3.4 LABELING

A. All cables will be labeled using color labels on both ends per TIA/EIA/ANSI 606.

B. All workstation and patch panel connections will be labeled using color coded labels per TIA/EIA/ANSI 606.

## 3.5 TESTING

A. Testing shall conform to the TIA/EIA/ANSI Standards for all test parameters.
1. All test data sheets shall be downloaded from the tester, printed out and provided to the Owner.
2. A USB flash drive shall be provided to the Owner with all test results.
3. Tester shall be capable of testing parameters for the warranted system.

B. Materials and documentation to be furnished under this Specification are subject to inspections and tests.
   1. All components shall be terminated prior to testing.
   2. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

C. Unshielded Twisted Pair Tests:
   1. All metallic cable pairs shall be tested for proper identification and continuity.
   2. All opens, shorts, crosses, grounds, and reversals shall be corrected.
   3. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet.
   4. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room.
   5. These tests shall be completed and all errors corrected before any other tests are started.

D. Category 6 Circuits:
   1. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA-568-C.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
   2. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.

E. Fiber Optic Cable:
   1. Unless stated otherwise, tests shall be performed from both ends of each circuit.
   2. All terminations shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist.
   3. Each link shall be tested for insertion loss using a light source similar to that used for the intended communications equipment.
   4. High-resolution optical time domain reflectometer (OTDR) tests shall be performed for each fiber.
   5. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 PCT of the X-axis.

**END OF SECTION**

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# SECTION 27 21 00
TELEMETRY SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Items required include but are not necessarily limited to the following:
      a. Radios.
      b. Antennas, masts, and associated appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 40 61 13 - Process Control Systems General Requirements.
   5. Section 40 61 43 - Surge Protection Devices (SPD) For Instrumentation and Control Equipment.
   6. Section 40 67 00 - Control System Equipment Panels and Racks.
   7. Section 40 61 96 – Process Control Descriptions.
   8. Section 40 97 00 - Control Auxiliaries.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Federal Communications Commission (FCC):
      a. 47 CFR 15 - Radio Frequency Devices, Section 15.247 - Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
   2. International Electrotechnical Commission (IEC):
      a. 61131-3 - Programmable Controllers, Part 3: Programming Languages.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
   4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 222-G, Structural Standards for Steel Antenna Towers and Antenna Supporting Structures.
   5. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Safety Industrial Control Panels.

### 1.3 DEFINITIONS

A. ARQ (Automatic Resend Query): Method of error correction where the receiver initiates an order to retransmit data blocks that are determined to be corrupted in transmission.

B. BER (Bit Error Rate):
   1. Ratio of the number of bits received in error to the total number of bits transmitted.
   2. Used as a measure of quality for data links.

C. CRC (Cyclic Redundancy Check):
   1. A method utilized for detecting errors in data transmission or storage.
   2. A number is calculated on the originating end based on the message contents, and then appended to the message before transmission.
   3. The CRC is re-calculated on the receiving end, and compared to the previously calculated value.

4. A match of the two calculated values indicates a high probability that the message was received correctly.

D. Omnidirectional Antenna: An antenna that radiates maximum power uniformly 360 DEG in the horizontal plane.

E. RTU (Remote Terminal Unit):
   1. A remotely located device that collects data, codes the data into a format that is transmittable and transmits the data back to a central Supervisory Control and Data Acquisition (SCADA) system.
   2. The RTU also receives communication from the SCADA system and implements processes as directed.

F. Spread Spectrum:
   1. Communications technique whereby a radio frequency signal is spread (modulated) in order to generate an expanded bandwidth signal.
      a. Frequency Hopping Spread Spectrum: Communications technique where the frequency of the radio signal repeatedly "hops" from one frequency to another in accordance with a random but predictable sequence.
      b. Direct Sequence Spread Spectrum: Communications technique whereby the stream of information (data signal) is combined with a higher data-rate bit sequence, or chipping code, that divides the user data according to a spreading ratio.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.
   3. Product technical data:
      a. As required by Specification Section 40 61 13.
      b. Arrangement drawings for RTU system components in accordance with Section 40 67 00.
      c. Panel and enclosure plans, sections and details in accordance with Section 40 67 00.
      d. Enclosure internal wiring and terminal blocks in accordance with Section 40 67 00.
      e. Manufacturer's installation instructions.
   4. Submit all catalog cut sheets under Specification Section 27 21 00 submittals.
   5. Submit all panel fabrication drawings and associated wiring diagrams for RTUs under Section 40 67 00 submittals.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Radio site survey results including the following minimum information:
      a. Electromagnetic noise level at each site.
      b. Data rate for each radio.
      c. Received radio signal strength at installed antenna height for each radio.
      d. Fade margin in dB (difference between weakest signal the radio can read and actual received signal strength).
   2. List of all recommended spares for maintenance purposes with each item separately priced.
      a. List shall include all special tools and test equipment necessary for the maintenance of the complete system.
   3. Results of factory testing procedures.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 RADIOS

A. Manufacturers:
   1. CalAmp Viper.
   2. No like, equivalent or "or-equal" item or substitution is permitted.

B. Design and Fabrication:
   1. Communication:
      a. Type:
         1) High speed Ethernet.
         2) Ethernet communication in accordance with IEEE 802.3.
      b. Ports:
         1) Ethernet: 10 BaseT Ethernet.
         2) Serial: RS-232 serial interface.
      c. Data throughput: 256 Kbps.
   2. FCC licensed.
   3. Diagnostics:
      a. Provide capability for remote diagnostics monitoring.
         1) Provide licensed copies to the Owner of any software required for remote diagnostics.
   4. Configuration:
      a. Provide remote configuration capability.
         1) Provide licensed copies to the Owner of any software required for remote configuration.
   5. Receiver sensitivity:
      a. -92 dBm at 512 Kbps with 0.000001 ($10^{-6}$) BER.
      b. -96 dBm at 230 Kbps with 0.000001 ($10^{-6}$) BER.
      c. -108 dBm at 115 Kbps with 0.000001 ($10^{-6}$) BER.
   6. Error detection/correction: 16 bit CRC with ARQ (Automatic Re-send Query).
   7. Temperature: -22 to +140 DEGF.
   8. Humidity: 90 PCT at 104 DEGF noncondensing.
   9. Input power: 10.5-24 VDC.
   10. Case: Aluminum.
   11. Agency approvals: FCC 47 CFR 15.247.

### 2.3 ANTENNAS AND MASTS

A. Design and Fabrication:
   1. All steel antenna and supporting structures shall be in accordance with TIA/EIA/ANSI 222-G.
   2. Type:
      a. Omnidirectional antenna for point-to-multipoint or multipoint-to-multipoint applications.
   3. Lightning protected: Mast or tower direct connected to ground.
   4. Materials:
      a. Antenna:
         1) Aluminum or aluminum with Teflon impregnated powder coat finish.
      b. Mounting hardware:
         1) 316 stainless steel or aluminum.

c. Masts:
1) Galvanized steel.

5. Frequency range: Specified by manufacturer to match frequencies at which radios operate.
6. Provide all masts, supports, lightning suppressors, and other apparatus required to make a complete and operable radio telemetry system.

### 2.4 TRANSMISSION CABLE AND MISCELLANEOUS

A. Acceptable Cable Manufacturers:
1. Andrew Corp. LDF Series.
2. Times Microwave Systems LMR Series.
3. Or approved equal.

B. Provide low-loss foam-dielectric type cable connecting radio antenna port(s) with the antenna.
1. Cable: 1/2 IN or larger diameter as required to prevent signal losses in cable from degrading performance.
2. Weatherproof, suitable for direct environmental exposure.
a. Use "O" ring seals on connections.

C. Provide "superflexible" transmission cable (length as required) at the radio antenna port.
1. Provide standard Type TNC connectors for connection to a continuous piece of cable extending to the antenna.

D. Provide antenna surge suppressor and connect to coaxial cable in cabinet housing radio.
1. Acceptable manufacturer:
a. Polyphaser.

E. Provide grounding connections to the antenna mast and cable in accordance with manufacturer's recommendations.

### 2.5 ACCESSORIES

A. Provide all accessories required to furnish a complete telemetry system to accomplish the requirements of the Drawings and Specifications.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install telemetry system as shown on Drawings in accordance with manufacturer's written instruction.

B. Provide documentation verifying the data communication rate (actual throughput), signal strength and signal quality for each radio.

### 3.2 FIELD QUALITY CONTROL

A. Conduct startup of equipment and perform operational checks.

B. Maintain and submit an accurate daily or weekly log of all commissioning and startup functions.
1. All commissioning/startup functions may be witnessed by the Engineer.
2. All reports shall be signed and dated by the Contractor.

C. Provide Owner with a written statement that equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

### 3.3 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01 75 00.

## END OF SECTION

# DIVISION 28

## ELECTRONIC SAFETY AND SECURITY

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# SECTION 28 05 01
## COMMON WORK RESULTS FOR ELECTRONIC SECURITY SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The security system is a delegated design with performance specifications. Provide a new, code compliant security system serving the Ashland Water Treatment Plant (WTP) that meets the requirements of all applicable local and national codes. Contractor shall fully coordinate installation with other trades. All design, labor, materials, tools, equipment, and services for Basic Materials and Methods for Electronics Systems, as indicated, in accordance with provisions of Contract Documents to provide full and operating electronic security systems as described within the Division 28 documents.

B. Related Requirements: Include but are not necessarily limited to:
   1. Division 03 - Concrete
   2. Section 07 84 00 – Fire Stopping
   3. Section 10 14 00 – Identifications Devices
   4. Section 26 05 19 – Wire and Cable – 600 Volt and Below
   5. Section 26 05 33 – Raceways and Boxes
   6. Section 26 05 43 – Electrical – Exterior Underground
   7. Section 26 05 48 – Electrical Seismic Restraint Systems
   8. Section 26 08 13 – Acceptance Testing
   9. Section 26 09 16 – Control Equipment Accessories
   10. Section 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Circuits
   11. Section 27 10 00 – Structured Cabling
   12. Section 27 05 01 – Common Work Results for Communications Systems
   13. Section 28 10 01 – Access Control
   14. Section 28 20 01 – Video Surveillance System

### 1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
   1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
      a. ANSI/TIA-568.0-E - Generic Telecommunications Cabling for Customer Premises.
      b. ANSI/TIA-568.1-E - Commercial Building Telecommunications Infrastructure Standard.
      c. ANSI/TIA-568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
      d. ANSI/TIA-568.2-D-2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard Addendum 2: Power Delivery Over Balanced Twisted-Pair Cabling.
      e. ANSI/TIA-568.3-D - Optical Fiber Cabling and Components Standard.
      f. ANSI/TIA-568.3-D-1 - Optical Fiber Cabling and Components Standard Addendum 1: General Updates.
      g. ANSI/TIA-569-E – Telecommunications Pathways and Spaces.
      h. ANSI--607-D - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
      i. ANSI/TIA-606-D Administration Standard for the Telecommunications Infrastructure.
      j. ANSI/TIA-526 - Standard Test Procedures for Fiber Optic Systems.
      k. ANSI/TIA-526-7-A – Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.

2. BICSI®
   a. Telecommunications Distribution Methods Manual (TDMM).
3. National Fire Protection Association (NFPA)
   a. 70, National Electrical Code (NEC).

## 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Build-out of all security equipment areas and outlets meeting the requirements of ANSI/TIA+/EIA.
2. Adherence to the design guidelines for installation of cabling in pathways and spaces as defined by ANSI/TIA/EIA 569
3. All material, labor, tool, apparatus, and equipment to furnish completely working security cabling system.
4. Horizontal cables, backbone cables, cross connects, patch cords and security outlets.
5. Complete bonding of all systems components and cabinets to the telecommunications primary busbar and secondary busbar(s) in compliance with ANSI/TIA/EIA 607.
6. Cable identification tags and system labeling shall match owners labeling conventions.
7. Coordination of the entire installation with all other divisions.

## 1.4 QUALITY ASSURANCE

A. Qualifications:
1. Security system integrator/installer:
   a. Ironclad Security:
      1) Contact Name: Jason McCauley
      2) Phone: (541) 326-0990
      3) Web: www.ironclad-security.com
   b. No like, equivalent or or-equal item is acceptable.
2. See Specification Section 28 05 01 for additional requirements.
3. Manufacturers:
   a. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
   b. Products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:
      1) Incoming inspection of raw materials.
      2) In-process inspection and final inspection of the cable product.
      3) Calibration procedures of test equipment to be used in the qualifications of the product.
      4) Recall procedures in the event that out of calibration equipment is identified.
      5) Conform to government standards on quality assurance for applications within these specifications.
   c. Material and equipment shall be new, and conform to grade, quality, and standards specified. Equipment and materials of the same type shall be a product of the same manufacturer throughout.
   d. Equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, shall be listed and labeled by the independent testing laboratory.
4. Installers:
   a. The intent of these specifications is to ensure the systems described in this division are provided and installed by a technically experienced installer and, further, that the work is fully coordinated between the various systems by a single installer who is technically qualified as described herein.
   b. Company specializing in installation of security systems and integration for a minimum of five years. Experience shall include the following:

1) List at least 10 facilities of equal size, complexity and technical requirements utilizing the equipment submitted.
2) For each facility, list:
   a) Name and location of facility.
   b) Date of occupancy by Owner.
   c) Owner's representative to contact and telephone number.
   d) Construction Manager or General Contractor.
   e) Architect.

c. Where the installer is a branch office or other division of a larger organization, the qualifications of the branch office or other division shall meet the requirements of the Contract Documents. The installer incorporated under the same name, shall have successfully completed a minimum of three similar security construction projects, both in scope and system types.

d. The work of this division shall be managed and supervised by a full-time site Electronic Security Systems superintendent who shall have the following qualifications:
   1) Experience in the applications engineering, installation, and supervision of similar construction projects both in scope and system type for a minimum of five years.
   2) Full time employee of the installer.
   3) Have a working knowledge of all systems installed under this division.

e. Project superintendent shall be on site full time through duration of construction.

## 1.5 SUBMITTALS

A. General:
1. Provide complete submittal package (shop drawings/product data) per individual specification section. Information contained within each submittal package shall only pertain to the referenced specification section.
2. All submittal documents shall be submitted as pdf files. Drawings shall be produced on 30 inch x 42 inch format and product data shall be produced on 8.5 inch x 11 inch format.

B. Action Submittals: Submit the following:
1. Shop drawings:
   a. General:
      1) Drawing comparison:
         a) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.
      2) All contractor provided equipment shall be identified in the shop drawing package by its associated room designation (i.e. PLC-A122, do not label equipment PLC-1, PLC-2, TS-1, TS-2, etc.).
   b. "Point-to-Point" sheet and detail references shall be provided throughout the shop drawing set to specifically identify:
      1) Field device location on floorplan to cable termination location.
      2) Cable termination location to equipment cabinet elevation.
      3) Equipment cabinet elevation to equipment component detail.
      4) Equipment component detail to equipment wiring diagram.
      5) Equipment wiring diagram to termination schedule.
      6) Termination schedule including:
         a) PLC input/output information.
         b) Power supply information.
         c) Field device wiring diagram.
         d) Field device rough-in detail.
         e) Programming information.
         f) Functional information.
         g) Interface to other system information (camera call-up to intercom/alarm, etc.)
         h) Any pertinent or device specific special operational information.

7) The cross-references shall be backwards and forwards referencing throughout the shop drawings to the level that each field device can be referenced from its floorplan location to its specific termination location and associated wiring information.

c. Equipment enclosure wiring diagrams:
   1) Show a pictorial illustration of each equipment enclosure and/or terminal cabinet.
   2) Show the device nomenclatures exactly as shown on the single line diagrams.
   3) Show the terminations including the wire numbers as shown on the single line diagrams.
   4) Show wire colors for each terminal.
   5) For each wire exiting the enclosure, show the destination of the wire by floor, room number and the drawing number of the panel where the wire terminates.

d. Field device wiring diagrams:
   1) For each field device, existing or new, provide a detailed wiring diagram.
   2) Show the termination connectors on the device.
   3) Show the wire numbers attached to the connectors, pigtails, or terminal blocks.
   4) Show the wire colors connected to the pins, pigtails, or terminal blocks on each device connector.

e. Freestanding device wiring diagrams:
   1) For each freestanding device, such as a computer, printer or the like, show the rear elevation of the device as a pictorial.
   2) Show the termination connectors on the device.
   3) Show the wire numbers attached to the connectors.
   4) Schedule the wire colors connected to the pins on each device connector.

f. Custom assembly diagrams:
   1) For each custom assembly such as a receptacle assembly, control panel or the like, provide an assembly drawing illustrating the appearance of the assembled device including dimensions, assembly components and functional attributes (momentary or alternate action switch, lens color, panel finish and the like).

g. Drawing comparison:
   1) Copy of drawing annotated where proposed system layout differs from designed system. Any differences to be explained.

2. Product data:
   a. Cover page: Each product shall have a cover page with the following information:
      1) Submitting Contractor's Logo.
      2) Specification Section.
      3) Specification Reference.
      4) Manufacturer Name.
      5) Manufacturer Part Number.
      6) Brief Description.
   b. Product Information: Include manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) to clearly describe the product's characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in Division 28. Include relevant products that will be installed, which are not listed in the specifications.
      1) Do not include sheets that are not relevant to the product data or the project.
   c. Specification comparison:
      1) Copy of specification annotated on a line-by-line basis where proposed product or system differs from specified product or system. Any differences to be explained.
   d. Table of Contents in the form of the Bill of Materials provided as defined by each Division 28 section.

e. Data sheets for each device as indicated in each Division 28 section and as indicated herein.
f. Description of system operation indicating overall system operation and purpose and capabilities of each component within system.
g. Cross reference data sheets to components shown on system/riser diagrams.

3. Security Electronics Control System (SECS) Graphic Maps:
   a. Graphic maps shall be submitted for each control station for approval by Engineer and Owner.
   b. Provide two PDF on USB colored, digitally tabbed, digital copies of each submission.
   c. Submittal Review Meeting: After initial Graphic Map Review a meeting shall be arranged at the Owner's site to discuss operational and functional issues relating to the design of the Graphics prior to creating the final maps for the submittal process outlined below.
   d. Graphic Map Shop drawings:
      1) Full size layout of each graphic map.
      2) List of system integrator suggested modifications to graphic maps.
      3) List of system integrator suggested system enhancement.
   e. Testing Plans, Procedures, and Testing Limitations:
      1) Testing procedure, apparatus, and limitations of apparatus and procedure, for:
         a) Source quality control activities indicated in each Division 28 section.
         b) Field quality control activities indicated in each Division 28 section.
4. Samples:
   a. As indicated in each Division 28 section.

C. Informational Submittals: Submit the following:
1. Certificates.
2. Manufacturer Instructions:
   a. Serial numbers of items furnished, equipment nameplate information, and similar information for all items furnished.
   b. Instructions for handling, installation, startup.
3. Qualification Statements:
   a. Manufacturer
   b. Installer

D. Closeout Submittals:
1. As indicated in each Division 28 section.
2. Operation and Maintenance Data
   a. Contract closeout information:
      1) Refer to Section 01 33 04 - Operation and Maintenance Manuals.
3. Record Drawings: Refer to Section 01 78 39 - Project Record Documents.

E. Maintenance Material Submittals: Furnish the items and submit documentation of delivery to and acceptance of such items by Owner or facility manager (as applicable) as defined in each Division 28 section.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to section 01 65 50 - Product Delivery, Storage, and Handling Requirements.

## 1.7 WARRANTY

A. Manufacturer's Special or Extended Warranty:
1. In addition to manufacturer's general, standard printed warranty, furnish any manufacturer's special warranty coverage. Special warranty shall remain in effect as indicated commencing on the date of Substantial Completion for the associated Work.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Acceptable manufacturers:
   1. As noted in each Division 28 section.

B. Use UL labeled electrical materials where listing has been established for materials or devices in question.

C. Structural steel for supports: ASTM-A36/A36M.
   1. Stainless steel members installed in all corrosive areas, including locations less than 10 miles from a saltwater source.
   2. Galvanize members installed in areas of high humidity or condensation.
   3. Furnish other members with shop coat of rust inhibiting primer.
   4. Shop fabricates for field assembly using bolts.
   5. Minimize field welding.
   6. Retouch primer and galvanizing after field welding.

### 2.2 EXTRA MATERIALS

A. Furnish spare parts required in each Division 28 section.

B. All spare parts shall be new and in original packaging from manufacturer.

C. Ensure parts are packaged to protect from damage and to allow for easy storage.

D. Provide inventory of all spare parts.

### 2.3 EQUIPMENT ENCLOSURE RATING

A. Use equipment enclosures suitable for the environment.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Provide access panels (detention and non-detention) in any area where equipment is located which requires accessibility for service and/or maintenance

B. Do not change indicated sizes or configuration without written approval of Architect/Engineer.

C. Conduit verification:
   1. Verify that all conduit is clear of foreign matter and substances prior to pulling of wire or cable.
   2. Apply a chemically inert conduit lubricant to all wire and cable prior to pulling. Do not subject wire and cable to tension greater than recommended by the manufacturer. Under no circumstances shall wire or cable be "jerked", "yanked" or attached to any mechanical pulling device which exerts excessive force, shear, or tensile.
   3. Secure all wire and cable runs vertically in conduit for continuous distances greater than 30 meters at the vertical run terminations. Non-coaxial cables shall be secured by screw-flange nylon cable ties or similar devices. Symmetrical clamping devices with split, circular or other wire conforming, non-metallic bushings shall be provided for all other cables.

D. Division 28 systems (i.e., communications, door control, CCTV, power) shall not occupy the same conduit/raceway, nor with any other system or power cables. All Class 1 and Class 2 circuits shall be routed within separate raceways and shall be portioned within all wireways.

### 3.2 COORDINATION

A. General:
   1. Coordinate the work with the Owner to assure that where this work interfaces to other trades, those interfaces are provided, complete and functional.

2. Verify all field conditions.
3. Positioning Members: Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Engineer or Owner without additional expense.
4. Interface Devices: Provide all items necessary to complete this work in conformance with the Contract Documents or the satisfaction of the Engineer or Owner without any additional expense.

## 3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in accord with manufacturer's recommendations.

B. Provide all necessary anchoring devices and supports.
   1. Use structural supports suitable for equipment.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.

C. Verify that equipment will fit support layouts indicated.
   1. Where substitute equipment is used, revise indicated supports to fit at no additional expense.

D. Arrange for necessary openings to allow entry of equipment.
   1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.

E. Installation of security electronics headend equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
   1. Temperature and humidity are controlled.
   2. Finished ceiling, if any, is installed.
   3. Walls are finish coated with final paint treatment.
   4. Floors are finished and sealed.

F. Installation of security electronics control room equipment shall not proceed until the progress of construction has reached the following status in the area of installation:
   1. Temperature and humidity are controlled.
   2. Finished ceiling, if any, is installed.
   3. Walls are finish coated with final paint treatment.
   4. Floors are finished and sealed.
   5. Millwork is completely installed, approved, and signed off.

G. Equipment installed in areas where the previously described conditions have not been met and maintained after equipment installation shall be removed and either cleaned or replaced at the Engineer's discretion.

H. Install equipment to permit easy access for normal maintenance.
   1. Maintain easy access to switches, pull boxes, panels, receptacles, etc.
   2. Relocate items which interfere with access.

I. Provide tamper resistant security fasteners on all device plates, etc., and for all exposed fasteners, in inmate areas within secure detention perimeter. These areas include but are not limited to the following: all spaces within the vehicular sallyport, inmate sallyport, holding cells, visitation booths, movement corridors, movement elevators and court holding cell areas within secure perimeter and all other areas as directed.

## 3.4 WIRING

A. Refer to section 27 10 00 Structured Cabling Systems.

## 3.5 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
   1. Conduct tests in presence of Engineer, Owner and, if required inspectors of agencies having jurisdiction.

2. Arrange date of tests in advance with Engineer, manufacturer and installer.
3. Schedule with the Engineer and Owner a minimum of 2 weeks prior to inspection.
4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.

B. Repair or replace equipment and systems found inoperative or defective and retest.
1. If equipment or system fails retest, replace it with products conforming with Contract Documents.
2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

## 3.6 SYSTEMS OPERATIONAL TESTS

A. Prior to the time of substantial completion, an acceptance test, witnessed by a representative of the Engineer and Owner, shall be held of each system comprising the total electronic system to determine full compliance with the contract drawings. Provide all personnel, equipment, instrumentation, and communication equipment and include all costs of testing in the contract.

B. It shall be the responsibility of the Integrator to submit for the Engineer's approval, a proposed "SECS Checklist" for use in final acceptance testing. This checklist shall consist of a list of individual tasks on a device-by-device basis, organized into logical groups per system being supplied; the checklist shall list each device and its associated function with a "comment" box for further description or clarification. The checklist shall be submitted not later than 90 days prior to the scheduled start of acceptance testing. Acceptance testing may not begin until the Engineer has approved the form and content of the acceptance checklist.

C. Not less than 2 weeks prior to the scheduled acceptance test, the installer/integrator shall certify in writing that the systems are installed in compliance with the manufacturer's recommendations, Refer to the requirements of the contract documents and are operating correctly. The contractor shall completely fill out the Engineer approved SECS Checklist that all devices and equipment have been tested and are operating correctly. These written certifications shall be submitted to the Engineer and shall signify that the total electronic system is operationally tested and ready for final acceptance testing by the Engineer.

D. Final acceptance tests of the total electronic systems shall be conducted as directed by the Engineer but generally described as follows:
1. Locking system shall be tested by operation of each individual locking device with status visual display observed.
2. Remote control and emergency release of locking systems shall also be tested.
3. Emergency lock-down shall be performed.
4. Intercom system shall be tested by operation of all individual features and stations.
5. Each individual alarm system and each group of alarm systems operating both individually and collectively shall be tested for alarm signal initiation, tamper signal initiation and loss of power signal initiation as directed by the Engineer.

E. All expenses for the Engineer to re-test after initial punch-list and subsequent "final acceptance test" will be the responsibility of this contractor.

## 3.7 ADJUST AND CLEAN

A. Inspect all equipment and put in good working order.

B. Clean all exposed and concealed items.

C. All equipment shall be clean and dust free.

D. Provide all adjustments in accordance with the manufacturer's recommendations and Owner's requirements, such as scheduling.

## 3.8 PUTTING SYSTEMS IN OPERATION - START UP

A. All systems shall be in satisfactory operation prior to final acceptance, at time agreed to by Owner and Engineer.

B. Operate all systems in good working order for period of 10 working days prior to final acceptance testing by Engineer and Owner.

## 3.9 DEVICE MOUNTING

A. Dimensions are to center of device unless otherwise indicated.

## 3.10 LABELING

A. Labeling:
   1. Engraved phenolic nameplates for security equipment cabinets, and enclosures.
   2. Label all junction boxes using black permanent ink with type of system wiring installed in junction box, i.e., access control, detention door controls, intercom, CCTV, etc.

## 3.11 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 4 HRS of on-site training in the operations and maintenance of the electronic security systems.

**END OF SECTION**

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# SECTION 28 10 01
ACCESS CONTROL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The access control system is a delegated design with performance specifications. Provide a new, code compliant access control system serving the Ashland Water Treatment Plant (WTP) that meets the requirements of all applicable local and national codes. Contractor shall fully coordinate installation with other trades.

B. Access control shall be provided at the following locations:
   1. Vehicle Entrance Gate:
      a. Provide card reader access control on unsecure side of gate.
   2. Pretreatment Building:
      a. Provide card reader access control on exterior side of each building exterior doorway including but not limited to door position switches, request to exit, power supplies, and interface hardware.
   3. Operations Building:
      a. Provide card reader access control on exterior side of each building exterior doorway including but not limited to door position switches, request to exit, power supplies, and interface hardware.
   4. Crowson Pump Station:
      a. Provide card reader access control on exterior side of each building exterior doorway including but not limited to door position switches, request to exit, power supplies, and interface hardware.

C. Section Includes:
   1. Design, material, and installation requirements for a complete and fully functional access control system, to allow access to authorized personnel within pre-determined areas of the site, based on time and/or authority level.
   2. Specifications require that access control reader interface devices and field devices to be interfaced with other security systems outlined in the Division 28 Sections.
   3. Section 28 05 01 - Common Work Results for Electronic Safety and Security provides requirements that apply to the work of this section.

D. Related Specification Sections but not necessarily limited to:
   1. Division 03 – Concrete
   2. Section 07 84 00 – Firestopping
   3. Section 08 11 16 – Aluminum Doors and Frames
   4. Section 08 33 22 – Aluminum Rolling Overhead Doors
   5. Section 08 71 00 – Door Hardware
   6. Section 09 91 10 – Architectural Painting
   7. Section 26 05 19 – Wire and Cable – 600 Volt and Below
   8. Section 26 05 33 – Raceways and Boxes
   9. Section 26 05 43 – Electrical – Exterior Underground
   10. Section 26 05 48 – Electrical Seismic Restraint Systems
   11. Section 26 08 13 – Acceptance Testing
   12. Section 26 09 16 – Control Equipment Accessories
   13. Section 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Circuits
   14. Section 27 10 00 – Structured Cabling
   15. Section 27 05 01 – Common Work Results for Communications Systems
   16. Section 28 05 01 – Common Work Results for Electronic Security Systems
   17. Section 28 20 01 – Video Surveillance System

18. Section 32 31 13 – Chain-Link Fences and Gates.

## 1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
   1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
      a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. UL Solutions. (UL).

## 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. Coordinate installation of readers and integrate into special assemblies for narrow jamb frames and pedestal mounts.

## 1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Security system integrator/installer:
      a. Ironclad Security:
         1) Contact Name: Jason McCauley
         2) Phone: (541) 326-0990
         3) Web: www.ironclad-security.com
      b. No like, equivalent or or-equal item is acceptable.
   2. See Specification Section 28 05 01 for additional requirements.

## 1.5 SYSTEM ARCHITECTURE AND DESCRIPTION

A. Provide a microprocessor-based networked security access control and alarm monitoring system. System components shall have as a minimum, Access Control System Servers and Workstations, required software and licenses, field devices, remote I/O modules, readers, printer and all the required hardware and software for a complete and operational system.

B. System.
   1. The alarm monitoring client workstation shall communicate with, and monitor, access control hardware devices, such as access control readers and access control panels. Administrative tasks including defining credential holder information, access groups, time zones, intrusion detection devices, configuring digital video cameras and recording devices, generating reports, creating maps, floor plans, site plans etc. shall be provided from any licensed client workstation on the network.
   2. All system data shall reside on a single database on the server and be accessible in real time to all licensed system workstations connected to the network, to allow for automatic change propagation to all client workstations on the system, as well as to provide a common database to consolidate all information.

C. Access Control:
   1. The system shall be programmed to provide access granted or denied decisions, define access levels, and set time zones and holidays. An input/output linkage feature shall allow linking of monitor zone points to output control points within Access control panels.

D. Alarm Monitoring:
   1. Alarms are to be prioritized. The main alarm window shall provide information to include the time and location of the alarm, along with its priority. The main alarm window shall be able to sort pending and/or insert new alarms based on any of the following attributes: priority, date/time, alarm description, Access control panel, Card Reader, Input Module or cardholder.

E. Network Video Management:
   1. The system shall include a seamlessly integrated network-based video management module, to allow for the central administration, monitoring, and archiving of network based video and the associated cameras. The system shall support network based video servers from multiple manufacturers.

F. Third Party Interfaces:
   1. The system shall integrate with a number of third-party hardware and software products. The system shall provide seamless integration with fire alarm systems, personal safety systems, video intercom systems, emergency assistance stations, and video systems.

G. System Administration:
   1. System Administrative tasks such as defining client workstation & System Operator permissions set-up, access groups, time zones, reports, maps, etc. shall be provided from any client workstation on the network. Initial setup of the cardholder screen layout shall occur on the database server. The system shall support an unlimited number of access control readers, input points, video cameras, intrusion detection points, and relay outputs.

H. Application Programming Interfaces:
   1. The system shall provide a set of standard Application Programming Interfaces (API's) and supporting documentation that allows hardware manufacturers and software application developers to integrate their products into the system. The Application Programming Interfaces shall allow requests from the end user to integrate a third party hardware or software solution based on system open architecture and system device independence.

I. Upgrades:
   1. All systems shall be upward compatible. Access control hardware shall be compatible with all systems. Access control hardware (Access control panels, Input Control Modules, Access Control Readers, etc.) shall not require replacement or upgrades as the Owner migrates from the existing system level to a newer version.

## 1.6 APPLICATION DESIGN

A. Open Architecture:
   1. The system shall have an open architecture design to support industry standards for databases, networks, credential printers, and video cameras.

B. Open Database Connectivity Compliance:
   1. The system shall be Open Database Connectivity (ODBC) compliant. The system shall support a relational database management system with the proper 32-bit ODBC drivers.

C. Network Support:
   1. The system shall be designed to support industry standard network protocols TCP/IP. The system shall also support peer-to-peer and FTP server capabilities.

## 1.7 DESIGN REQUIREMENTS

A. System shall consist of a server, one or more networked client workstations and access control and alarm monitoring processors, interfaced to the Owner's building network.
   1. System Software: 64-bit, latest version Windows operating system and application software. Software shall have the following capabilities:
      a. Graphical user interface to show pull-down menus and a menu tree format that complies with interface guidelines of Microsoft Windows operating system.
      b. System license shall be for the entire system and shall include capability for future additions that are within the indicated system size limits specified in this Section.
      c. System shall have open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with Microsoft Windows operating system.
      d. Password-protected operator login and access.

B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to access control processors to allow each access control processor to make access-control decisions for its location. Intermediate access control processors used to store access control information is not acceptable. In the event that communications to the server is lost, all access control and alarm monitoring processors shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Server.

C. Server/workstations shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Server shall control system networks to interconnect all system components, including workstations and field-installed access control and alarm monitoring processors.

D. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of control panels, readers, sensors, etc.

E. Coordinate color of devices and readers with Architect to blend with surrounding environment prior to procuring. If color options of device are not acceptable to Architect, furnish the devices that have a paintable surface and coordinate with the painting contractor the requirements to paint the devices prior to installation.

F. Systems that require annual license renewal shall not be acceptable.

G. Communication.
   1. Network connecting the Server and workstations shall be by the Owner.
   2. Field equipment shall include access control/alarm monitoring processors, sensors, and controls. Access control/alarm monitoring processors shall serve as an interface between the Server and sensors and controls. Data exchange between the Server and the access control/alarm monitoring processors shall include down-line transmission of commands, software, and databases to access control/alarm monitoring processors. The up-line data exchange from the access control/alarm monitoring processor to the Server shall include status data such as intrusion alarms, status reports, and entry-control records. Access control/alarm monitoring processors are classified as alarm-annunciation or entry-control type.

H. Access Control/Alarm Monitoring Processors.
   1. Access control field devices shall have an onboard UPS to allow for independent operation during power loss periods.
      a. Provide battery back up to all access control/alarm monitoring processors and power supplies, where Division 26 UPS power is not available. Refer to the Division 26 plans and specifications for UPS power circuit schedules and locations.
   2. Equipment enclosures in the field shall be key-lockable, and equipped with tamper switches, to annunciate at monitoring workstations.
   3. Locate access control panels adjacent to power supplies and door hardware power supplies in dedicated equipment rooms or communications rooms. Locating the panels at the door location is unacceptable.

I. The system shall comply with Underwriters Laboratories (UL) standards and shall carry the UL labels for UL 294 Access Control System Units.
   1. The access control system shall operate within the limits of Class 2 remote-control and signal circuits as defined by Article 725 of the National Electrical Code, NFPA 70.

J. Integration with other trades.
   1. Integrate Readers into Outdoor Pedestal Mounts.
   2. Integrate Readers into Precast and Construction Walls, Door Frames, etc.
   3. Door Hardware Interface: Coordinate with Division 08 Sections that specify door hardware required to be monitored or controlled by the security access system. The access control/alarm monitoring processors in this Section shall have electrical characteristics that

match the signal and power requirements of door hardware. Integrate door hardware specified in Division 08 Sections to function with the hardware in this Section.

a. Provide interface to integral Request to Exit (REX) switch in the door hardware.
b. In Line Power/Continuous Duty Protection Devices.
    1) Provide protection devices with built-in surge protection and voltage regulation at each electric hardware device to protect the relays and sensitive electronics of the system from the electrical spike that occurs when electric hardware locks or unlocks. The equipment shall also provide protection to door which are programmed for continuous duty operation, reducing the output voltage by 25 percent to extend the life of the electric locks. Design Basis: HES model 2005 - SMART PAC II or approved equal.

4. Fire Alarm Interface. Provide interface from the fire alarm release directly to the hardware or hardware interface to release delayed egress equipment and locked doors in the path of egress in compliance with UL and Life Safety requirements. The fire alarm release shall not interface through security equipment.

K. Request to Exit Motion Detectors (where indicated on drawings)
1. Adjust request to exit motion detector timers to 1-2 seconds. The access control systems shall govern the duration time of door unlocks and door held opens.
2. Request to exit motion detectors shall be programmed to shunt door position switches only, unless life safety codes require the affected door to be unlocked.

L. Cable Requirements.
1. Sensor and card reader cable shall be a minimum 22 AWG
2. Lock cable shall be a minimum 18 AWG, however, shall be sized larger base on distance and current rating.

## 1.8 PERFORMANCE REQUIREMENTS

A. System Response to Alarms: Field device network shall provide a system end-to-end response time of 1 second or less for every device connected to the system. Alarms shall be annunciated at the monitoring station within 1 second of the alarm occurring at an access control/alarm monitoring processor or device controlled by a local Access control panel, and within 100 ms if the alarm occurs at the Server. Alarm and status changes shall be displayed within 100 ms after receipt of data by the monitoring station. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within 5 seconds of alarm receipt at the security console. The response times shall be maintained during system heavy load.

B. Acknowledgeable Events: Any user programmed alarm event shall cause the card access system workstation to provide an audible and visual alarm requiring the operator to acknowledge the event and enter via the keyboard a report of the event and cause.

C. Handicap Entrances:
1. Interface to electric locks and automatic door opening equipment at handicapped access locations. Presentation of a valid card shall unlock the door, and enable the door open button. The credential holder shall then have the option to press the door open button, or manually open the door. The card access system shall not disable the egress door-open button.

D. ADA Accommodation.
1. Cards designated for ADA access shall be programmed to an extended door unlock time to allow sufficient time for handicapped individuals to open the door.

## 1.9 SUBMITTALS

A. Action Submittals
1. Shop Drawings:
    a. Fabrication and/or layout drawings:
        1) Routing, size, and fittings.

2) Seismic location installation details.

2. Product data.
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 28 05 01 for additional requirements.

B. Informational Submittals:
   1. Cable tray fill calculations.
   2. Cable schedule of number and type of cables in cable trays.
   3. Project planning documents.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Maintenance Material Submittals:
   1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner:
      a. One card reader of each type used as a spare.
      b. One access control/alarm monitoring processor as a spare.
      c. One reader interface module for each type used as a spare.
      d. One power supply of each type used as a spare.
      e. 1000 access cards.
      f. Backup software and database programs upon completion of the programming of all access control information. Demonstrate to the Owner that the copies provided can be accessed by the Owner and that the entire database is contained on the disks. Demonstrate to the Owner the procedure for restoring the system using the backup disks.
      g. One factory box for each component, addressed to the manufacturer to facilitate factory return for repair authorizations.
      h. Written procedures for obtaining return authorizations. (If not required, state so in writing.)

### 1.10 PROJECT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 28 05 01.

### 1.11 WARRANTY

A. Comply with the requirements of Section 28 05 01 - Warranty.

B. User Cards shall be warranted for a period of five years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with Contract requirements, furnish products of one of the following listed manufacturers.

B. Access Control Equipment:
   1. Software House
   2. Lenel
   3. AMAG Technology
   4. Hirsch
   5. Or Equal.

C. Request to Exit Motion Equipment:
   1. Interlogix - Model RCR-REX

2. Securitron - Model XMS
3. Visonic
4. Or Equal.

D. Card Reader:
1. HID Corp.
2. CISCO
3. IBM
4. Or Equal.

E. Motion Detection Equipment:
1. Interlogix
2. Detection Systems
3. Honeywell International
4. Or Equal.

F. Door Position Switches:
1. Magnasphere
2. GRI, Inc
3. Honeywell
4. Aleph International
5. Flair Electronics
6. Or Equal.

G. Power Supplies.
1. LifeSafety Power
2. Alarm Saf
3. Altronix.
4. Or Equal.

H. Enclosures:
1. Hoffman
2. Rittal Corporation
3. Hammond
4. Middle Atlantic Products
5. Stantron
6. Bud
7. Or Equal.

## 2.2 SYSTEM REQUIREMENTS

A. Workstation Software:
1. The access control software shall operate with the latest Windows Server and client workstation operating system.
2. Password levels shall be individually customized at each workstation to allow or disallow operator access to program functions for each location. Each user's access shall be partitioned to restrict access to only view and modify authorized files, database, remote servers, menus, screens, and individual fields within each screen.
3. The system shall provide two-way communication with third party database on the building network for other database sharing applications. The relational database shall ODBC compliant.

B. The access control database shall have the following minimum system capabilities.
1. Readers - 2000.
2. Cardholders - 400,000.
3. Alarm Points - 35,000.
4. Time schedules - 250.
5. Access Groups - 1500.
6. Relay outputs - 35,000.

7. Alarm priorities - 250.
8. Operator passwords - 2000.
9. Operator groups - 1000.
10. User definable cardholder fields - 120.

## 2.3 ACCESS CONTROL SYSTEM SOFTWARE REQUIREMENTS

A. General Requirements:
   1. The system shall provide for password restricted operator access levels. This feature shall restrict access to sensitive programming functions to authorized personnel only. The highest-level password shall have access to all system databases and functions. Each password shall be individually programmable to restrict operator access to programming and operator functions, commands, database access, and alarm point and control point functions.
   2. The system shall provide an audit feature to maintain an historical record of what changes were made and who made them.
   3. Graphical Maps:
      a. The system shall provide for map graphics, floor plans, site plans that graphically depict system status. Icons placed on graphical backgrounds shall be used to indicate the real time status of each system connection including access control reader connections, alarm inputs, control point outputs, communication connections, etc.
      b. The icon of the device in alarm shall be differentiated from other device symbols by enhancement, color change and/or flashing. Different enhancements shall indicate normal, alarm, trouble, time schedule shunt, manual shunt and other status conditions provided by the system.
      c. The system shall be capable of being configured to automatically call up a graphical map upon system-generated alarms without an operator request.
      d. The system shall provide for the import of graphics generated by other drawing programs.
   4. The system shall provide for a status screen on the security monitoring screen. The status screen shall be manually displayed by an operator any time during a session with a mouse click. The operator shall be able to select any group to view in more detail. The status screen shall display the following:
      a. A complete list of all alarm points displaying the status of each alarm point.
      b. A complete list of all doors displaying the status of each door.
      c. A complete list of all outputs displaying the status of each output.
      d. A complete list of all Alarm Zones displaying the status of each Alarm Zone.
   5. The operator shall have the ability to display multiple alarms, queued in their order of priority.
   6. The system monitoring screen and event printer shall display and record the alarm message in real time including: the time, date location, point description, event type and point status of each point transaction.
   7. The operator shall be able to verify current status of any point in the system and change any of the programmable point descriptors via the Client Workstation.
   8. All software applications shall be specifically designed for security and access control. A current high-level language shall have been used to develop all application programs.
   9. The system shall include a schedule program that will allow the Owner to automatically schedule events such as report printing, output commands, door access, alarm access, etc. on a time/day programmable basis in advance.

B. Access Control:
   1. The system shall provide control point outputs for lock power control activated by access control reader, client workstation keyboard or time schedule.
   2. All alarm control points as well as access control reader inputs shall be capable of independent time schedule via software controls from the access control/security monitoring system.

3. The system shall provide for controlled access through reader controlled doors based on the user's access levels. An access level shall define a door or group of doors accessible by authorized individuals during a certain time period(s). Time periods shall include both authorized days and hours. The system shall provide for controlled access through reader controlled doors based on the user's authorization. Users shall be allowed to add or remove selected doors within an access level for individual credential holders. This shall also include the ability to assign multiple access levels to credential holders.
4. The system shall provide for automatic credential holder activation and expiration by specified time and date.
5. The system shall store in memory every access transaction, describing the nature of the transaction, time, date, reader location, credential holder name and validity status.
6. The system shall provide screen display and event printing of transactions (all transactions or violations only; by user and by reader).
7. The system shall provide momentary or maintained release of reader controlled door locks via the monitoring screen.
8. The system shall provide for user programming of the following data for each card:
    a. Card number (internal and hot stamp).
    b. Access Levels.
    c. Authorized Areas.
    d. Effective Date.
    e. Expiration Date.
    f. Credential holder Name.
    g. Credential holder ID number.
    h. Employee status (active, retired, temporary, etc.).
    i. Credential holder department name.
    j. Credential holder automotive license number.
    k. Credential holder phone number.
    l. Company name (if other than system owner).
    m. User definable fields.

C. Database Queries, Editing and Printing:
1. The system shall provide for database queries, database editing and report printing via user definable parameters. The system shall be capable of printing requested queries and reports to the system monitoring screen or its associated report printer. In addition, the system shall be capable of conducting a file search by field or combination of user definable fields. Upon the users request, searched and sorted files shall be capable of being printed in the order dictated by the user, i.e. alphabetically by last name, numerically by badge number, alphabetically by department name, etc.
2. The system shall provide for report printing and/or display of any group of events within any selectable time period. The Report printer shall be capable of producing a hard copy of any report that the system may generate. Reports shall include historical events, defined by any combination of the following categories:
    a. All Events.
    b. Location.
    c. Point Number.
    d. Event Type (e.g. intrusion, door open, etc.)
    e. Point Status (e.g. on, off, alarm, normal, shunted, etc.)
    f. Management reports of transactions history by card number, cardholder data, reader number, time period, or invalid attempts.
    g. Audit trail reports.
3. The system shall allow the exporting of report outputs directly to another database.

## 2.4 SECURITY APPLICATION SERVER AND WORKSTATIONS

A. The Database Server for the Access Control & Alarm Monitoring Systems shall consist of the following minimum specifications:

1. 2 RU TIA/EIA Rack Mountable.
2. Operating System: Microsoft Windows, latest version.
3. Processor: Intel Xeon processor E5-2600v4 Series.
4. Chip Set: Intel C612 (or Latest)
5. Memory Specifications:
    a. Quad channel memory 1TB 2400 MHz DDR4 ECC memory.
    b. Dual CPU's.
6. Graphics:
    a. 4 PCI Express x16 Gen 3 graphics cards - 675W
        1) Total 3 x 225W graphic cards in 3 slots.
7. Storage: 3.5 inches SATA (4) 4TB 5400 rpm drives.
8. Storage Controller:
    a. Integrated: LSI SAS 3008 12Gb/s SAS (6Gb/s SATA) controller.
        1) RAID 0, 1, 10 capable of 8 drives.
        2) 2 integrated Intel controller (6Gb/s) SATA ports for optical drives.
9. Communications:
    a. Integrated: Intel I217 & I 210 Gigabit Ethernet controllers.
        1) Intel Remote Wake Up.
        2) PXE and Jumbo frames support.
10. Audio Controller: Integrated Realtek ALC3220 High Definition Audio Codec (2 Channel).
11. I/O Ports:
    a. 6 - USB 2.0
    b. 4 - USB 3.0
    c. 1 - Microphone.
    d. 1 - Headphone.
    e. 1- 2x5 USB 2.0 header.
    f. 8 - SAS @ 12Gb/s (supports SATA @ 6 Gb/s as well)
    g. 1 - Audio Line out.
    h. 1 - Audio Line in/Microphone.
    i. 1 - Serial port.
    j. 2 - RJ45 Network ports.
12. Bays.
    a. (1) External slimline optical bay.
    b. (4) Internal 3.5 inches bays (support total of (4) 3.5 inches or 2.5 inches drives)
    c. (1) External 5.25 inches bay.
13. Slots.
    a. (2) PCIe x16 Gen 3
    b. (1) PCIe x16 Gen 3 (wired as x4 - Slot 1)
    c. (1) PCIe x16 Gen2 (wired as x4)
    d. (1) PCI 32 Bit.
14. Power Supply:
    a. 1300W (input voltage 120VAC-240VAC)
    b. 90 percent efficient (80PLUS Gold Certified)
    c. Externally accessible and removable.
15. Storage devices: Slimline DVD-ROM; DVD+/-RW
16. USB Keyboard.
17. USB Optical 3 button Mouse with scroll wheel.
18. User Interface: Remote operation via the security management operator workstation.
19. Surge Suppression Strip.
20. Server Software:
    a. Microsoft Server Operating System, latest edition.
        1) Minimum of five (2) client licenses.

B. The client workstation for the latest Microsoft Windows operating systems shall consist of the following minimum specifications:

1. 2 RU TIA/EIA Rack Mountable.
2. Processor: Intel Core i7 (8 core, 16M cache, 2,9Ghz)
3. Memory: 16GB DDR4 2666Mhz SoDIMM Non-ECC Memory.
4. HD:
   a. 512GB PCIe NVMeClass 40 M.2 SSD for operating system.
   b. 1TB secondary Hard drive, RAID 1 500GB backup drive.
5. Five (5) USB 3.0 ports.
6. Anti-virus software.
7. PCIe 2.0 x 16 NVIDIA or ATI Video card 8 GB GDDR6 with 4 mDP to DP adapter outputs.
8. Optical mouse.
9. 48XCDRW and 16XDVD+RW/+R.
10. C9- All SCSI drives, RAID 1, 2 drive total configuration.
11. Two (2) 73GB Ultra 320 SCSI, 1 inch (15,000 rpm) (15,000 rpm).
12. U320 SCSI Controller Card.
13. PERC RAID Controller.
14. Intel Pro 1000MT Copper Gigabit Network Adapter.
15. LAVA QUATTRO-PCI Bus 4-Port Serial Board.
16. Provide monitor trees to accommodate multiple monitors where indicated on drawings. Monitor trees shall accommodate standard VESA mounting.
17. 128MB PCIe x16 nVidia Quadro FX 1300.
18. Sound Blaster- Audigy™ 2 (D), w/Dolby Digital 5.1. Include software programming and hardware provisions to inhibit users from adjusting the volume and silencing/disabling the sounder after the initial volume setup.
19. Stereo speakers.
20. Standard Windows Keyboard.
21. Surge Suppression Strip.
22. Epson FX-870 Logging Dot Matrix Printer, or equivalent.
23. Hewlett Packard 1320n Report Laser Printer, or equivalent.
24. Software:
    a. Microsoft Windows - Latest Version.
    b. Microsoft SQL Server - Latest Version Client License.
    c. System Client Software - Latest Version.

## 2.5 MONITORS

A. Diagonal Viewing Size: 24 inches.

B. Aspect Ratio: 16:10

C. Panel Type, Surface: AH In-plane switching, anti glare with hard coat 3H

D. Optimal Resolution: 1920 x 1200 at 60 Hz.

E. Contrast Ratio: 1000 to 1 (typical), Dynamic Contrast Ratio: 2 Million:1 (Max)

F. Backlight Technology: LED

G. Brightness: 350 cd/m2 (typical), 50 cd/m2 (minimum)

H. Response Time: 6ms (grey to grey)

I. Max Viewing Angle: 178° vertical / 178° horizontal.

J. Color Support:
   1. Color Depth: 1.074B colors.
   2. Color Gamut (typical): Adobe RGB 99%, sRGB 100% and 120% (CIE 1976)

K. Pixel Pitch: 0.27 mm.

L. Display Type: Widescreen Flat Panel Display.

M. Connectivity - Minimum:
   1. 1 Digital Visual Interface connectors (DVI-D) with HDCP
   2. 1 DisplayPort 1.2 (DP)
   3. 1 High Definition Multimedia Interface (HDMI)
   4. 1 USB 3.0 upstream port.
   5. 4 USB 3.0 downstream ports.
   6. 1 DisplayPort out.
   7. 1 Audio output Max Sync Rate: 76 Hz x 81 kHz.

N. Provide video monitor tree to support 4 monitors. Provide anchoring to the desk surface.

## 2.6 ACCESS CONTROL HARDWARE COMMUNICATIONS

A. The system shall have the ability to communicate with the access control/alarm monitoring processors by either RS485 or LAN/WAN connections utilizing TCP/IP communications protocol. The system shall also have the ability to communicate with the access control panels through remote dial up capabilities.

B. Downloading or database changes shall not interfere with any output control, access decisions, alarm monitoring, traces, or any other required function of the access control hardware and alarm monitoring client workstation. Communications between the system client workstation(s) and the access control/alarm monitoring processors shall be interleaving so that alarms will still report to their respective alarm monitoring client workstations while downloads are occurring.

C. Upon losing and then restoring communications between the access control/alarm monitoring processors and the system database, database synchronization between the system database and the local database in each access control/alarm monitoring processor shall be fast and efficient.

## 2.7 ACCESS CONTROL/ALARM MONITORING PROCESSORS

A. Access control/alarm monitoring processors shall operate as an autonomous intelligent processing unit. Access control/alarm monitoring processors shall make decisions about access control, alarm monitoring, linking functions, and door locking schedules for its operation, independent of other system components. Access control/alarm monitoring processors shall be part of a fully distributed processing control network. The portion of the database associated with access control/alarm monitoring processor and consisting of parameters, constraints, and the latest value or status of points connected to that access control/alarm monitoring processor, shall be maintained in the access control/alarm monitoring processor.

B. Description overview:
   1. The access control/alarm monitoring processor shall communicate to the host computer in a single path configuration of Ethernet or RS485.
   2. The access control processor shall support a minimum of twenty readers, easily populated through the use of the following.
      a. Distributed reader modules for support of:
         1) Biometric Gateways.
         2) Credential Readers.
      b. Input Control Modules.
         1) Input module shall provide 8 fully supervised inputs and 4 non supervised inputs.
      c. Output Control Modules.
         1) Each reader module shall have the additional capacity of 8 relay outputs.
   3. The access control processor shall have the following characteristics:
      a. Shall store a minimum of 100,000 credential holders online.
      b. Incorporate Flash upgradeable firmware.
      c. Provide supervised alarm inputs to monitor the status of alarm circuits and report the status information to the monitoring screen.
      d. Provide control relay outputs for controlling devices by remote command from the system, through time schedules or on alarm point activation.
      e. Contain enough RAM to maintain a card database of 100,000.

f. Automatically disconnect from the communication loop upon a communication failure within the access control processor to prevent the communication to other access control processors in the loop from being interrupted.
g. Upon loss of communication, the access control/alarm monitoring processor shall contain enough memory to operate normally. In addition, the access control/alarm monitoring processor shall store a minimum of 10,000 prioritized transactions or events and shall automatically transmit that data to the system as soon as communication is restored.
h. Upon verification of credential authorization or request to exit, the processor shall activate a door control relay output and shunt the intrusion alarm. The lock control outputs shall be rated for a minimum of 1A @24 VDC. Relay activation time shall be adjustable from 0 to 49,999 seconds on an individual reader basis. The door shall automatically relock upon opening.
i. Provide an intrusion alarm indication on the system if the reader controlled door is opened without an authorized credential use or request to exit.
j. Shall provide a door prop alarm indication on the monitoring screen if the reader controlled door is held open past an adjustable time period after an authorized credential use or request to exit. The door prop alarm delay shall be adjustable from 0 to 99 seconds on an individual reader basis.
k. Acceptable manufacturer for the access control/alarm monitoring processor shall be the same manufacturer of the software to insure control of quality and integrated performance capabilities.

C. Input Control Module.
1. The Input Control Module (ICM) shall monitor all system alarm inputs. The Input Modules shall be able to operate independently and in conjunction with Output Control Modules, which will send an output signal to a corresponding output device upon alarm input activation. System Administrators shall have the ability to set the following options for each input or output configured on the Input Control Modules in the system:
   a. Alarm Masking:
      1) This feature shall allow System Administrators to mask the alarm input manually, or on a time zone basis.
   b. Local Linkage:
      1) This feature shall allow System Administrators to locally link outputs with inputs that are attached to the same Input control module/Output Control Module. Inputs shall be linked to multiple outputs and outputs shall be triggered by multiple inputs.
   c. Activate Output:
      1) This feature shall allow System Administrators to activate an output tied to the Input control module/output control module on a time zone basis.
   d. Activate Output Always:
      1) This feature shall allow System Administrators to activate an output always.
   e. Configuration of Debounce Times:
      1) Debounce time configuration allows System Administrators to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state, and shall prevent contact "flickers" from being reported up as changes of state.
   f. Configuration of Hold Times:
      1) When configuring an Alarm Input, a hold time setting shall be settable from 0-15. When an input goes active and is restored, the hold time is the amount of time in seconds to wait until reporting the input activation as restored. This feature is used when there is no advantage to log the specific number of times a point is tripped after the initial event.

D. Individual Access Control/Alarm Monitoring Processor Operation:
   1. Card-reader ports of an access control processor shall be custom configurable for a minimum of 120 different card-reader or keypad formats. Multiple reader or keypad formats may be used simultaneously at different access control processors or within the same access control processor.
   2. Access control processors shall provide a response to card-readers or keypad entries in less than 0.25 seconds, regardless of system size.
   3. Access control processors that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to its proper working state. This shall happen without any operator intervention.
   4. Initial Startup: When access control/alarm monitoring processors are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each access control/alarm monitoring processor.
   5. Failure Mode: On failure for any reason, access control/alarm monitoring processors shall perform an orderly shutdown and force access control/alarm monitoring processor outputs to a predetermined failure mode state, consistent with the failure modes shown and the associated control device.
   6. Startup after Power Failure: After power is restored, startup software shall initiate self-test diagnostic routines, after which access control/alarm monitoring processors shall resume normal operation.
   7. Startup after Access Control/Alarm Monitoring Processor Failure: On failure, if the database and application software are no longer resident, access control/alarm monitoring processors shall not restart, but shall remain in the failure mode until repaired. If database and application programs are resident, access control/alarm monitoring processors shall immediately resume operation. If not, software shall be restored automatically from the Server.

E. Communications Monitoring:
   1. System shall monitor and report status of communications of each location.
   2. Missed polls indicate that messages had to be retransmitted and reflect the soundness or quality of the access control/alarm monitoring processor-to-access control/alarm monitoring processor network.
   3. Communication status window shall display which access control/alarm monitoring processors are currently communicating, a total count of missed polls since midnight, and which access control/alarm monitoring processor last missed a poll.

F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central processing units a minimum of once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

## 2.8 OPERATIONS

A. Inputs in system shall have two icon representations, one for the normal state and one for the abnormal state.

B. When viewing and controlling inputs, displayed icons shall automatically change to the proper icon to display the current system state in real time. Icons shall also display the input's state, whether armed or bypassed, and if the input is in the armed or bypassed state due to a time zone or a manual command.

C. Outputs in system shall have two icon representations, one for the secure (locked) state and one for the open (unlocked) state.

D. Icons displaying status of the I/O points shall be constantly updated to show their current real-time condition without prompting by the operator.

E. The operator shall be able to scroll the list of I/Os and press the appropriate toolbar button, or right click, to command the system to perform the desired function.

F. Graphic maps or drawings containing inputs, outputs, and override groups shall include the following:
   1. Database to import and store full-color maps or drawings and allow for input, output, and override group icons to be placed on maps.
   2. Maps to provide real-time display animation and allow for control of points assigned to them.
   3. System to allow inputs, outputs, and override groups to be placed on different maps.
   4. Software to allow changing the order or priority in which maps will be displayed.

G. Operator Commands:
   1. Command Input: Plain-language words and acronyms shall allow operators to use the system without extensive training or data-processing backgrounds. System prompts shall be a word, a phrase, or an acronym.
   2. Command inputs shall be acknowledged, and processing shall start in not less than 1 second.
   3. Tasks that are executed by operator's commands shall include the following:
      a. Acknowledge Alarms: Used to acknowledge that the operator has observed the alarm message.
      b. Place Zone in Access: Used to remotely disable intrusion alarm circuits emanating from a specific zone. System shall be structured so that console operator cannot disable tamper circuits.
      c. Place Zone in Secure: Used to remotely activate intrusion alarm circuits emanating from a specific zone.
      d. System Test: Allows the operator to initiate a system-wide operational test.
      e. Zone Test: Allows the operator to initiate an operational test for a specific zone.
      f. Print reports.
      g. Change Operator: Used for changing operators.
      h. Display Graphics: Used to display any graphic displays implemented in the system. Graphic displays shall be completed within 20 seconds from time of operator command.
      i. Run system tests.
      j. Generate and format reports.

H. Alarms:
   1. System Setup:
      a. Assign manual and automatic responses to incoming point status change or alarms.
   2. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
   3. Multimedia Alarm Annunciation: WAV files to be associated with alarm events for audio annunciation or instructions.
   4. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
   5. Video Surveillance Alarm Interface: Allow commands to be sent to video surveillance systems during alarms (or input change of state).
   6. Camera Control: Provides operator ability to select and control cameras from graphic maps.

I. Alarm Monitoring: Monitor sensors and access control panels, and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.
   1. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.

2. Printed alarm data shall include type of alarm, location of alarm, date and time (to nearest second) of occurrence, and operator responses.
3. Maps shall automatically display the alarm condition for each input assigned to that map, if that option is selected for that input location.
4. Alarms initiate a status of "pending" and require the following two handling steps by operators:
    a. First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
    b. Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.
5. Each workstation shall display the total pending alarms and total unresolved alarms.
6. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
7. Alarms shall transmit to Server in real time.
8. Alarms shall be displayed and managed from a minimum of four different windows.
    a. Input Status Window: Overlay status icon with a large red blinking icon. Selecting the icon will acknowledge the alarm.
    b. History Log Transaction Window: Display name, time, and date in red text. Selecting red text will acknowledge the alarm.
    c. Alarm Log Transaction Window: Display name, time, and date in red. Selecting red text will acknowledge the alarm.
    d. Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.
9. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
10. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
11. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.

J. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.
    1. Color Code:
        a. FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
        b. STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
        c. YELLOW: Advises operator that a zone is in access.
        d. GREEN: Indicates that a zone is secure and that power is on.
    2. Graphics:
        a. Support a minimum of 100 graphic display maps and allow import of maps from a minimum of 16 standard formats from a graphics program.
        b. Allow I/O to be placed on graphic maps by the drag-and-drop method.
        c. Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on graphic map.
        d. Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic map associated with inputs or outputs.
        e. Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
        f. Camera icons shall have the ability to be placed on graphic maps that, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.

g. Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

K. Entry-Control Enrollment Software: Database management functions that allow operators to add, delete, and modify access data as needed.
1. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
2. The program shall provide means to disable the enrollment station when it is unattended to prevent unauthorized use.
3. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of personnel identity verification subsystems, this shall include biometric data. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.
4. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:
a. MASK: Determines a specific format that data must comply with.
b. REQUIRED: Operator is required to enter data into field before saving.
c. UNIQUE: Data entered must be unique.
d. DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
e. NAME ID: Data entered will be considered a unique ID for the cardholder.
5. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
6. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
7. Default card data can be programmed to speed data entry for sites where most card data are similar.
8. Enhanced ACSII File Import Utility: Allows the importing of cardholder data and images.
9. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.

L. Access control/alarm monitoring processors shall be capable of communicating with the host computer and other panels via RS232, RS485, fiberoptics and LAN/WAN - TCP/IP.

## 2.9 SYSTEM DATABASE

A. Time Zones:
1. Each zone consists of a start and stop time for 7 days of the week and three holiday schedules. A time zone is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
2. Four time zones may be assigned to inputs and outputs to allow four arm or disarm periods per day or four lock or unlock periods per day; three holiday override schedules may be assigned to a time zone.
3. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.

B. Holidays:
1. Three different holiday schedules may be assigned to a time zone. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date

matches the current date of the time zone, the holiday schedule replaces the time zone schedule for that 24-hour period.
2. Three separate holiday schedules may be applied to a time zone.
3. Holidays have an option to be designated as occurring on the designated date each year. The holidays remain in system and will not be purged.
4. Holidays not designated to occur each year shall be automatically purged from database after the date expires.

C. Access Levels:
1. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-passback.
2. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
3. System shall have the ability to create multiple door and time zone combinations under same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same Access control panel.

D. User-Defined Fields:
1. System shall provide a minimum of 99 user-defined fields, each with 50 characters, for specific information about each credential holder.
2. System shall accommodate a title for each field; field length shall be 20 characters.
3. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
4. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
5. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
6. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
7. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include search for a character string.
8. System shall have the ability to print cardholders based on and organized by the user-defined fields.

E. Code Tracing:
1. System shall perform code tracing selectable by cardholder and by reader.
2. Any code may be designated as a "traced code" with no limit to how many codes can be traced.
3. Any reader may be designated as a "trace reader" with no limit to which or how many readers can be used for code tracing.
4. When a traced code is used at a trace reader, the access-granted message that usually appears on the monitor window of the monitoring station shall be highlighted with a different color than regular messages. A short singular beep shall occur at the same time the highlighted message is displayed on the window.
5. The traced cardholder image (if image exists) shall appear on workstations when used at a trace reader.

## 2.10 CARD READER FUNCTIONS

A. The system shall support a variety of card readers that must encompass a wide functional range. The system may combine any compatible card readers for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, supervised inputs, etc.). Card readers shall be available in Open Supervised Device Protocol (OSDP) output format and Wiegand. All card readers shall include card reader back boxes for conduit installations.

B. The use of keypads with the card reader will require the user to enter a personal identification number in conjunction with the card to obtain authorized access.

## 2.11 READERS

A. Contactless SmartCard 13.56 MHz Technology.

B. Exterior readers shall be weatherproof. Seal all openings and penetrations with manufacturer approved sealant.

C. No special housing shall be required for those readers designated for outdoor use.

D. Electrical connections and cabling from the reader assembly to the system interface shall be per manufacturer's specifications.

E. All card readers shall be installed on an electrical include electrical back boxes for conduit installations.

F. Card readers shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two beeps shall indicate access granted and three beeps shall indicate access denied. All keypad buttons shall provide tactile audible feedback.

## 2.12 CARDS / CREDENTIALS

A. Combination Proximity and 16k bit (2k Byte), 13.56 MHz read/write contactless smart card technology. The Smart Card Technology shall have the following features:
   1. Sufficient read/write memory to store multiple biometric templates.
   2. 16k available in a two or sixteen application area configuration. 32k available with 16k memory configured in either 2 or 16 application areas, plus an additional 16k user configurable memory.
   3. Multiple securely separated files enable numerous applications, including the HID standard access control application, and support future growth.
   4. Complies with ISO 15693 and 14443B for contactless communications.

B. Card Dimensions: 3-3/8 inches x 2-1/8 inches.

C. Provide for future card modifications to include custom artwork, laminated photo I.D., and slot punching for strap or chain, without requiring replacement of card.

## 2.13 REQUEST TO EXIT MOTION DETECTOR

A. The request to exit motion detector shall include as a minimum the following features:
   1. Dual technology passive infrared and microwave.
   2. Adjustable time delay.
   3. Tamper output.
   4. Microwave frequency: 5.8 GHz.
   5. Range, depth: 3 to 15 feet, adjustable.
   6. Range, width: 7.9 feet.
   7. Range, PIR: 15 feet (4.6 m), adjustable.
   8. Relay output - Form "C".
   9. Approximate dimensions (HxWxD): 1.76 x 7.395 x 1.85 inches.
   10. Provide a trim plate to mount between the request to exit motion and the mounting surface. The trim plate shall be approximately 1/8 inches in depth, and shall be sized approximately 1/2 IN - 3/4 inches larger than the motion detector mounting surface and large enough to cover the backbox opening. The trim plate shall be supplied by the manufacturer. If a trim plate is not available from the manufacturer, one shall be fabricated using ABS plastic. The trim plate color shall match the existing surface.

## 2.14 ACTIVITY/REPORT PRINTER

A. The laser printer shall meet the following minimum requirements:
   1. Minimum 27 pages/minute.

2. Equipped with a 16 meg internal buffer memory.
3. Minimum Print Quality: 600 x 600 dpi.
4. Minimum Tray Capacity: 125 sheets.
5. USB 2.0 and Ethernet connection.

## 2.15 MOTION DETECTION SENSORS

A. Ceiling Mounted.
   1. Dual optic technology.
   2. 60 feet diameter coverage.
   3. Ceiling mount.
   4. 360 degree coverage.
   5. Mask all unused curtain areas.
   6. Utilize recessed mounting kit.
   7. Powered by 7 to 18 volts DC.

B. Wall Mounted:
   1. Dual Tech: (Honeywell DT7450 basis of design)
   2. Passive infrared motion detector with self-contained microprocessor employing dual technology motion detection.
   3. Integral bug guard.
   4. Form C, 125mA max, 25VDC (minimum) alarm output.
   5. Integral combination cover/ tamper switch.
   6. Digitally adjust thresholds to account for room disturbances
   7. Fresnel lens shall provide the same sensitivity for human targets at the edge of the pattern as exists directly in front of the sensor.
   8. Continuous internal signal diagnostic supervision.
   9. PIR supervision performed once every hour.
   10. Temperature compensation monitored and updated every 30seconds.
   11. Additional minimum requirements:
      a. Range: 50 feet x 60 feet (short range - wall mounted), 100 inches x 25 feet (long range - wall mounted), 50 feet x 360 degree (ceiling mounted)
      b. Alarm Relay: Energized Form C @125 mA, 25 VDC, w/20 Ohm series resistor.
      c. Tamper: (NC) 50 mA, 24 VDC.
      d. Power Requirements: 8.0 - 16 VDC.
      e. Frequency: 24.125 GHz (K-Band).
      f. PIR White Light Immunity: 6,500 lux typical.
      g. Fluorescent Light Filter: 50 Hz or 60 Hz, selectable.
      h. RFI Immunity: 30 V/m, 10 MHz - 1000 MHz.
      i. Operating Temperature: 14 degrees to 131 degrees F @ 5 percent - 95 percent relative humidity (non-condensing)
      j. PIR Fields of View: 22 long range edges, 12 intermediate edges, Six lower edges.
      k. Four look-down edges.
      l. Maximum Dimension: 4.685 inches x 2.795 inches x 1.654 inches.
      m. Sensitivity: Standard: 3-4 steps Intermediate: 2-3 steps.

## 2.16 DOOR POSITION SWITCHES

A. Magnetic door position switches - Recessed - Magnasphere model MSS Series used as Basis of Design, any/all substitution request shall meet the following criteria:
   1. Recessed mounted magnetic switches.
   2. 1 inches diameter self-locking.
   3. UL 634 Listed.
   4. Resistant to defeat by placing magnet against frame.
   5. Resistant to arcing and fusing from lighting and voltage spikes.
   6. Weatherproof, fully sealed.
   7. 0.25 Watt contact rating.

8. Double Pole-Single Throw (DPST)
9. Closed-loop configuration.
10. Coordinate color to match door frame.

B. Magnetic door position switches - Surface Mount - Magnasphere model MSS Series used as Basis of Design, any/all substitution request shall meet the following criteria:
1. Anodized aluminum housing.
2. UL 634 Listed.
3. Resistant to defeat by placing magnet against frame.
4. Resistant to arcing and fusing from lighting and voltage spikes.
5. Weatherproof, fully sealed.
6. 0.25 Watt contact rating.
7. Double Pole-Single Throw (DPST)
8. 24 inches Armored Cable.
9. Closed-loop configuration.
10. Coordinate color to match door frame.

## 2.17 ACCESS CONTROL AND DOOR HARDWARE POWER SUPPLIES

A. Power Supplies for door hardware and access control hardware shall be designed specifically for the system equipment installed. Power supplies shall be regulated, isolated versions for the access control panel, I/O Modules, Readers, Door Locking Hardware and the security monitoring peripheral equipment. Each version shall be available in UPS with battery back-up and non-UPS models. All power supplies shall be housed in locked enclosures that also allow mounting space for the access control panels, I/O Modules, single reader modules, dual interface modules or other device/panel required.
1. Provide separate power supplies for the access control equipment and door locking hardware.
2. The power supplies shall be UL listed for use with the specified access control system.
3. Electric lock power supplies shall be UL listed for use with the specified lock manufacturer.
   a. Coordinate with Division 08 for electric lock manufacturer.
   b. The Contractor has the option to combine more than one door on one power supply. Coordinate with Division 08, the power requirements for each lock to determine the size of power supply required.
4. Power supplies for doors with high current electric latch retraction will be provided by Division 08.

## 2.18 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.
1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and submit as Project planning documents for review and approval by Owner and Architect.
   1. Record setup data for control station and workstations.
   2. For each location, record setup of Access control panel features and access requirements.
   3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
   4. Set up groups, facility codes, linking, and list inputs and outputs for each Access control panel.
   5. Assign action message names and compose messages.
   6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
   7. Prepare and install alarm graphic maps.
   8. Develop user-defined fields.
   9. Develop screen layout formats.
   10. Complete system diagnostics and operation verification.
   11. Prepare a specific plan for system testing, startup, and demonstration.
   12. Develop acceptance test concept and, on approval, develop specifics of the test.
   13. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

B. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.2 INSTALLATION

A. Comply with the requirements of Section 28 05 01.

B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.

C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

D. Install and terminate all security circuits to the door hardware supplied and installed by Division 08. Coordinate with the Division 08 contractor the installation and termination of all cabling and security devices.

E. Coordinate the conduit/raceway installation with the Division 26 contractor. Conduit to be provided beyond what is shown on the Electrical series project drawings shall be the responsibility of the Security Contractor.

F. Install equipment and devices in accordance with manufacturer's specifications.

G. Coordinate with the Owner the complete system configuration requirements of the Owner.
   1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.

H. Install readers and integrate into special assemblies as may be required for narrow jamb frames and pedestal mounts.

I. Provide stanchion support(s) with concrete foundation for devices mounted at the Vehicle Entrance Gate.

### 3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 05 01.

## 3.4 SYSTEM STARTUP

A. Coordinate requirements of this Section with Section 01 75 00 – Checkout and Startup Procedures when applicable.

B. Coordinate with the manufacturer's services and requirements.

## 3.5 DEMONSTRATION AND TRAINING

A. Comply with requirements in Section 28 05 01.

**END OF SECTION**

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# SECTION 28 20 01
## VIDEO SURVEILLANCE SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The video surveillance system is a delegated design with performance specifications. Provide a new, code compliant video surveillance system serving the Ashland Water Treatment Plant (WTP) that meets the requirements of all applicable local and national codes. Contractor shall fully coordinate installation with other trades.

B. Video surveillance and intercom shall be provided at the following locations:
   1. Vehicle Entrance Gate:
      a. Pole mounted PTZ camera inside gate to record vehicles and vehicle license plates approaching the gate.
      b. Stanchion mounted entry control video intercom located at card reader location. Entry control video camera to include the following features:
         1) Ring button.
         2) Intercom.
         3) Works in conjunction with audio intercom located in Operations Building Command Room (300-205).
   2. Pretreatment Building:
      a. None.
   3. Operations Building:
      a. Network video recorder located in the I.T. Room (300-207).
      b. Display monitor located in the Command Room (300-205).
      c. Audio intercom located in the Command Room (300-205).
         1) Intercom shall work in conjunction with video intercom located at the Vehicle Entrance Gate.
      d. Camera at exterior of main entrance door (300-100A).
      e. PTZ camera on the exterior of the NW corner of the building.
      f. PTZ camera on the exterior of the NE corner of the building.
      g. PTZ camera on the exterior of the SW corner of the building.
      h. PTZ camera on the exterior of the SE corner of the building.
      i. PTZ camera on the exterior in the chemical storage area.
   4. Crowson Pump Station:
      a. None
   5. Clearwell:
      a. PTZ camera mounted to the Clearwell and directed towards the Operations Building.
      b. Pole mounted PTZ camera oriented towards the fence line near the public trail.

C. Section Includes:
   1. Design, material and installation requirements include system expandability to accommodate the addition of multiple monitors, as well as multiple cameras and increased coverage areas and integration of the system with the access control system to allow automatic camera call-up during alarm events. The system allows for the surveillance/viewing of remote areas from one or more local and remote-control stations.

D. Related Specification Sections but not necessarily limited to:
   1. Division 03 – Concrete
   2. Section 09 91 10 – Architectural Painting
   3. Section 26 05 19 – Wire and Cable – 600 Volt and Below
   4. Section 26 05 33 – Raceways and Boxes
   5. Section 26 05 43 – Electrical – Exterior Underground

6. Section 26 05 48 – Electrical Seismic Restraint Systems
7. Section 26 08 13 – Acceptance Testing
8. Section 26 09 16 – Control Equipment Accessories
9. Section 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Circuits
10. Section 27 10 00 – Structured Cabling
11. Section 27 05 01 – Common Work Results for Communications Systems
12. Section 28 05 01 – Common Work Results for Electronic Security Systems
13. Section 28 10 01–- Access Control

## 1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to the following:
   1. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA).
      a. ANSI/TIA--569-E – Telecommunications Pathways and Spaces.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. UL Solutions. (UL).

## 1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Security system integrator/installer:
      a. Ironclad Security:
         1) Contact Name: Jason McCauley
         2) Phone: (541) 326-0990
         3) Web: www.ironclad-security.com
      b. No like, equivalent or or-equal item is acceptable.
   2. Manufacturers:
      a. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
      b. See Specification Section 28 05 01 for additional requirements.
   3. Installers:
      a. Comply with ANSI/NFPA 70 – National Electric Code.
      b. Comply with ANSI/TIA-569E Standard and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of Communication Pathways.
      c. See Specification Section 28 05 01 for additional requirements.

## 1.4 SYSTEM DESCRIPTION

A. The system specified herein shall include all components necessary for a complete and operating video system, interfaced to the Owner's building network. The hardware shall include but not limited to, encoders, decoders, servers, workstations, display monitors, video storage units, and management software. The system shall include an intuitive computerized graphical user interface for system configuration, diagnostics, and video surveillance.

B. Include all programming and configuration, for the complete set up, operation and administration of the system.

C. Include all programming for graphical map representation of each camera location. The graphical maps, floor/site plans, shall be the same as used by the card access control system.

D. Design Requirements:
   1. Provide an interface from the video management system to the access control system for alarm assessment camera call up, and review of video events prior and during the alarm.
   2. Visit the project site prior to the bid date to verify the existing site conditions.

E. Performance Requirements:

1. All cameras shall be environmentally rated for its intended installed location. The Security Contractor shall be responsible for visiting the project site prior to bid to evaluate each camera location to verify the environmental camera housing requirement.
2. All cameras shall be continuously recorded on the network video recorders.
3. Provide network video storage for each camera installed on the project.
    a. Network video storage shall include the storage of each video signal at a minimum frame rate of 15 images per second at 2-megapixel resolution for 30 days.

### 1.5 SUBMITTALS

A. Action Submittals
    1. Shop Drawings:
        a. Fabrication and/or layout drawings:
            1) Routing, size, and fittings.
            2) Seismic location installation details.
    2. Product technical data.
        a. Provide submittal data for all products specified in PART 2 of this Specification Section.
        b. See Specification Section 28 05 01 for additional requirements.
    3. Testing Plans, Procedures, and Testing Limitations:
        a. Project planning document: Submit 2 weeks prior to the Project planning document review meeting.

B. Informational Submittals:
    1. Cable tray fill calculations.
    2. Cable schedule of number and type of cables in cable trays.

C. Maintenance Material Submittals:
    1. Furnish the following items and submit documentation of delivery to and acceptance of such items by Owner:
        a. One camera housing for each type utilized on the project as spares.
        b. One power supply for each type utilized on the project as spares.
        c. Two cameras for each type utilized on the project as spares.
        d. Two lenses for each type utilized on the project as spares.
        e. One factory box for each component, addressed to the manufacturer to facilitate factory returns for repair.
        f. Written procedures for obtaining return authorizations (If not required, state so in writing).

### 1.6 ADMINISTRATIVE REQUIREMENTS

A. Project planning documents review meeting: Met with Owner and Engineer to review project planning document.

### 1.7 PROJECT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 28 05 01

### 1.8 WARRANTY

A. Comply with the requirements of 28 05 01.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers of LCD Monitor.
    1. Hanwha Techwin
    2. Axis
    3. Avigilon

4. Or equal.

B. Manufacturers of Integrated Dome Color Camera Systems:
   1. Hanwha Techwin
   2. Axis
   3. Avigilon
   4. Or equal.

C. Manufacturers of Camera System Mounting Adapters:
   1. Hanwha Techwin
   2. Axis
   3. Avigilon
   4. Or equal.

D. Manufacturers of Video Intercom and Audio Intercom Systems:
   1. Hanwha Techwin
   2. Axis
   3. Avigilon
   4. Or equal.

E. Manufacturers of Network Video Recorders:
   1. Hanwha Techwin
   2. Axis
   3. OnSSI
   4. Or equal.

F. Manufacturers of Camera Power Supplies:
   1. Hirschmann
   2. Or equal.

## 2.2 VIDEO SURVEILLANCE CAMERAS

A. High Definition Mini Dome Camera:
   1. 2.16 Megapixel resolution.
   2. Image Sensor: Progressive Scan CMOS 1/2.8-inch.
   3. Lens: Varifocal, Remote focus and zoom, P-Iris Control, IR corrected.
   4. Focal Length: 2.8 ~ 12 mm.
      a. Angle of view: H: 119.5 degrees ~ 27.9 degrees / V: 62.8 degrees ~ 15.7 degrees / D: 142.1 degrees ~ 32.0 degrees
   5. Day and Night: Automatically removable infrared-cut filter.
   6. Minimum Illumination:
      a. Color: 0.015 lux, F1.4, 30IRE.
      b. B&W: 0.0015 lux, F1.4, 30 IRE
   7. Camera Angle Adjustment: Pan 360 degrees, tilt 160 degrees, rotation 340 degrees.
   8. Video Compression: H.265 and H.264 Baseline and Main Profile, MJPEG.
   9. Frame Rate: 60fps H.265 and H.264, 30fps MJPEG.
   10. Resolution: Adjustable to 1920x1080 maximum.
   11. Casing: Tamper-resistant polycarbonate transparent cover and casing, Aluminum inner camera module with encapsulated electronics.
   12. Color: White.
   13. Memory: 512GB Micro SD/SDHC/SDXC card slot.
   14. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1, Class 2, max. 5.9 Watts., 12VDC, 24VAC.
   15. Connectors: RJ45 10BASE-T/100BASE-TX PoE.
   16. Operating Conditions: -40 degrees F to 131 degrees F, Humidity 10-100% RH (condensing).
   17. Furnish Pendant kit, wall mount, and pole adapter with each camera.
   18. Design basis: Hanwha Techwin, Model XNV-6080

B. High Definition Integrated Dome Camera:
   1. The network integrated dome camera dome shall operate in a Power over Ethernet Network environment and accept open architecture connectivity for third-party software recording solutions.
   2. The outdoor integrated camera dome system shall be a discreet, camera dome system consisting of a dome drive with a variable speed/high speed pan and tilt drive unit with continuous 360 degree rotation, motorized zoom lens with optical and digital zoom and autofocus; and an IP66/IK10 rated housing/enclosure consisting of a back box, Lexan lower dome, and the appropriate mounting supports/assemblies.
   3. Resolution: 2.38 Megapixel.
   4. Image Sensor: 1/2.8 inch CMOS.
   5. Scanning System: Progressive Scan.
   6. Frame rate:
      a. 30fps, H.264
      b. 15fps, MJPEG
   7. Pixels:
      a. 1952 (H) x 1116 (V) total; 1944 (H) x 1104 (V) effective.
   8. Lens:
      a. F1.6 (f=4.44-102 mm, 23X optical zoom)
   9. Electronic Shutter Speed:
      a. 2 - 1/12,000 sec.
   10. Zoom Speed:
      a. 4.2 seconds.
   11. Horizontal Angle of View:
      a. 62.8 degrees at 4.44 mm wide.
      b. 3.14 degrees at 102 mm telephoto/zoom.
   12. Vertical Angle of View:
      a. 36.8 degrees at 4.44 mm wide.
      b. 1.76 degrees at 102 mm telephoto/zoom.
   13. Focus:
      a. Automatic with manual override.
   14. Removable automatic mechanical IR-cut filter.
      a. Sensitivity at 35IRE:
      b. NTSC, color: 0.15 lux minimum, 1/30 sec, F1.6, 30IRE.
      c. NTSC, B&W: 0.015 lux minimum, 1/30 sec, F1.6, 30IRE.
   15. Synchronization System:
      a. Internal/ AC line lock phase adjustable via remote control, V-sync.
   16. White Balance:
      a. Automatic with manual override.
   17. Iris Control:
      a. Automatic with manual override.
   18. Gain Control:
      a. Automatic/ Off.
   19. Video Encoding:
      a. H.264 Main and High Profile, MJPEG.
   20. Video Signal-to-Noise ratio >50dB.
   21. Video Streams: 10, simultaneous
      a. Video Resolutions: Variable.
         1) 1920 x 1080
         2) 1280 x1024
         3) 1280 x 960
         4) 1024 x768
         5) 800 x 600
         6) 640 x 480
         7) 320 x 180 Minimum.

22. Power:
    a. Sources.
        1) 24 VAC +/- 10%
        2) PoE+: IEEE 802.3af, Class 4
    b. Power Consumption:
        1) 24V AC: Max. 65W (24V AC heater on & PoE heater on)
        2) PoE+: Max. 25W (24V AC heater off / PoE heater on)
23. Furnish Pendant kit, wall mount, and pole adapter with each camera.
24. Design Basis: Hanwha Techwin, Model QNP-6250H.

## 2.3 NETWORK VIDEO RECORDER

A. Network Video Recorder – Rack Mounted:
    1. Design and fabrication:
        a. Capable of 32 channels, 32MP resolution camera support.
        b. Capable of 400Mbps network camera recording.
        c. Dual HDMI display video out.
        d. Dynamic Event support.
        e. Bookmark management for easy retrieval and protection of video clips (Up to 100 bookmarks)
        f. H.265, H.264, MJPEG compression support.
        g. Supports 16 SATA HDDs, up to 10Tb each (Maximum capacity 160TB)
        h. External iSCSI storage.
        i. RAID 5.
        j. Compression - H.265, H.264, MJPEG
        k. Fisheye De-warping.
        l. Web viewer.
        m. Local viewing with manufacturer's software.
            a) Resolution - 32MP (15fps, H.265 Only), 12MP(30fps, H.265 Only), 8.3MP(120fps), 1080p(480fps), 720P(960fps), D1(960fps)
        n. Provide viewing workstations with 24" monitors that meet the manufacturer's minimum requirements.
    2. Basis of Design: Wisenet XRN-3210B4 - 32 channel.

## 2.4 VIDEO INTERCOM AND AUDIO INTERCOM

A. Video Intercom:
    1. Design and fabrication:
        a. 1/2.8" 2MP sensor.
        b. 1.6mm fixed lens: HFoV 180°, VFoV 114 degree.
        c. IR viewable length 5m.
        d. Built-in mic and speaker: 85dB speaker out at 0.5 meter.
        e. Echo cancellation and noise reduction.
        f. Touchless call, Built-in tamper switch.
        g. SIP 2.0 support.
        h. MicroSD 1 slot, PoE/12VDC.
        i. Max. 550mA relay out with 2A 12VDC adapter.
        j. Ingress protection rating: IP65, IK08, NEMA4X.
        k. UL Listed.
    2. Compatible to communicate with the Audio Intercom specified below.

B. Audio Intercom:
    1. Design and fabrication:
        a. Built-in mic and speaker: 90dB speaker out a 1 meter.
        b. Power over Ethernet.
        c. Call indication light.
        d. Polycarbonate (white) faceplate.

e. Ingress protection rating: IP-42.
f. UL Listed.

2. Compatible to communicate with the Video Intercom specified above.

## 2.5 POWER SUPPLIES

A. Power Over Ethernet Midspan.
1. Design Basis: L-Com, BTD-CAT5-P4J.
2. Quad Port Passive PoE Midspan with integral Surge Protection.
3. Extended Temperature Range.
4. Operating Temperature: -40 degrees C to +70 degrees C.
5. Operating voltage: +/- 55V, Maximum current 1 Amp.
6. Enclosure Dimensions: 2.5 inches H x 4.5 inches W x 1.5 inches D Nominal.
7. Cast aluminum enclosure with Din Rail Mounting clip.
8. 8 RJ45 Ports.
9. Grounding Lug.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal at the security monitoring screen when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

## 2.6 ETHERNET CABLE

A. Design basis: Superior Essex, 6F-246-DA, Shielded Category 6 Cable.

B. Video/data interconnects for cameras and field processors, and radio equipment shall utilize shielded twisted pair (STP) Broadband Category 6 cable.
1. Cable shall be Power over Ethernet (PoE) capable.
2. Every cable run shall be a continuous single cable, homogenous in nature. Splices are not permitted anywhere.
3. The electrical performance of the horizontal cable shall comply with ANSI/TIA/EIA requirements for Category 6, and independently tested and verified by the manufacturer.
4. All horizontal and backbone cables shall be a minimum of #23 AWG solid copper, overall shielded core, and fully insulated with a flame retardant thermoplastic material.
5. All patch cables shall be a minimum of #23 AWG stranded and factory pre-terminated.
a. STP Copper Patch cords shall be of the same manufacturer as the installed STP Copper cables or the manufacturer of the termination equipment.
b. Supply STP Copper patch cords, in sufficient numbers, proper length to facilitate the complete and operational system.
6. All twisted pairs shall be individually color coded within color-coded bundles to industry standards.

C. Furnish all necessary anchors, fasteners, and any other appurtenances necessary to install the mounting adapters in accordance with the manufacturer's recommendations.

## 2.7 CAMERA SYSTEM MOUNTING ADAPTERS

A. Wall Mount Arm.
1. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated positioning system pan & tilt units.
2. The mounting adapter shall consist of a rugged wall mount arm designed specifically for use with the integrated dome camera system pan & tilt units.
a. The integrated dome camera mounting adapter shall be equipped with 1-1/2 inch NPT adapter to facilitate the mounting of pendant mount dome housings.
3. The adapter shall be capable of handling a load of up to 100 pounds.
4. The adapter shall be constructed of an aluminum casting and flat plate and shall be finished in a polyester powder coating.
5. The adapter shall weigh a maximum of 9 pounds.

6. The adapter shall be mounted via four user supplied 5/16 inches fasteners suitable for the mounting surface.

B. Pole Mount Adapter.
   1. The pole mount shall facilitate the mounting of the integrated positioning system and integrated dome system to a pole with a minimum diameter of 3.00 inches.
   2. The pole mount shall support up to 100 pounds.
   3. The pole mount shall feature three mounting slots for the attachment of stainless steel straps for strapping to the pole.
   4. The pole mount adapter shall be constructed of 5052H32 aluminum, .190 inches thick.
   5. The pole mount adapter shall be finished in gray polyester powder coat.
   6. The pole mount adapter shall weigh a maximum of 3 pounds.
   7. Furnish the following hardware with each adapter.
      a. Two, 5 feet stainless steel straps.
      b. Two banding clips.
      c. Six hex head cap screws.
      d. Six flat and lock washers.
      e. Six hex nuts.

C. Parapet Mounting Adapter.
   1. Provide aluminum alloy construction.
   2. The parapet mount shall facilitate the mounting of the integrated positioning system to the inside of a parapet wall or to the top of the parapet or roof top.
   3. The parapet mount shall be capable of supporting up to 100 pounds.
   4. The parapet mount shall require a minimum of 18 inches of inside wall height for mounting.
   5. The parapet mount shall utilize four 5/16 inches mounting studs for attaching the Wall Arm.
   6. The parapet mount for the inside wall application shall be secured to the wall with sixteen fasteners of 1/4 inches minimum diameter suitable for the mounting surface.
   7. The parapet mount for the top of the parapet shall be secured to the horizontal surface with a minimum of eight 3/8 inches fasteners suitable for the mounting surface.
   8. The parapet mount vertical tube for inside wall mounting shall measure 24 inches L and the width of the mount shall be 15 inches W and shall weigh a maximum of 10 pounds.
   9. The parapet mount vertical tube for top surface mounting shall measure 48 inches L with a mounting base which is 18 inches square and shall weigh a maximum of 30 lbs.
   10. The parapet mount shall be finished in a Corrosion-resistant white polyester powder coat.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Obtain detailed Project planning forms from manufacturer of surveillance system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval by Owner and Engineer.
   1. Record setup data for control station and workstations.
   2. For each location, record setup of camera features and view requirements.
   3. Assign action message names and compose messages.
   4. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
   5. Prepare and install camera graphic maps.
   6. Develop user-defined fields.
   7. Develop screen layout formats.
   8. Complete system diagnostics and operation verification.
   9. Prepare a specific plan for system testing, startup, and demonstration.
   10. Develop acceptance test concept and, on approval, develop specifics of the test.
   11. Develop cable and asset management system details, input data from construction documents. Include system schematics and Visio Technical Drawings.

B. In meetings with Engineer and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

## 3.2 INSTALLATION

A. Comply with the requirements of Section 28 05 01.

B. Coordinate all work with the Owner prior to the commencement of the scope of work as specified herein.

C. Apply for, and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

D. Install and terminate all security circuits to the cameras supplied and installed by this section.

E. Coordinate the conduit/raceway installation with the Division 26 contractor. Conduit to be provided beyond what is shown on the Electrical series project drawings shall be the responsibility of the Security Contractor.

F. Install equipment and devices in accordance with manufacturer's specifications.

G. Coordinate with the Owner the complete system configuration requirements of the Owner.
   1. The installer/contractor shall be responsible for configuring/programming the system to meet the operational requirements of the Owner.

H. Provide poles with concrete foundation for the pole mounted cameras located at the Vehicle Entrance Gate and at the Clearwell.

## 3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections
   1. Test and inspect all system components and cabling to assure compliance with manufacturer's requirements for operation in accordance with the requirements in Section 28 05 01.

## 3.4 SYSTEM STARTUP

A. Coordinate requirements of this Section with Section 01 75 00 – Checkout and Startup Procedures when applicable.

B. Coordinate with the manufacturer's services and requirements.

## 3.5 ADJUSTING

A. Provide all adjustments in accordance with the manufacturer's recommendations and Owner's requirements, such as camera views.

## 3.6 DEMONSTRATION AND TRAINING

A. Comply with requirements in Section 28 05 01.

**END OF SECTION**

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# SECTION 28 42 00
## GAS DETECTION AND ALARM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The gas detection and alarm system is a delegated design with performance specifications. Provide a new, code compliant gas detection and alarm system serving as an Emergency Alarm System for the Chemical Storage Room, 300-105, within the Operations Building, of the Ashland Water Treatment Plant (WTP) that meets the requirements of all applicable local and national codes for an Emergency Alarm System. Contractor shall fully coordinate installation with other trades.

B. Section Includes:
   1. Requirements for the design, fabrication, and installation of emergency alarm systems.

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Section 26 05 00 - Electrical - Basic Requirements.
   5. Section 26 09 16 - Control Equipment Accessories.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Industrial Control Panels.
      b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

B. Miscellaneous:
   1. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A or UL 698A.
      a. Entire assembly shall be affixed with a UL 508A or UL698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
   2. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
      a. Determine the SCCR rating by one of the following methods:
         1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
         2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
         3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
      b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
      c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

### 1.3 SYSTEM DESCRIPTION

A. Chemical storage room 300-105, within the Operations Building, as indicated on the Drawings shall have an Emergency Alarm as required by the building code.

B. Submit documents after design has been approved by Authority Having Jurisdiction (AHJ).

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section:
      b. Control panel bill of material.
      c. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.
      d. See Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout Drawings.
      a. Control panel interior and exterior layout.
      b. Control panel wiring diagrams.
   4. Test reports.
      a. Factory test report.
      b. Commissioning test report.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Update Shop Drawing data with as-constructed information.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Control Panels:
   1. NEMA 12 enclosure per Section 26 09 16.

B. Control Relays:
   1. Industrial type per Section 26 09 16.

C. Pilot Devices:
   1. Selector switches, pushbuttons, indicator lights per Section 26 09 16.

D. Termination Equipment:
   1. Terminal blocks per Section 26 09 16.

E. Manual Emergency Alarm Pushbutton Station:
   1. Single maintained pushbutton when pressed with a manual twist to reset feature.
   2. Polycarbonate faceplate and stainless steel backplate.
   3. Pushbutton station shall be blue in color with "EMERGENCY" lettering.
   4. Pushbutton stations shall have a protective clear, UV stabilized, NEMA 3R rated cover with door to protect the pushbutton from the weather and accidental activation.
   5. Basis of Design: Safety Technology International, Inc.

F. Emergency Alarm Status Indicator:
   1. Wall mounted audible-visual stackable status indictor containing number and color of molded-in light modules as required and a pulsating horn module.
   2. All modules are gasketed for a NEMA 3R and NEMA 4X rating.
   3. Light modules shall be flashing LED type.

4. Horn modules shall have selectable tone and volume of 85 dB at 5 FT.
    a. The sound of the Horn shall not be temporal 3 or Temporal 4 and must be unique and different than the sound of the horns for the fire alarm system.
5. PLC/SCADA compatible.
6. Modular rearrangement requires no wiring.
7. Light module colors:
    a. Emergency Alarm: Blue lens.
8. Voltage: 120 VAC.
9. Basis of Design: Edwards Signaling and Security Systems "102 Series".

### 2.2 DESIGN REQUIREMENTS

A. Each room or area requiring an emergency alarm system shall function independently but controlled by a single Emergency Alarm Panel (EAP).

B. An emergency alarm is initiated at the EAP by the activation of any of the manually operated Emergency Alarm Pushbuttons located on the exterior side of the exit doors.

C. When an emergency alarm occurs, flashing lights and audible horns are activated inside the room and on the exterior side of each exit doors.
    1. The horns can be silenced by use of a pushbutton on the face of the EAP.
    2. The alarm condition will be reset by use of a pushbutton on the face of the EAP provided the control panel is no longer receiving any alarm activation signal from the pushbuttons.
        a. The Emergency Alarm Pushbuttons have to be manually reset.

D. The control panel will go into test mode by the use of a pushbutton on the face of the EAP.
    1. All lights, horns and indicators will be turned on.
    2. Pressing the reset pushbutton will return the EAP back to non-alarm monitoring mode.

E. Indications on the face of the EAP:
    1. White control power on light.
    2. Blue indicator light for each chemical room or areas system emergency alarm activation status.

F. The EAP shall provide alarm dry contacts for each chemical room or area to be monitored by the Plant PLC/SCADA based control system.

G. Protective Devices:
    1. A through door type rotary disconnect shall be used to disconnect the EAP 120V power.
    2. Each pushbutton and status indicator circuits shall be fuse protected.

H. Power Supply
    1. 120 VAC dedicated circuit from panel board to integral DC regulated power supply in EAP.

### 2.3 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
    1. Conduct a test where the control panel is operated and checked for correct operation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's instructions.
    1. All wiring shall be in conduit.
    2. Conduit shall be ¾ IN minimum.
    3. Conduit shall be either painted or made of corrosion-resistant material.
    4. For additional requirements, see Specification Section 26 05 33.

B. For identification and tagging and for warning or caution signs, comply with Section 10 14 00.
    1. At the Emergency Alarm Status Indicator provide a sign saying "EMERGENCY ALARM".

## 3.2 DEMONSTRATION

A. Commission the system to verify all functions of the system are operational.
   1. The commissioning shall be witnessed by the Owner.

B. Personnel Training:
   1. Provide training of the Owner's personnel in the operation of the system.

## 3.3 SCHEDULES

A. The following is a list of rooms or areas that require an emergency alarm system and associated control panel.
   1. See Drawings for quantity of devices.
   2. Emergency Alarm Panel EAP-3020, located outside doors to Chemical Room 105:
      a. Serves Chemical Room, 300-105, within the Operations Building.
         1) Manually activated by pushbutton.
         2) Monitored by Plant PLC/SCADA.

**END OF SECTION**

# SECTION 28 46 00
## FIRE DETECTION AND ALARM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Provide a FACU in the 100 Pretreatment Building, 300 Operations Building, and 600 Crowson Pump Station Building.
   1. These three UL Listed Fire Alarm Control Units (FACUs) shall be provided by the Contractor.
   2. These three FACUs shall each serve as a "Sprinkler Waterflow and Supervisory System" as described in Chapter 23 of 2016 NFPA 72 and also meeting the automatic sprinkler system supervision, alarm, and monitoring requirements of Section 903 in the OSSC.
   3. The FACU serving 300 Operations Building shall also provide elevator recall control and supervisory services.
   4. These three FACUs shall be networked via a dedicated fiber.
   5. The 300 Operations Building panel shall serve as a global annunciator and shall report all signals from all FACUs on the fire alarm network via its DACT.

B. The fire alarm system is a delegated design with performance specifications. Provide a new, code compliant fire alarm system serving the Ashland Water Treatment Plant (WTP) that meets the requirements of all applicable local and national codes. Contractor shall fully coordinate installation with other trades.

C. Section Includes:
   1. Material and installation requirements for:
      a. Fire Alarm Control Units.
      b. Initiating Devices.
      c. Notification Appliances.
      d. Miscellaneous Devices.

D. Related Specification divisions include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   4. Section 26 05 33 - Raceways and Boxes.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards (appropriate editions as adopted by Authority(ies) Having Jurisdiction (AHJ) and including all local amendments):
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
      b. ADA Standards for Accessible Design.
   2. FM Approval Guide.
   3. National Electrical Manufacturers Association (NEMA).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 760, Fire Alarm Systems.
      b. 72, National Fire Alarm and Signaling Code.
      c. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   5. Underwriters Laboratories, Inc. (UL):
      a. 38, Standard for Manual Signaling Boxes for Fire Alarm Systems.
      b. 268, Smoke Detectors for Fire Alarm Systems.
      c. 268A, Standard for Smoke Detectors for Duct Applications.

d. 464, Standard for Audible Signaling Appliances.
e. 497B, Standard for Protectors for Data Communication and Fire Alarm Circuits.
f. 521, Standard for Heat Detectors for Fire Protective Signaling Systems.
g. 864, Standard for Control Units and Accessories for Fire Alarm Systems.
h. 1971, Standard for Signaling Devices for the Hearing Impaired.

B. Design Criteria:
1. Provide a complete fire alarm system as described in the Contract Documents and according to criteria of the AHJ and all applicable national and local codes such as NFPA, ADAAG, building code, etc.
a. Where system requirements described in the Contract Documents exceed those of the AHJ and/or NFPA, meet the requirements of both.
b. Perform a thorough examination of Contract Documents and shall coordinate with other disciplines and trades, e.g., verification of hazardous area locations requiring equipment rated for that type of environment.
c. Contractor shall be responsible for providing a fully functional and code compliant fire alarm system at no additional cost to the Owner.
d. Work includes the design and installation of cable and raceway systems to support the fire alarm system which shall monitor all heat detectors, smoke detectors, alarm devices, relay modules, monitoring modules, and pull stations, and other fire alarm devices and appurtenances.
e. Provide fire alarm systems under the supervision of a single specialty contractor (fire alarm system contractor), which is regularly engaged in the design and installation of such systems of similar scope and complexity. Be responsible for performance of all systems as specified and as approved by the AHJ governing authority.
f. All conduits and wiring among fire alarm sensors, boxes, and panels shall be supplied, installed, and tested by the fire alarm system contractor.
g. All fire alarm system wiring, and cable shall be installed in conduit.
2. Submit documents after design has been approved by Authority Having Jurisdiction (AHJ).
3. The fire alarm system shall be designed by a NICET Fire Alarm Systems Level III or IV engineering technician.
a. The designer is responsible for understanding the construction of the building to take in consideration ceiling heights, ceiling construction (flat or not flat), and other features of the building that will affect the layout of devices as required to provide a fire alarm system that is fully compliant with NFPA 72.
4. If required by state regulations, a Professional Fire Protection Engineer shall seal drawings submitted to the AHJ.
5. This Section establishes minimum standards and guidelines for providing a complete and operable and tested fire alarm system including final design, permitting, and supervision, and installed by a qualified firm specializing in fire alarm design and installation.

C. Service Organization Qualifications:
1. Offer an annual maintenance contract including complete service and equipment costs for maintenance of complete system.
2. 10 years' experience minimum serving fire alarm systems.
3. Provide for 24 HR emergency service. Response time to site shall be 24 HRS or less and service office shall be within 250 miles of site.
4. System shall be installed under the direct supervision of a technician who is factory trained by manufacturer and is certified as a minimum of NICET Level II in Fire Alarm Systems.

D. Field quality control:
1. Manufacturer's field services: Provide service by a factory-authorized and certified service representative to supervise field assembly and connection of components and pre-testing, testing, and adjustment of system.

2. Pre-testing: Determine, through pre-testing, conformance of system to requirements of drawings and specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
3. Inspection:
    a. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
    b. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

E. Authority Having Jurisdiction (AHJ) review:
1. Concurrent or prior to submission to Engineer, submit shop drawing and product data to Authority Having Jurisdiction (AHJ).
2. Upon receipt of comments from AHJ, make resubmissions, if required, to make clarifications or revisions to obtain approval.
3. The AHJ shall witness final testing and inspection in order to obtain final approval for system.

## 1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
1. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
2. Architecturally Finished Area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architecturally Finished Area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
    a. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater, or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
4. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
5. Shop Fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.
6. Service Organization: Commercial entity comprised of professionals capable of providing the technical knowledge and a supply of replacement equipment required for the comprehensive maintenance of a fire alarm system.

## 1.4 SYSTEM DESCRIPTION

A. Automatic and manual, addressable, general alarm and non-coded evacuation alarm, supervised, closed-circuit, 24 VDC microprocessor based fire detection and alarm system.

B. Provide components and features as required by the applicable codes, AHJ and/or Fire Department, including but not limited to following.
1. Main FACU in Electrical Room 300-112 within the Operations Building, as indicated on the Electrical Drawings.
2. Remote Fire Alarm Annunciators (FAA's).
3. Remote FACU's in Rooms 100-1010 of the Pretreatment Building and 600-100 of the Crowson Pump Station Building, as indicated on the Electrical Drawings.
    a. Independent Systems: Each system shall be monitored both for the presence of an alarm condition and for a trouble condition.
4. Printer terminals.
5. Smoke sensors (Above FACUs and as needed for elevator recall control and supervisory services in 300 Operations Building).

6. Ductwork smoke sensors (for any air handling units serving that exceed 2,000 CFM, duct detection shall be provided for only this space in accordance with both NFPA 90A and the International Mechanical Code; please note that if 100% exhaust and 100% outside air supply, or a Chemical Room is on dedicated HVAC zone, no duct detection is required).
7. Remote alarm indicator for concealed smoke sensors.
8. Smoke sensors with auxiliary relays.
9. Sprinkler flow switch and main waterflow detector circuits.
10. Main, post indicator valve, and indicating sprinkler valve tamper switch circuits.
11. Sprinkler system pressure switch monitoring circuits.
12. A non-silenceable 24 VDC notification appliance circuit serving a dedicated, exterior alarm device activated upon a waterflow alarm.
    a. Exterior water flow alarm device shall be a weatherproof audible/visible notification device provided on the exterior of the building located above the Fire Department Connection (FDC).
13. Fan control relays (as needed for AHU shutdown activated from duct detectors per NFPA 90A and the International Mechanical Code).
14. Visual and audible notification appliances (in the chemical storage room 300-105 within the Operations Building).
15. Fire alarm system wire, with all wiring in conduit.
16. Tone generator.
17. Digital Alarm Communicator Transmitter (DACT):
    a. The DACT shall be an IP DACT as allowed by NFPA 72 and approved by the Ashland Fire Department.
    b. The DACT shall automatically communicate all Alarm, Supervisory, and Trouble signals to a listed Central Station per the Oregon Structural Specialty Code and NFPA 72.
18. Elevator interfaces:
    a. Provide all required initiating devices and control modules for the elevator equipment interface.
    b. May include but not limited to the following:
        1) Smoke detection in machine rooms, shafts and lobbies.
        2) Heat detection in machine rooms and shafts.
        3) Shunt trip of elevator circuit breaker.
        4) Elevator recall.
        5) Firefighter's hat activation (visual warning in elevator).
19. Plant control system interface:
    a. Provide one dry contact, relay outputs signal to indicate alarm.

C. Basic Performance:
1. Signal Line Circuits (SLC) shall be wired Class B (NFPA Style 4).
2. Notification Appliance Circuits (NAC) shall be wired Class B.
3. Each SLC and NAC shall be limited to only 80 PCT of its total capacity at the time of initial installation.
4. Fire alarm system and all associated equipment and devices shall be suited to the environment in which it is installed, e.g. in a hazardous areas all equipment shall be appropriately rated as explosion-proof, intrinsically safe, etc.

## 1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Shop drawings submittal shall include minimum required documentation as prescribed in NFPA 72. This includes, but is not limited to, the following:
    a. Written narrative providing design intent and system description.
    b. Floor plan layout showing location of all devices and control equipment:

1) Indicate salient features of each device (e.g., weatherproof, strobe candela rating).
2) Designate where protective equipment is provided (e.g. pull station covers, device guards, etc).
3) Explosion-proof or intrinsically safe ratings for devices.

c. Wiring diagrams (including riser diagram).
d. Include system details including location of FACU and all devices and circuiting.
e. System power and battery backup calculations and voltage drop calculations to assure that system will operate in accordance with prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
f. Provide equipment technical data sheet Submittal for all products specified in product section (PART 2), below.
g. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs.
h. Provide list of all input and output points in system with label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.
i. Equipment design considerations for future expansion as indicated.
j. Operating instructions for FACU.
k. Completed NFPA 72 record of inspection and testing (see Contract Closeout Information: below for additional requirements).
l. Copy of site specific software.
m. Name of local service organization.
n. Documentation of AHJ approval for system submittal.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Field test reports.
3. Owner instruction report.
4. Pro-rated warranty for batteries.
5. Spare parts: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
a. Manual Stations: Furnish quantity equal to 15 PCT of number of manual stations installed but no less than one.
b. Notification Appliances: Furnish quantity equal to 5 PCT of each type and number of units installed, but not less than one of each type.
c. Automatic initiation devices including but not limited to smoke sensors and heat sensors: Furnish quantity equal to 5 PCT of each type and number of units installed but not less than one of each type.
d. Detector or Sensor Bases: Furnish quantity equal to 2 PCT of each type and number of units installed but not less than one of each type.

C. As-Built Record Documents:
1. For all drawings prepared for the submittals, provide updated CAD drawings to reflect as-built conditions in *.dwg format per Section 01 33 00 upon completion of Operational Testing.

## 1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
1. Outdoor areas:
a. Wet.
b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specification Sections.
2. Indoor areas:

a. Dry.
b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specification Sections.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable.
   1. Fire alarm system:
      a. Edwards Systems Technology (EST).
      b. Gamewell FCI.
      c. Notifier.
      d. Monaco.
      e. Siemens Industry.
      f. Silent Knight.
      g. Simplex Grinnell.
      h. Cooper Wheelock.
   2. Manufacturer must have a service organization local to the project site(s).

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. All Equipment:
   1. UL listed or FM approved as a product of a single manufacturer under appropriate category.
   2. Equipment shall not be modified or installed to alter or void UL label or listing.
   3. Approved by Fire Marshal.
   4. Signs:
      a. NFPA approved identification signs shall be provided for each FACU with wording approved by the Fire Marshall.

### 2.2 MAIN FIRE ALARM CONTROL UNIT (FACU)

A. FACU shall perform operations as described in Fire Alarm System Operation:

B. The Fire Alarm system shall have 100 point minimum initiating device capacity with the capability to add additional 100 point minimum initiating device control modules.

C. Construction shall be modular with solid-state, microprocessor-based electronics.
   1. An 80-character LCD display shall indicate alarms, supervisory service conditions and any troubles.

D. Keyboards or keypads shall not be required to operate system during fire alarm conditions.

E. Provide necessary switches, relays, indicator lamps, wiring terminals, etc., to provide complete operation supervising, control, and testing facilities for entire system.

F. FACU shall allow for loading or editing special instructions and operating sequences as required.
   1. System shall be capable of on-site programming to accommodate and facilitate expansion, building parameter changes or changes as required by local codes.
   2. All software operations shall be stored in a non-volatile programmable memory within FACU.

G. System shall have provisions for disabling and enabling all circuits individually for maintenance and testing purposes.

H. System shall be capable of logging and storing 300 events in a history log.
   1. These events shall be stored in a battery protected random access memory.
   2. Each recorded event shall include time and date of that event's occurrence.

3. System shall have capability of recalling alarms, supervisory conditions, trouble conditions, acknowledgments, silencing and reset activities in chronological order for purpose of recreating an event history.

I. FACU shall be listed under UL 864 or FM approved.

J. FACU shall be in an enclosed metal cabinet with glass door specifically designed for public areas.
   1. Mounting: Surface.
   2. Finish: Red baked enamel.

K. Each addressable device shall be represented individually in FACU.
   1. Indicate TROUBLE by a discreet LCD readout for each supervised circuit.
   2. Indicate ALARM by a discreet LCD readout for each alarm initiating addressable device.
   3. Include individual supervisory and alarm relays in each circuit arranged so that ground or open condition in any circuit or group of circuits, will not affect proper operation of any other device.

L. FACU shall include the capability to report alarm and trouble conditions via a DACT utilizing Internet Protocol (IP) transmission technology approved by NFPA 72 and Ashland Fire. Transmission shall be to an approved Central Station.

M. FACU shall include a system testing capability to help ensure that zoning and supervision have been maintained throughout system.
   1. Actuation of the enable walk test program at FACU shall activate "Walk-Test" mode of system which shall cause the following to occur:
      a. Third party reporting connection circuit shall be disconnected or put in test mode with central station.
      b. Control relay functions shall be bypassed.
      c. FACU shall indicate a trouble condition.
      d. FACU shall, at a minimum, be capable of causing audible signals to activate for 2 SEC upon alarm activation of any initiation device.
      e. FACU shall automatically reset itself after code is complete.
      f. Any momentary opening of alarm initiating or alarm indicating circuit wiring shall cause audible signals to sound continuously for 4 SEC to indicate trouble condition.
      g. System shall have four distinctive walk test groups such that only a portion of system need be disabled during testing and an alarm in any other area will be processed normally.

N. General Alarm Circuits: Positive non-interfering type so that a second device can be annunciated simultaneously, or closely following first zone.

O. Power Supply:
   1. Power limited operation per NFPA 70, Article 760.
   2. 120 VAC dedicated circuit from panel board to integral 24 VDC regulated power supply in FACU and battery charger.
      a. The power supply shall provide all panel and peripheral device power needs.
   3. If the FACU cannot provide power for the required number of notification appliances a power extender shall be used.
      a. An additional 120 VAC dedicated circuit from a panel board shall be used to power the power extenders power supply and battery charger.
   4. Provide transient voltage surge suppression (TVSS) for Main FACU for power supply and communication channel(s).
   5. Label the branch circuits serving the FACUs as "FIRE ALARM CONTROL UNIT" with red marking and make them accessible to only authorized personnel in accordance with NFPA 72.

P. Battery:
   1. Low maintenance sealed type, for fire alarm use with automatic battery charger.

2. Fire alarm systems without voice evacuation capability shall be provided with batteries capable of operating maximum normal load of system for 24 HRS and then capable of operating system for 5 minutes in alarm condition.
3. Fire alarm systems with voice evacuation capability shall be provided with batteries capable of operating maximum normal load of system for 24 HRS and then capable of operating system for 15 minutes in alarm condition.
4. Size batteries for the total maximum number of devices that can be connected to the FACU not the install number of devices.
5. The notification appliance power extender shall have the same battery requirements as the FACU.

## 2.3 INITIATING DEVICES

A. Addressable Manual Pull Stations:
   1. Pull-type with handle which shall lock in a protruding manner to facilitate quick visual identification of activated station.
      a. Reset using key or special tool after operation.
      b. Non-coded.
      c. Single action.
   2. High impact red Lexan with operating directions in white letters.
      a. Semi-flush mounted in architecturally finished areas.
      b. Surface mounted in non-architecturally finished areas.
      c. Surface mounted with clear Lexan weatherproof protective shield in areas designated as wet or in areas indicated in the schedules herein.
   3. Stations shall be keyed alike with FACU.
   4. Standards: UL 38.

B. Addressable Detector Base:
   1. Plug-in arrangement:
      a. Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection.
      b. The plug connection requires no springs for secure mounting and contact maintenance.
      c. Terminals in the fixed base accept building wiring.
      d. Detector construction shall have a mounting base with a twist-lock detecting head that is lockable.
      e. The locking feature must be field removable when not required.
      f. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the Control Unit.
   2. LED that will flash each time it is scanned by the Control Unit.
      a. When the Control Unit determines that a detector is in an alarm or a trouble condition, the Control Unit shall command the LED on that detector's base to turn on steady indicating that abnormal condition exists.
      b. Detectors which do not provide a visible indication of an abnormal condition at the detector location shall not be acceptable.
   3. Each detector shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another detector type.
      a. The Control Unit shall operate with the installed device but shall initiate a "Wrong Device" or "Incorrect Device ID" trouble condition until the proper type is installed or the programmed detector type is changed.
   4. Addressability: Detectors include a communication transceiver in the detector or mounting base having a unique identification and capability for status reporting to the FACU.
   5. Provide auxiliary relays in detector base to provide local control of equipment as described under system operation.
      a. Provide separate 24 VDC supply to detector base with auxiliary relays to guarantee that sufficient power will be available to operate relays.

C. Addressable Heat Detectors:

1. Fixed temperature type or combination rate-of-rise and fixed temperature type.
2. Rated at 135°F for ordinary areas where normal ceiling temperatures do not exceed 100°F, or rated 190°F for up to 150°F ceiling temperatures.
3. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
4. Quantity and spacing based upon manufacturer's UL listed spacing and the following:
   a. Provide detectors in accordance with NFPA 72 and the requirements of the AHJ.
   b. Devices shall be suitable for environment in which they are installed.
   c. For ceilings higher than the base UL listing, reduce spacing as required by manufacturer and NFPA 72.
5. The detector's electronics shall be immune from false alarms caused by EMI and RFI.
6. Standards: UL 521.

D. Addressable Smoke Detectors:
1. Photoelectric type that utilizes a sensor chamber with a light source and a photosensitive element that detects products of combustion.
2. Self-restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Quantity and spacing based upon manufacturer's UL listed spacing and the following:
   a. Provide detectors in accordance with NFPA 72 and the requirements of the AHJ.
   b. Devices shall be suitable for environment in which they are installed.
   c. Spacing shall be reduced for increased air changes as required by NFPA 72.
4. Detectors in non-accessible or controlled access locations shall be provided with a remotely located test switch to provide for ease of testing.
5. The detector's electronics shall be immune from false alarms caused by EMI and RFI.
6. Standards: UL 268.

E. Air Duct Smoke Detector:
1. Duct smoke detectors shall utilize addressable photoelectric type detector as specified herein.
2. Duct housing mounted directly to outside of duct with a sampling tube extended across duct to sample air movement.
3. Duct housing couplings slotted to insure proper alignment of sampling and exhaust tubes.
   a. Tube lengths as required per duct width.
4. Detector housing shall have an alarm LED visible through front cover.
5. Remote red LED alarm indicators shall be provided on the wall or ceiling adjacent to detectors above the ceiling or that are not visible from the ground.
   a. Duct detectors in non-accessible locations shall be provided with a remotely located test switch to provide for ease of testing.
6. Standards: UL 268A.

F. Addressable Monitor Modules:
1. Provides addressability and supervision to a conventional initiating device (e.g., tamper switches, pressure switches, flow switches, etc).
   a. The conventional initiating device shall be wired Class B, Style B.
2. Integral or remote LED shall be provided that will flash each time it is scanned by the FACU.
   a. When the FACU determines that a monitor module is in an alarm or a trouble condition, the FACU shall command the LED on that module to turn on steady, change color, or otherwise indicate that an abnormal condition exists.

G. Sprinkler System Devices:
1. Provide monitor module as specified herein for waterflow switches(s).
   a. Waterflow switches provided in Specification Section 21 05 00.
2. Provide monitor module as specified herein for pressure switch(es).
   a. Pressure switch(es) provided in Specification Section 21 05 00.

3. Provide monitor module as specified herein, for tamper switches associated with main water valve, post indicator valve (PIV) or OS&Y valves.
    a. Tamper switches provided in Specification Section 21 05 00.

## 2.4 AUTOMATIC CONTROL DEVICES

A. Addressable Relay/Control Modules:
1. Allows FACU to control a remotely located Form "C" contact (e.g., HVAC fans, dampers, fire shutters, elevator capture).

## 2.5 NOTIFICATION APPLIANCES

A. Alarm Horns:
1. Electric-vibrating polarized type, operating on 24 VDC, with provision for housing the operating mechanism behind a grille.
2. Horns produce a sound pressure level of 85 dB, measured at 10 FT.
3. Housing: Red with white "FIRE" lettering.
    a. Semi-flush or flush mounted in architecturally finished areas.
    b. Surface-mounted in non-architecturally finished areas.
4. Horns shall be weatherproof in areas designated as wet.

B. Alarm Strobes:
1. White tamper resistant lexan lens with 24 VDC xenon strobe.
2. Provide Candela rating as required per ADA and synchronize of multiple strobes when required.
3. Housing: Red with white "FIRE" lettering.
    a. Semi-flush or flush mounted in architecturally finished areas.
    b. Surface-mounted in non-architecturally finished areas.
4. Strobes shall be weatherproof in areas designated as wet or in areas indicated in the schedules herein.

C. Combination Audio/Visual Devices:
1. Shall be mounted in an integral unit and shall have the same features as the individual units specified in the previous sub sections.

D. Alarm Bells:
1. Heavy-duty vibrating type, operating on 24 VDC.

E. Standards: UL 464, UL 1971.

## 2.6 MISCELLANEOUS DEVICES

A. Isolated Loop Circuit Protector (Transient Suppression):
1. Hybrid solid state high performance suppression system.
    a. Do not use gas tubes, spark gaps or other suppression system components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
2. Line-to-line response time of less than 1 nanosecond capable of accepting a 2000 A (8 x 20 usec pulse) at 28 V.
3. Line-to-ground response time of less than 1 nanosecond capable of accepting a 2000 A (8 x 20 usec pulse) to earth.
4. Shield-to-ground shall be capable of accepting a 5,000 A (10 x 50 usec pulse) to earth.
5. Standard: UL 497B.

## 2.7 WIRING

A. Conduit:
1. 3/4 IN rigid minimum.
2. All fire alarm wiring and cable shall be in conduit.
3. Fire alarm conduit shall be dedicated to fire alarm wiring and cable only.
    a. Free-run wiring or cable is not permitted.

4. See Specification Section 26 05 33.

B. Conductors:
   1. Insulation type per NFPA 70, Article 760.
   2. 120 VAC and power supply connections: 12 GA, minimum.
   3. Low-voltage general alarm circuits: 14 GA, minimum.
   4. Low-voltage initiating circuits: 18 GA, minimum.
   5. Annunciator and data communication circuits: As required by manufacturer, UL listed.
   6. Use larger wire sizes when recommended by equipment manufacturer and per voltage drop calculations.
   7. See Specification Section 26 05 33.

C. Cable to interconnect the various components of the fire alarm system per NFPA 70.

D. Outlet Boxes: See Specification Section 26 05 33.

## 2.8 SYSTEM OPERATION

A. Activation of any alarm-causing Initiating device shall cause the following:
   1. General evacuation notification via activation of audible and visual notification appliances.
   2. Automatic control devices to operate as defined by the operating sequences.
   3. Alarm information shall be displayed at the FACU.
   4. DACT shall automatically communicate the alarm to a listed Central Station, which in turn shall contact the local Fire Department to initiate Emergency Services Notification.

B. All fire alarm signals are automatically locked on the display of the FACU until originating device is returned to normal and FACU is manually reset.
   1. Audible alarm signals shall be silenceable from FACU allowing for re-initiation following a subsequent alarm.
      a. Silencing of alarm signals shall not impair ability of system to continue to perform as specified.

C. Air Handling Equipment Fan Control:
   1. De-energize indicated air-handling equipment and interlocked exhaust fans upon alarm and close all associated smoke dampers.
   2. See Specification Section 23 09 00 for mechanical equipment sequence of operation and coordinate all fan controls.
   3. Fans shall not restart until FACU is manually reset.

D. Alarm signal(s) will be initiated under following conditions:
   1. Activation of the initiating device shall occur within 90 seconds of waterflow at the alarm-initiating device when flow occurs that is equal to or greater than that from a single sprinkler of the smallest orifice size installed in the system.
   2. Activation of a smoke detector or manual pull station.

E. Activation of any system trouble shall initiate the following:
   1. Common audible trouble signal shall sound and common trouble light shall illuminate at the FACU, any FAA's, and any remote FACU's.
   2. Specific device in trouble shall be indicated.
   3. DACT shall automatically communicate the trouble to a listed Central Station, which in turn shall contact the appropriate parties, identified by the Engineer on the call list, to inform them that the system requires attention and/or maintenance.

F. Activation of any system supervisory signal shall initiate the following:
   1. Common audible supervisory signal shall sound and common supervisory light shall illuminate at the FACU and all FAA's.
   2. Specific device with the supervisory signal shall be indicated.
   3. DACT shall automatically communicate the supervisory to a listed Central Station, which in turn shall contact the appropriate parties, identified by the Engineer on the call list, to inform them that the system requires attention and/or maintenance.

G. Audible trouble signal shall be silenceable by FACU.
   1. Visual trouble indication remains until trouble condition is corrected.
      a. A subsequent trouble condition received after manually silencing shall cause audible trouble signal to resound.
      b. Restoration of system to normal causes audible trouble signal until silencing switch is returned to normal position.
   2. Trouble signal(s) will be initiated under following conditions:
      a. Open on an initiation or alarm indicating circuit.
      b. Open in wiring to any FAA or any remote FACU's.
      c. Ground fault condition.
      d. Auxiliary manual control switch out of normal position.
      e. Loss of 120 VAC operating power to the Main FACU or any Remote FACU's.
      f. Low or no battery voltage condition.
   3. Supervisory Signal(s) shall be initiated under the following conditions:
      a. Main sprinkler valve is closed.
      b. Post indicator valve is closed.
      c. Any sprinkler or standpipe indicating valve is closed.

H. Install isolated loop circuit protectors on all fire alarm data communication circuits, SLC and NAC wiring, including shields, which extends beyond the building.
   1. The isolated loop circuit protector shall be located as close as practicable to the point at which the circuits leave or enter a building.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install all fire alarm equipment and wiring in accordance with local and national codes and NFPA 72.

B. Install all wiring in raceways and all devices in boxes:
   1. Install raceways and boxes in accordance with Specification Section 26 05 33.
   2. In unfinished areas, exposed fire alarm conduit shall be red in color.
   3. All boxes are to be red in color (either painted or a manufacturer's red box).

C. Install all components as indicated and in accordance with manufacturer's wiring diagrams, instructions, and recommendations.

D. Make all fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead.
   1. Circuit splices not permitted.
   2. Wiring joints, only when required at device pigtail leads shall utilize insulated conical spring connector.

E. Color coding or other identification is required for all fire alarm wiring.
   1. Coordinate requirements with Owner.

F. Installation of equipment and devices that pertain to other work in contract shall be closely coordinated with appropriate subcontractors.
   1. Coordinate 8 IN minimum square access door with rubber gasket in duct approximately 2 FT upstream from smoke detector for testing and servicing.

G. Detection devices shall be protected during construction as required by NFPA 72.

H. Device Mounting Schedule:
   1. Dimensions are to center of item unless otherwise indicated.
   2. Mounting heights as indicated below unless otherwise indicated on the Contract Drawings.
      a. Manual pull stations (Install per ADA and ADAAG Standards):
         1) Forward Reach.

a) Unobstructed: Maximum 48 IN.
b) Obstructed High Reach (depth less than 20 IN): Maximum 48 IN.
c) Obstructed High Reach (depth greater than 20 IN): Maximum 44 IN.

2) Side Reach.
a) Unobstructed: Maximum 48 IN.

3) Obstructed High Reach (reach depth less than 10 IN): Maximum 48 IN.
4) Obstructed High Reach (reach depth greater than 10 IN): Maximum 46 IN.

b. Notification appliances: Lens is not less than 80 IN and not greater than 96 IN.
c. Control panels and remote annunciators: 72 IN to top (display at eye level).

## 3.2 TESTING

A. Obtain services of factory trained representative of system manufacturer to supervise installation and its progress, supervise final connections to equipment and provide testing to assure that system is in proper operating condition, and is in compliance with all applicable regulations.

B. Entire system shall test free from opens, grounds, and short circuits.

C. Test system to satisfaction of Engineer and state and local fire authorities in accordance with NFPA 72, state and local codes and manufacturer's requirements.

D. Acceptance Operational Tests:
1. Perform operational system tests to verify conformance with specifications:
a. Each alarm initiating device installed shall be operationally tested.
b. Each device shall be tested for alarm and trouble conditions.
c. Fire Alarm Submit written certification that Fire Alarm System installation is complete including all punch-list items.
d. Test battery operated emergency power supply. Test emergency power supply to minimum durations specified.
e. Test supervising station signal transmitter. Coordinate testing with supervising station monitoring firm/entity.
f. Test each notification appliance installed for proper operation. Submit written report indicating sound pressure levels at specified distances.
g. Test FACU.
2. Provide minimum 5 business days notice of acceptance test performance schedule to Owner, and local Authority Having Jurisdiction (AHJ).

E. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by system test that total system meets Specifications and complies with applicable standards.

F. Report of Tests and Inspections: Provide written record of inspections, tests, and detailed test results in form of test log. Use NFPA 72 Forms for documentation.

G. Final Test, Record of Completion, and Certificate of Occupancy:

H. Test system as required by Authority Having Jurisdiction in order to obtain certificate of occupancy. Provide completed NFPA 72 Record of Completion form to Owner and AHJ.

## 3.3 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris from all devices and equipment panels. Clean panel internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of substantial completion, provide on-site assistance in adjusting sound pressure levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to site for this purpose.

## 3.4 TRAINING

A. Provide services of factory-authorized service representative to demonstrate system and train Owner's personnel in operation of system as specified below.
   1. Train Owner's maintenance personnel in procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of system.
   2. Provide minimum of 8 HRS training.
   3. Schedule training with Owner at least two weeks in advance.
   4. Fill out Owner instruction reports.

## 3.5 COMPLETION

A. Prior to Final Acceptance:
   1. Turn all FACU's access keys over to the Project Representative.
   2. Turn in As-Built Records.

**END OF SECTION**

# DIVISION 31

## EARTHWORK

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# SECTION 31 10 00
SITE CLEARING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Site clearing, tree protection, stripping topsoil and demolition.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 00 - Earthwork.
   4. Section 31 25 00 - Soil Erosion and Sediment Control.
   5. Section 32 91 13 - Topsoiling and Finished Grading.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect existing trees and other vegetation to remain against damage.
   1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
   2. Avoid foot or vehicular traffic or parking of vehicles within drip line.
   3. Provide temporary protection as required.

B. Repair or replace trees and vegetation damaged by construction operations.
   1. Repair to be performed by a qualified tree surgeon/licensed arborist.
   2. Remove trees which cannot be repaired and restored to full-growth status.
   3. Replace with new trees of minimum 4 IN caliper or as required by local tree ordinance.

C. Owner will obtain authority for removal and alteration work on adjoining property, as applicable.

### 3.2 SITE CLEARING

A. Topsoil Removal:
   1. Strip topsoil to depths encountered or as specified within the soils report, 4 IN minimum.
      a. Remove heavy growths of grass before stripping.
      b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.
      c. Separate from underlying subsoil or objectionable material.
   2. Stockpile topsoil where directed by Engineer.
      a. Construct storage piles to freely drain surface water.
      b. Seed or cover storage piles to prevent erosion.
   3. Do not strip topsoil in wooded areas where no change in grade occurs.
   4. Borrow topsoil: Reasonably free of subsoil, objects over 2 IN DIA, weeds and roots.

B. Clearing and Grubbing:
   1. Clear from within limits of construction all trees not marked to remain.
      a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.

2. Grub (remove) from within limits of construction all stumps, roots, root mats, logs and debris encountered.

C. Disposal of Waste Materials:
   1. Do not burn combustible materials on site.
   2. Remove all waste materials from site.
   3. Do not bury organic matter on site.

**END OF SECTION**

# SECTION 31 22 00
SITE GRADING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Earthwork - site excavation, grading, compaction, disposal of waste and surplus materials, construction of berms, dewatering and other Earthwork related work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 25 00 - Soil Erosion and Sediment Control.
   4. Section 31 23 17 - Rock Excavation.
   5. Section 31 23 19 - Dewatering.
   6. Section 32 15 40 - Crushed Stone Surfacing.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/CUFT).
      c. D1241, Standard Specification for Material for Soil-Aggregate Subbase, Base, and Surface Courses.
      d. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/CUFT (2,700 kN-M/M)).
      e. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      f. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
      g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      h. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
      i. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   2. American Association of State Highway and Transportation Officials (AASHTO)
      a. M 43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
      b. M 57, Standard Specification for Materials for Embankment and Subgrades.
      c. M 147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
   3. Federal Regulations:
      a. Occupational Safety and Health Administration (OSHA):
         1) 29 CFR Part 1926.650, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

### 1.3 DEFINITIONS

A. Excavation:
   1. Consists of removal of material encountered to subgrade or rough grade elevations required or indicated.

2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.

B. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.

C. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.

D. Finish Grade: The earth or soil layer immediately below the surfacing material of the site.

E. Rough Grade: The earth or soil layer immediately below the finish grade surface.

F. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

G. Unauthorized Excavation:
1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
   a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

## 1.4 SUBMITTALS

A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Product Data:
1. Acknowledgement that products submitted meet requirements of standards referenced.
2. Manufacturer's installation instructions.
3. Certifications.

C. Samples:
1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.

## 1.5 PROJECT CONDITIONS

A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.

B. Dispose of waste materials, legally, off site.
1. Burning, as a means of waste disposal, is not permitted.

C. Site Information:
1. Data in subsurface investigation reports was used for the basis of the design.
   a. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings.
   b. The Owner or Engineer will not be responsible for interpretations or conclusions drawn from this data by Contractor.
2. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
3. Site data provided is not contractual and shall be considered "for information only."

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Fill:
   1. Selected on-site material from site excavation or from off-site borrow approved by Geotechnical Engineer.
   2. Structural Fill:
      a. Free of organic matter, frozen material and debris.
      b. Granular soil:
         1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM or SC.
   3. Non-Structural Fill:
      a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
      b. Liquid limit: Less than 45.
      c. Maximum plasticity index: 20.

B. Aggregate Base:
   1. Granular Fill Material:
      a. Clean, Granular material.
      b. Less than 5 PCT fines passing the No. 200 sieve.
      c. ASTM D1241/AASHTO M147 Grading "B" or other material acceptable to Geotechnical Engineer.

C. Geotextile Filter Fabric:
   1. Nonwoven type.
   2. Equivalent opening size: 50 - 100 (U.S. Standard Sieve).
   3. Permeability coefficient (cm/second): 0.07 minimum, 0.30 maximum.
   4. Grab strength: 90 LBS minimum in either direction in accordance with ASTM D4632 requirements.
   5. Mullen burst strength: 125 PSI minimum in accordance with ASTM D3786 requirements.

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.
   2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
   3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
      a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.

B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain bench marks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
      b. Secure and examine local utility records for location data.
      c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
         1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
3) Obtain Owner's approval prior to disconnecting any utility service.

d. Repair damages to utility items at own expense.
e. In case of damage, notify Engineer at once so required protective measures may be taken.

4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
   a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
   b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
   c. All repairs to be made and paid for by Contractor.
5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

C. Protection of trees to remain:
   1. Perform excavation by hand within dripline of large trees designated on Drawings to remain. Protect root systems from damage or dryout to the greatest extent possible.
      a. Maintain moist condition for root system and cover exposed roots with moistened burlap.

## 3.2 SITE EXCAVATION AND GRADING

A. The site excavation and grading work includes the offsite disposition of all material:
   1. That exceed quantities required for earthwork on the project.
   2. That the Geotechnical engineer classifies as unclassified excavation.
   3. That the Geotechnical engineer classifies as unacceptable.
   4. That the Geotechnical engineer classifies as potentially contaminated.

B. Excavation and Grading:
   1. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
      a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
      b. Perform other layout work required.
      c. Replace property corner markers to original location if disturbed or destroyed.
   2. Preparation of ground surface for embankments or fills:
      a. Before fill is started, scarify to a minimum depth of 6 IN in all proposed embankment and fill areas.
      b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.
   3. Protection of finish grade:
      a. During construction, shape and drain embankment and excavations.
      b. Maintain ditches and drains to provide drainage at all times.
      c. Protect graded areas against action of elements prior to acceptance of work.
      d. Reestablish grade where settlement or erosion occurs.

C. Borrow:
   1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.

2. Include cost of all borrow material in original proposal.
3. Fill material to be approved by Geotechnical Engineer prior to placement.

D. Construct embankments and fills as required by the Contract Drawings:
   1. Construct embankments and fills at locations and to lines of grade indicated.
      a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
   2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
      a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
      b. Do not place material in layers greater than 8 IN loose thickness.
      c. Place layers horizontally and compact each layer prior to placing additional fill.
   3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
      a. In general, compact cohesive soils by sheepsfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
      b. Control moisture for each layer necessary to meet requirements of compaction.

E. Grading Tolerances: ±0.1 IN.

## 3.3 USE OF EXPLOSIVES

A. Rock Excavation: Refer to Specification Section 31 23 17.

## 3.4 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.

C. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.

D. Assure by results of testing that compaction densities comply with the following requirements:
   1. Sitework:

| LOCATION | COMPACTION DENSITY | MOISTURE CONTENT |
|---|---|---|
| **Subgrade:** | | |
| Cohesive soils | 90 PCT per ASTM D698 | -2 to +3 PCT of optimum |
| Cohesionless soils | 65 PCT relative density per ASTM D4253 and ASTM D4254 | |
| **Rough Grade:** | | |
| Cohesive soils | 95 PCT of ASTM D698 | -2 to +3 PCT of optimum |
| Cohesionless soils | 75 PCT relative density per ASTM D4253 and ASTM D4254 | |
| **Finish Grade:** | | |
| Cohesive soils | 95 PCT of ASTM D698 | -2 to +3 PCT of optimum |
| Cohesionless soils | 75 PCT relative density per ASTM D4253 and ASTM D4254 | |

## 3.5 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA standards 29 CFR Part 1926.650 Subpart P, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. Special Inspection and testing:
   1. See Section 01 45 33.

C. Responsibilities of Special Inspector:
   1. Review proposed materials for fill and backfill around structures.
   2. All testing, observation and work indicated as being performed by the Geotechnical Engineer in this Specification Section.
   3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
   4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
   5. Extent of compaction testing will be as necessary to assure compliance with specifications.
   6. Prepare and submit inspection and test reports to Engineer.
      a. Coordinate such work with other Special Inspectors.
   7. Test reports to include the following:
      a. Report and certification of aggregate fill and drainage fill.
      b. Test reports on borrow material.
      c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
      d. Field reports; in-place soil density and moisture tests.
      e. One optimum moisture-maximum density curve for each type of soil encountered.
      f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
      g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
      h. Assist Engineer to determine corrective measures necessary for defective work.

D. Responsibilities of Testing Agency for Site Excavation and Grading:
   1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
   2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
   3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
   4. Extent of compaction testing will be as necessary to assure compliance with specifications.

**END OF SECTION**

# SECTION 31 23 00
EARTHWORK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Earthwork - excavation, backfilling, grading, compaction, disposal of waste and surplus materials, placing crushed stone, construction of berms, sheeting, bracing, dewatering and other Earthwork related work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 07 26 00 - Under Slab Vapor Retarder.
   4. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.
   5. Section 31 25 00 - Soil Erosion and Sediment Control.
   6. Section 31 23 19 - Dewatering

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33/C33M, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT$^3$).
      c. D1241, Standard Specification for Material for Soil-Aggregate Subbase, Base, and Surface Courses.
      d. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT$^3$(2,700 kN-M/M$^3$)).
      e. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      f. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
      g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      h. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
      i. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   2. American Association of State Highway and Transportation Officials (AASHTO)
      a. M 43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
      b. M 57, Standard Specification for Materials for Embankment and Subgrades.
      c. M 147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

B. Federal Regulations:
   1. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

### 1.3 DEFINITIONS

A. Excavation:
   1. Consists of removal of material encountered to subgrade elevations required or indicated.

2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.

B. Foundations: Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

C. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.

D. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.

E. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

F. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

G. Unauthorized Excavation:
1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
   a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

## 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Certifications.

B. Samples:
1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
2. Submit samples and source of fill and backfill materials proposed for use.

## 1.5 PROJECT CONDITIONS

A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.

B. Dispose of waste materials, legally, off site.
1. Burning, as a means of waste disposal, is not permitted.

C. Site Information:
1. Data in subsurface investigation reports was used for the basis of the design.
   a. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings.
   b. The Owner or Engineer will not be responsible for interpretations or conclusions drawn from this data by Contractor.
2. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
3. Site data provided is not contractual and shall be considered "for information only."

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Fill and Backfill:
   1. Selected material approved by Geotechnical Engineer from site excavation or from off site borrow.
   2. Structural Fill:
      a. Free of organic matter, frozen material and debris.
      b. Granular soil:
         1) ASTM D2487 classification: GW or GP.
         2) Less than 7 PCT fines passing the No. 200 sieve.
         3) Maximum plasticity index: 5
   3. Non-Structural Fill:
      a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
      b. Liquid limit: Less than 45.
      c. Maximum plasticity index: 20.

B. Granular Fill Under Building Floor Slabs-On-Grade, Electrical Equipment Pads, Manholes and Handholes:
   1. Clean, granular material.
   2. Less than 5 PCT fines passing the No. 200 sieve.
   3. ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4 or other material acceptable to Geotechnical Engineer.

C. Granular Fill Under Base Slabs with Pressure Relief Valves:
   1. Drainage material: Conform to ASTM C33/C33M, Size No. 67.
   2. Filter material: Conform to ASTM C33/C33M requirements for fine aggregate.

D. Drainage Course: Free draining stone such as #57 stone or #67 stone meeting the requirements of ASTM C33/C33M specifications.

E. Granular Fill Under Electrical Equipment Pads, Manholes and Handholes: Clean, crushed, nonporous rock, crushed or uncrushed gravel complying with ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4.

F. Geotextile Filter Fabric:
   1. Nonwoven type.
   2. Equivalent opening size: 50 - 100 (U.S. Standard Sieve).
   3. Permeability coefficient (cm/second): 0.07 minimum, 0.30 maximum.
   4. Grab strength: 90 LBS minimum in either direction in accordance with ASTM D4632 requirements.
   5. Mullen burst strength: 125 PSI minimum in accordance with ASTM D3786 requirements.

G. Vapor Retarder: Refer to Specification Section 07 26 00.

H. Flowable Fill: See Section 03 31 30.

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.
   2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
   3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
      a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.

B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain bench marks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
      b. Secure and examine local utility records for location data.
      c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
         1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
         2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
         3) Obtain Owner's approval prior to disconnecting any utility service.
      d. Repair damages to utility items at own expense.
      e. In case of damage, notify Engineer at once so required protective measures may be taken.
   4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
      a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
      b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      c. All repairs to be made and paid for by Contractor.
   5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
   6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
   7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

C. Protection of trees to remain:
   1. Perform excavation by hand within dripline of large trees designated on Drawings to remain. Protect root systems from damage or dryout to the greatest extent possible.
      a. Maintain moist condition for root system and cover exposed roots with moistened burlap.

## 3.2 SITE EXCAVATION AND GRADING

A. The site excavation and grading work includes the offsite disposition of all material:
   1. That exceed quantities required for earthwork on the project.
   2. That the Geotechnical engineer classifies as unclassified excavation.
   3. That the Geotechnical engineer classifies as unacceptable.
   4. That the Geotechnical engineer classifies as potentially contaminated.

B. Excavation and Grading:
   1. Perform as required by the Contract Drawings.
   2. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
      a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
      b. Perform other layout work required.

c. Replace property corner markers to original location if disturbed or destroyed.

3. Preparation of ground surface for embankments or fills:
   a. Before fill is started, scarify to a minimum depth of 6 IN in all proposed embankment and fill areas.
   b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.
4. Protection of finish grade:
   a. During construction, shape and drain embankment and excavations.
   b. Maintain ditches and drains to provide drainage at all times.
   c. Protect graded areas against action of elements prior to acceptance of work.
   d. Reestablish grade where settlement or erosion occurs.

C. Borrow:
1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
2. Include cost of all borrow material in original proposal.
3. Fill material to be approved by Geotechnical Engineer prior to placement.

D. Construct embankments and fills as required by the Contract Drawings:
1. Construct embankments and fills at locations and to lines of grade indicated.
   a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
   a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
   b. Do not place material in layers greater than 8 IN loose thickness.
   c. Place layers horizontally and compact each layer prior to placing additional fill.
3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
   a. In general, compact cohesive soils by sheepsfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
   b. Control moisture for each layer necessary to meet requirements of compaction.

E. Grading Tolerances: 0.1 ±IN.

## 3.3 ROCK EXCAVATION

A. See Specification Section 31 23 17.

## 3.4 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Provide dewatering system necessary to successfully complete compaction and construction requirements.

C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.

D. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.

E. Assure by results of testing that compaction densities comply with the following requirements:
1. Sitework:

| LOCATION | COMPACTION DENSITY | MOISTURE CONTENT |
|---|---|---|
| Under Paved Areas, Sidewalks and Piping: | | |
| Cohesive soils | 95 PCT per ASTM D698 | -2 to +3 PCT of optimum |
| Cohesionless soils | 75 PCT relative density per ASTM D4253 and ASTM D4254 | |
| Unpaved Areas: | | |
| Cohesive soils | 90 PCT of ASTM D698 | -2 to +3 PCT of optimum |
| Cohesionless soils | 65 PCT relative density per ASTM D4253 and ASTM D4254 | |

2. Structures:

| LOCATION | COMPACTION DENSITY | MOISTURE CONTENT |
|---|---|---|
| Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material | 98 PCT per ASTM D698 | -2 to +3 PCT of optimum |
| Outside structures next to walls, piers, columns and any other structure exterior member | 92 PCT per ASTM D698 | -2 to +3 PCT of optimum |

3. Specific areas:

| LOCATION | COMPACTION DENSITY | MOISTURE CONTENT |
|---|---|---|
| Outside structures under equipment support foundations | 98 PCT per ASTM D698 | -2 to +3 PCT of optimum |
| Under void | 85 PCT per ASTM D1557 | -2 to +3 PCT of optimum |
| Granular fill under base slabs with pressure relief valves | 75 PCT relative density per ASTM D4253 and ASTM D4254 or 98 PCT of ASTM D698 | |
| Granular fill under building floor slabs-on-grade | 60 PCT relative density per ASTM D4253 and ASTM D4254 | |

## 3.5 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:
   1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
   2. Obtain fill and backfill material necessary to produce grades required.
      a. Materials and source to be approved by Geotechnical Engineer.
      b. Excavated material approved by Geotechnical Engineer may also be used for fill and backfill.
   3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:
   1. General:

a. Do not commence excavation for foundations for structures until Geotechnical Engineer approves:
    1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
    2) Density and moisture content of site area compacted fill material meets requirements of specifications.
    3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
    4) Surcharge or mass fill material has been removed from construction area or portions thereof.
b. Engineer grants approval to begin excavations.

2. Dimensions:
    a. Excavate to elevations and dimensions indicated or specified.
    b. Allow additional space as required for construction operations and inspection of foundations.
    c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
    d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
    a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Geotechnical Engineer.
    b. Remove unsuitable subgrade soils located below foundations. The bottom of the overexcavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
        1) Distance equal to depth of overexcavation below bottom of foundations.
        2) 5 FT.
        3) As directed by Geotechnical Engineer.
    c. When excavation has reached required subgrade elevations, notify Geotechnical Engineer, who will make an inspection of conditions.
        1) If Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.
4. Install working surface over approved subgrade.
    a. Minimum thickness: 12 IN.
5. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
    a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
    b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 6 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
    c. Do not carry excavations lower than shown for foundations except as directed by Geotechnical Engineer or Engineer.
    d. If any part of excavations is carried below required depth without authorization, notify Engineer and correct unauthorized excavation as directed. Corrections may include:
        1) Under soil supported footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
            a) Concrete fill may be used to bring elevations to proper position.
        2) In locations other than those above, including slabs on grade and pile supported foundations, backfill and compact unauthorized excavations as specified for

authorized excavations of same classification, unless otherwise directed by Geotechnical Engineer.

3) No extra compensation will be made to Contractor for correcting unauthorized excavations.

6. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
7. Notify Geotechnical Engineer and Engineer as soon as excavation is completed in order that subgrades may be inspected.
   a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Geotechnical Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.
   b. Geotechnical Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
   c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
   d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
8. Dewatering:
   a. Refer to section 31 23 19 Dewatering.
   b. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.
   c. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
   d. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
   e. Employ dewatering specialist for selecting and operating dewatering system.
   f. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.
   g. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
      1) Install groundwater monitoring wells as necessary.
   h. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
9. Subgrade stabilization:
   a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Geotechnical Engineer.
   b. Provide compaction density of replacement material as stated in Specification Section 3.4.
   c. Loose, wet, or soft materials, when approved by Geotechnical Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
   d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
   e. Remove and replace frozen materials as directed by Geotechnical Engineer.
   f. Method of stabilization shall be performed as directed by Geotechnical Engineer.
   g. If geotextile fabric is necessary for soil stabilization, see Specification Section 31 32 19.

h. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Geotechnical Engineer.

10. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.
    a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DEGF before structure is completed and heated to a temperature of at least 50 DEGF.
11. Protection of structures:
    a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
    b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
12. Shoring:
    a. Shore, slope, or brace excavations as required to prevent them from collapsing.
    b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
    c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
13. Drainage:
    a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
    b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
    c. Provide pumping required to keep excavated spaces clear of water during construction.
    d. Should any water be encountered in the excavation, notify Engineer and Geotechnical Engineer.
    e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
14. Frost protection:
    a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
    b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
    c. Protect excavation from frost if placing of concrete or fill is delayed.
    d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.
    e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.

C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:
    1. General:
        a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Geotechnical Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
        b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 PCT.
        c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Geotechnical Engineer as being free of undesirable material and compacted to specified density.

2. Obtain approval of fill and backfill material and source from Geotechnical Engineer prior to placing the material.
3. Granular fill under floor slabs-on-grade: Place all floor slabs-on-grade on a minimum of 6 IN of granular fill unless otherwise indicated.
4. Vapor barrier: Install a continuous vapor barrier under floor slabs-on-grade as required by Specification Section 07 26 00 and shown on Contract Drawings.
5. Fill and backfill placement:
    a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Geotechnical Engineer.
    b. Place fill and backfill material in 8 IN lifts.
    c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
    d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
        1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
        2) Contractor is responsible for method of compaction so as not to damage wall.
    e. Use hand operated equipment for filling and backfilling next to walls.
    f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
    g. Use vibratory equipment to compact granular material; do not use water.
6. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.

D. Filling and Backfilling Outside of Structures:
1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
2. Provide material as approved by Geotechnical Engineer for filling and backfilling outside of structures.
3. Fill and backfill placement:
    a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Geotechnical Engineer.
    b. Place fill and backfill material to maximum allowable lift thickness indicated in Paragraph 3.5, C, 5, b of this Section.
    c. Compact material with equipment of proper type and size to obtain density specified.
    d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
        1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
        2) Contractor is responsible for method of compaction so as not to damage wall.
    e. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
    f. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
    g. Use vibratory equipment for compacting granular material; do not use water.
4. Backfilling against walls:
    a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
    b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
    c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.

1) See Contract Drawings for specific exceptions.

d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.

E. Backfilling Outside of Structures Under Piping or Paving:
1. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in Specification Section 3.4.
2. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
3. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Specification Sections for the Project.

## 3.6 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA Standards, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. Special Inspection and Testing:
1. See Section 01 45 33.

C. Responsibilities of Special Inspector:
1. Review proposed materials for fill and backfill around structures.
2. All testing, observation and work indicated as being performed by the Geotechnical Engineer in this Specification Section .
3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
5. Extent of compaction testing will be as necessary to assure compliance with specifications.
6. Prepare and submit inspection and test reports to Engineer.
   a. Coordinate such work with other Special Inspectors.
7. Test reports to include the following:
   a. Report and certification of aggregate fill and drainage fill.
   b. Test reports on borrow material.
   c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
   d. Field reports; in-place soil density and moisture tests.
   e. One optimum moisture-maximum density curve for each type of soil encountered.
   f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
   g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
   h. Assist Engineer to determine corrective measures necessary for defective work.

D. Responsibilities of Testing Agency for Site Excavation and Grading:
1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
4. Extent of compaction testing will be as necessary to assure compliance with specifications.

**END OF SECTION**

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# SECTION 31 23 17
ROCK EXCAVATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Earthwork - excavation, grading, disposal of waste and surplus materials, and other Earthwork related work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 22 00 - Site Grading.
   4. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.
   5. Section 31 25 00 - Soil Erosion and Sediment Control.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. United States Bureau of Mines.
      a. Report of Investigations 8507/1980, titled "Structure Response and Damage Produced by Ground Vibrations from Surface Mine Blasting."
   2. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR Part 1926, Subpart P – Excavations, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
      b. 29 CFR Part 1926, Subpart U – Blasting and the Use of Explosives, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

### 1.3 DEFINITIONS

A. Rock Excavation:
   1. Classification of rock excavation shall include solid ledge rock in its natural location that requires systematic quarrying, drilling and/or blasting for its removal and also boulders that exceed 1/2 CUYD in volume.
   2. Rock excavation includes any material which cannot be dislodged by a D-8 Caterpillar tractor, or equivalent, equipped with a hydraulically operated power ripper, or by a Caterpillar 330 hydraulic excavator, or equivalent, without the use of drilling or blasting.

B. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.

C. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

### 1.4 PROJECT CONDITIONS

A. See Specification Section 31 22 00.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.

2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
    a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.

B. Protect existing surface and subsurface features on-site and adjacent to site:
    1. See Specification Section 31 22 00.

## 3.2 ROCK EXCAVATION

A. The rock excavation work includes the offsite disposition of all material:
    1. That exceed quantities required for earthwork on the project.
    2. That the Geotechnical engineer classifies as unclassified excavation.
    3. That the Geotechnical engineer classifies as unacceptable.
    4. That the Geotechnical engineer classifies as potentially contaminated.

B. Contract Drawings may indicate both existing grade and rough grade required for construction of Project.
    1. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
    2. Perform other layout work required.
    3. Replace property corner markers to original location if disturbed or destroyed.

C. When rock is encountered:
    1. Strip free of earth.
    2. Employ an independent surveyor to determine rock quantities before operations begin.
    3. In computing the volumetric content of rock excavation for payment, the pay lines shall be taken as follows:
        a. For Structures: 3 FT outside the exterior limits of foundation and from rock surface to 6 IN below bottom of foundations.
        b. For piping and utilities: A width 18 IN wider that the outside diameter of the pipe or conduit and from rock surface to 6 IN below bottom exterior surface of the pipe or conduit.
        c. For rough or finish grading: 2 FT outside the exterior limits of excavation and rock surface to 6 IN below bottom of finish grade surface.

## 3.3 TEST BLASTING PROGRAM:

A. Establish maximum explosive charge weight per delay necessary to meet the specified vibration limits.

B. Confirm proposed blasting plan is within specified limits.

C. Start test blasts with smaller charges and progressively increase the charge to production levels.

D. Monitor blast parameters and evaluate after each blast before proceeding with the next larger blast.

E. Vibration levels from test blast shall not exceed the specified limits.

## 3.4 USE OF EXPLOSIVES

A. The use of explosives shall be limited to the magnitude and location of the charge that will not cause damage to adjacent existing construction and utilities through shock vibrations or other stress loadings.

B. Blast vibration limits:
    1. Per U.S. Bureau of Mines' Report of Investigations 8507/1980, titled "Structure Response and Damage Produced by Ground Vibrations from Surface Mine Blasting", except the maximum peak particle velocity as measured by an engineering seismograph shall not exceed 4 IN per second.

2. Blast vibration level may change, depending on the presence of nearby structures and the results of the preconstruction survey.

C. Provide adequate blanket protection to ensure that there will not be fragments of rock or other debris flying through the air when discharging explosives.

D. Contractor to employ personnel certified by the City of Ashland_____ to execute blasting operations if the city requires such certification.
   1. Any damage to existing construction or other features caused by blasting operations to be repaired and paid for by Contractor.

E. Explosive permits shall be obtained from all applicable authorities.

F. Coordinate blasting with other work to avoid damage to new construction and possible decrease in concrete strength place less than 28-days prior to the blast.

G. Hold blasting charges above the design grades and minimize fractured rock from overblast.
   1. Actual grades for setting charges selected by the Contractor.

H. Do not drill more than 2 FT below the proposed subgrades to minimize the presence of fractured rock below final grade.

I. Excavate and remove rock damaged by blasting and replace loose rock with structural fill per Section 31 22 00.

J. The Contract unit price for rock excavation shall include all equipment and materials and other work necessary for excavation and hauling the rock from the site, and for furnishing and placing suitable replacement material as specified in its place.

K. Where explosives and blasting are used, comply with all laws and ordinances of municipal, state and Federal agencies relating to the use of explosives.
   1. Use qualified personnel for blasting and take proper precautions to protect persons, property or the work from damage or injury from blast or explosion.

## 3.5 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA standards 29 CFR Part 1929 Subpart P, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. All use of explosives or blasting operations shall comply with the requirements of OSHA standards 29 CFR Part 1926, Subpart U, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

C. Special Inspection and Testing:
   1. See Section 01 45 33.

D. Responsibilities of Testing Agency for Site Excavation and Grading:
   1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.5 of this Specification Section.
   2. Determination of rock verses non-rock material subject to bid item adjustment per Specification Section 01 22 00.

**END OF SECTION**

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# SECTION 31 23 19
DEWATERING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Dewatering system.
2. Surface water control system.
3. Monitoring wells.
4. System operation and maintenance.
5. Water disposal.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 31 22 00 - Site Grading.
4. Section 31 23 00 - Earthwork.
5. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
6. Section 31 25 00 - Soil Erosion and Sediment Control.

### 1.2 QUALITY ASSURANCE

### 1.3 DEFINITIONS

A. Dewatering:
1. Lowering of groundwater table and intercepting horizontal water seepage to prevent groundwater from entering excavations and trenches.
2. Disposing of removed water.
3. Surface runoff.

B. Surface Water Control:
1. Removal of surface water within open excavations.

C. Foundations:
1. Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

### 1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Dewatering plan design data and Drawings including the following:
   a. Proposed type of dewatering system with complete description of equipment and instrumentation to be used.
   b. Arrangement, locations, and depths of system components.
   c. Pipe sizes and capacities.
   d. Filter types and sizes.
   e. Water disposal method and location.
   f. Surface water control devices.
   g. System operation, monitoring, and maintenance procedures.
   h. Method of monitoring water quality.
   i. Signed and sealed by professional engineer.
3. Product technical data including:
   a. Dewatering pump data including the following:
      1) Size, capacity, and means of operation of engine and motor.

b. Pumping equipment for control of surface water within excavation.

### 1.5 PROJECT CONDITIONS

## PART 2 - PRODUCTS

### 2.1 DEWATERING EQUIPMENT

A. Select dewatering equipment to meet specified performance requirements.

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.
   2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
   3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
      a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.

B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain bench marks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
      b. Obtain and examine local utility records for location data.
      c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
         1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
         2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
         3) Obtain Owner's approval prior to disconnecting any utility service.
      d. Repair damages to utility items at own expense.
      e. In case of damage, notify Engineer at once so required protective measures may be taken.
   4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
      a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
      b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      c. All repairs to be made and paid for by Contractor.
   5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.

## 3.2 DEWATERING

A. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.

B. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.
   1. Employ dewatering specialist for selecting and operating dewatering system.
   2. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
   3. Install groundwater monitoring wells as necessary.
   4. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.

C. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
   1. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
   2. Discharge water into existing storm sewer system, drainage channels and settling basins.

## 3.3 SURFACE WATER CONTROL SYSTEMS

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation area as specified in Specification Section 31 25 00.

B. Divert surface water and seepage water within excavation areas into sumps and pump water into drainage channels, storm drains or surface runoff in accordance with requirements of the agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation.

**END OF SECTION**

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# SECTION 31 23 33
## TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Excavation, trenching, backfilling and compacting for all underground utilities.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   4. Division 26 - Electrical.
   5. Section 31 23 00 - Earthwork.
   6. Section 33 05 16 - Precast Concrete Manhole Structures.
   7. Section 33 11 13 – Water Main Construction
   8. Section 33 31 11 – Gravity Sewer Pipeline and Manhole Construction

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT$^3$ (600 kN-M/M$^3$)).
      b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      c. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   2. Construction Standards: State of Oregon, Department of Transportation, "Oregon Standard Specifications for Construction", 2024 Edition, as amended to date.

B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

### 1.3 DEFINITIONS

A. Excavation: All excavation will be defined as unclassified.

B. Geotechnical Engineer: Independent geotechnical specialist providing field quality control for the project.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.

B. Samples:
   1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
   2. Submit sieve analysis reports on all granular materials.

3. Submit test reports and fully document each with specific location or stationing information, date, and other pertinent information.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Trench shield (trench box) certification if employed:
      a. Specific to Project conditions.
      b. Re-certified if members become distressed.
      c. Certification by registered professional structural engineer, registered in the state where the Project is located.
      d. Engineer is not responsible to, and will not, review and approve.

### 1.5 SITE CONDITIONS

A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
   1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.

B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.

C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

D. Verify location of existing underground utilities

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Trench Backfill Material:
   1. As approved by the Engineer.
   2. Trench Backfill shall be Class B Backfill Material per State of Oregon Department of Transportation Standard Specifications (2024) per 00405.14 – Trench Backfill.

B. Trench Foundation Materials:
   1. As approved by the Engineer.
   2. Trench Foundation Material shall be per State of Oregon Department of Transportation Standard Specifications (2024) per 00405.11 – Trench Foundation.

C. Bedding Materials:
   1. As approved by the Engineer.
   2. Pipe Bedding Material shall be 3/4"- 0 Aggregate Bedding per State of Oregon Department of Transportation Standard Specifications (2024) per 00405.12 – Bedding.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Remove and dispose of unsuitable materials as directed by Geotechnical Engineer to site provided by Contractor.

### 3.2 EXCAVATION

A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Geotechnical Engineer.

B. Excavation for Appurtenances:
   1. 12 IN (minimum) clear distance between outer surface and embankment.

2. See Specification Section 31 23 00 for applicable requirements.
3. See Specification Section 33 05 16 for applicable requirements.

C. Groundwater Dewatering:
1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade to allow subgrade stabilization, pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
2. Groundwater shall be drawn down and maintained at least 3 FT below the bottom of any trench or manhole excavation prior to excavation.
3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
   a. Employ dewatering specialist for selecting and operating dewatering system.
4. Keep dewatering system in operation until dead load of pipe, structure, and backfill exceeds possible buoyant uplift force on pipe or structure.
5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
6. Install groundwater monitoring wells as necessary.
7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
8. Cost of groundwater dewatering shall be incidental.

D. Trench Excavation:
1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
   a. Support existing utility lines and yard piping where proposed work crosses at a lower elevation.
      1) Stabilize excavation to prevent undermining of existing utility and yard piping.
2. Open trench outside buildings, units, and structures:
   a. No more than the distance between two manholes, structures, units, or 100 LF, whichever is less.
   b. Field adjust limitations as weather conditions dictate.
3. Trenching within buildings, units, or structures:
   a. No more than 100 LF at any one time.
4. Any trench or portion of trench, which is opened and remains idle for seven calendar days, or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to Owner.
   a. Said trench may not be reopened until Owner is satisfied that work associated with trench will be prosecuted with dispatch.
5. Observe following trenching criteria:
   a. Trench size:
      1) See Contract Plans
      2) Keep trenches free of surface water runoff.
         a) Include cost in Bid.
         b) No separate payment for surface water runoff pumping will be made.

E. Trenching for Electrical Installations:
1. Observe the preceding Trench Excavation paragraph in PART 3 of this Specification Section.
2. Modify for electrical installations as follows:
   a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
   b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
   c. Do not over excavate trench.

d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
e. See Division 26 for additional requirements.

## 3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Over-Excavation:
1. Backfill and compact to 95 PCT of maximum density per Oregon Department of Transportation Standard Specifications section 00330.43 Earthwork Compaction Requirements.
2. Backfill with granular bedding material as option.

B. Rock Excavation:
1. Excavate minimum of 6 IN below bottom exterior surface of the pipe or conduit.
2. Backfill to grade with suitable earth or granular material.
3. Form bell holes in trench bottom.

C. Subgrade Stabilization:
1. Stabilize the subgrade when directed by the Owner.
2. Observe the following requirements when unstable trench bottom materials are encountered.
a. Notify Owner when unstable materials are encountered.
1) Define by drawing station locations and limits.
b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.
1) Replace with subgrade stabilization with no additional compensation.

## 3.4 BACKFILLING METHODS

A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.

B. Carefully Compacted Backfill:
1. Furnish where indicated on Drawings, specified for trench embedment conditions and for compacted backfill conditions up to 12 IN above top of pipe or conduit.
2. Comply with the following:
a. Place backfill in lifts not exceeding 6 IN (loose thickness).
b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
d. Compact each lift to specified requirements.

C. Common Trench Backfill:
1. Perform in accordance with the following:
a. Place backfill in lift thicknesses capable of being compacted to densities specified.
b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.

D. Water flushing for consolidation is not permitted.

E. Backfilling for Electrical Installations:
1. Observe the preceding Carefully Compacted Backfill paragraph or Common Trench Backfill paragraph in PART 3 of this Specification Section or when approved by the Engineer.
2. Modify for electrical installation as follows:
a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

## 3.5 COMPACTION

A. General:
   1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
   2. In no case shall degree of compaction below minimum compactions specified be accepted.

B. Compaction Requirements:
   1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
      a. Bedding material:
         1) 95 PCT of maximum density per Oregon Department of Transportation Standard Specifications section 00330.43 Earthwork Compaction Requirements.
      b. Carefully compacted backfill:
         1) 95 PCT of maximum density per Oregon Department of Transportation Standard Specifications section 00330.43 Earthwork Compaction Requirements.
      c. Common trench backfill:
         1) 95 PCT of maximum density per Oregon Department of Transportation Standard Specifications section 00330.43 Earthwork Compaction Requirements.

## 3.6 FIELD QUALITY CONTROL

A. Testing:
   1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in this Specification Section.
      a. Verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
   2. Perform in-place moisture-density tests as directed by the Owner.
   3. Perform tests through recognized testing laboratory approved by Owner.
   4. Costs of "Passing" tests paid by Owner.
   5. Perform additional tests as directed until compaction meets or exceeds requirements. Extent of compaction testing will be as necessary to assure compliance with specifications.
   6. Cost associated with "Failing" tests shall be paid by Contractor.
   7. Reference to Engineer in this Specification Section will imply Geotechnical Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.
   8. Ensure excavations are safe for testing personnel.
   9. Test reports to include the following:
      a. Report and certification of aggregate fill
      b. Test reports on borrow material.
      c. Field reports; in-place soil density and moisture tests.

**END OF SECTION**

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# SECTION 31 25 00
## SOIL EROSION AND SEDIMENT CONTROL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Soil erosion and sediment control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Section 00280 -Erosion and Sediment Control of the Oregon Department of Transportation, Standard Specifications

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Reference Sections 00280.14 00280.15 00280.16 from the Oregon Department of Transportation Standard Specifications for acceptable materials.

B. Pipe Riser and Barrel: 16 GA corrugated metal pipe (CMP) of size indicated.

C. Stone for Stone Filter: 2 IN graded gravel or crushed stone.

D. Fiber Rolls: Pre-manufactured, filled with plant based, naturally occurring fiber (e.g. straw, coconut fiber), that contains no weed seeds and that is not moldy, caked, decayed or of otherwise low quality. When straw is used, furnish straw meeting the requirements detailed in 32 92 00. Fiber roll must be fully biodegradable with enclosing netting derived from antural fibers (e.g. jute, sisal, hemp, coir fiber). Fiber rolls shall have a minimum density of 2.75 LBS per 1 CU FT and constructed to hold its shape to provide a diameter of 8 IN minimum.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Prior to construction, contractor to designate and provide erosion control sediment manager with valid ODOT ESCM certificate or who has successfully completed an erosion control training that is acceptable to the Engineer to perform the following duties outlined in section 00280.30 of the Oregon Department of Transportation Standard Specifications.

B. Contractor to comply with section 00280.03, 00280.04,00280.30, of the Oregon Standard Specifications for Construction 2024.

### 3.2 DURING CONSTRUCTION PERIOD

A. Contractor to comply with section 00280.40, 00280.41, 00280.43, 00280.44, 00280.45, 00280.46, 00280.47,00280.60, 00280.61, 00280.62, 00280.63, and 00280.64 of the Oregon Department of Transportation Standard Specifications.

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### 3.3 NEAR COMPLETION OF CONSTRUCTION

A. Contractor to comply with section 00280.70 and 00280.71 of the Oregon Department of Transportation Standard Specifications.

**END OF SECTION**

# SECTION 31 32 19
GEOTEXTILES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Nonwoven geotextile material.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 00 - Earthwork.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway Transportation Officials (AASHTO):
      a. M288, Standard Specification for Geotextile Specification for Highway Applications.
   2. ASTM International (ASTM):
      a. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
      b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
      c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
      d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
      e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      f. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
      g. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
      h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
      i. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
      j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

B. Qualifications:
   1. Each manufacturing, fabricating firm shall demonstrate five years continuous experience, including a minimum of 10,000,000 SQFT of geotextile installation in the past three years.
   2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 SQFT of geotextile.
   3. Installer shall attend pre-installation conference.

### 1.3 DEFINITIONS

A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
   3. Manufacturer and Installer quality control manuals.

4. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
   a. Results shall include or bracket the rolls delivered for use in the Work.
5. Geotextile layout plan with proposed size, number, position and sequencing of geotextile rolls and direction of all field seams.
6. Proposed details of anchoring and overlapping if different than included in Contract Documents.

B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Submit written certifications that:
   a. The nonwoven geotextile material delivered to site meets the requirements of this Specification Section.
   b. The nonwoven geotextile material was received and accepted in undamaged condition from shipper.
   c. The subgrade has been properly prepared and acceptable for the placement of the nonwoven geotextile material.
   d. The nonwoven geotextile material was installed in accordance with this Specification Section and with approved Shop Drawings.
3. For needle punched geotextiles, the manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
4. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 01 65 50.

B. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.

C. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
1. Do not remove the plastic wrapping until deployment.

D. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

E. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.

F. Do not expose geotextile to temperatures in excess of 71 DEGC (160 DEGF) or less than 0 DEGC (32 DEGF) unless recommended by the manufacturer.

G. Do not use hooks, tongs or other sharp instruments for handling geotextile.
1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
2. Do not drag geotextile along the ground.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. GSE Lining Technology.
2. Propex Geosynthetics.
3. SKAPS Industries.
4. TenCate Mirafi.
5. Tenax.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS AND MANUFACTURE

A. Geotextile:
   1. Nonwoven pervious sheet of polymeric material.
   2. Geotextile fibers:
      a. Long-chain synthetic polymer composed of at least 85 PCT by weight polyolefins, polyesters, or polyamides.
      b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
      c. Do not as reclaimed or recycled fibers or polymer to the formulation.
   3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
   4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
      a. Values shown are for the weaker principal direction.
      b. Acceptance of geotextile shall be in accordance with ASTM D4759.
      c. Type I Geotextile: AASHTO M288 Class 2, for use in demolition fill.

| PROPERTY | TEST METHOD | MINIMUM AVERAGE ROLL VALUE |
|---|---|---|
| Mass per Unit Area, OZ/SY | ASTM D5261 | =10 |
| AOS, U.S. Standard Sieve | ASTM D4751 | 70-100 |
| Permittivity, SEC-1 | ASTM D4491 | =0.5 |
| Puncture, LBS | ASTM D4833 | =90 |
| Grab Tensile, LBS | ASTM D4632 | =250 |
| Trapezoidal Tear, LBS | ASTM D4533 | =90 |
| Burst Strength, PSI | ASTM D3786 | =190 |
| Ultraviolet Degradation % retained @ 500 HRS | ASTM D4355 | =50 |
| Sewn Seam Strength, LBS | ASTM D4632 | =220 |

      d. Type 2 Geotextile: AASHTO M288 Class 2, for use in drainage composite and other areas shown on the Drawings.

| PROPERTY | TEST METHOD | MINIMUM AVERAGE ROLL VALUE |
|---|---|---|
| Mass per Unit Area, OZ/SY | ASTM D5261 | =8 |
| AOS, U.S. Standard Sieve | ASTM D4751 | 70-100 |
| Permittivity, SEC-1 | ASTM D4491 | =0.5 |
| Puncture, LBS | ASTM D4833 | =90 |
| Grab Tensile, LBS | ASTM D4632 | =250 |
| Trapezoidal Tear, LBS | ASTM D4533 | =90 |
| Burst Strength, PSI | ASTM D3786 | =190 |
| Ultraviolet Degradation % retained @ 500 HRS | ASTM D4355 | =50 |
| Sewn Seam Strength, LBS | ASTM D4632 | =220 |

B. Thread:
   1. High-strength polyester, nylon, or other approved thread type.
   2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
   3. Contrasting color with the geotextile.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

### 3.2 INSTALLATION

A. Install geotextiles in accordance with manufacturer's written recommendations.

B. Hand place geotextile.
   1. No equipment will be permitted to traffic in direct contact with the geotextile.

C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.

D. Seam Construction:
   1. Sew all Type I geotextile seams.
   2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
   3. Sew seams continuously using an SSA flat seam with one row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
   4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 IN unless otherwise recommended by the manufacturer.
   5. Test seams at the frequency specified in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
   6. Tie off thread at the end of each seam to prevent unraveling.
   7. Construct seams on the top side of the geotextile to allow inspection.
   8. Sew skipped stitches or discontinuities with an extra line of stitching with 18 IN of overlap.
   9. Type 2 geotextile seams may be sewn or overlapped.
      a. Construct overlapped seams in accordance with manufacturer's recommendations or as shown on Drawings.

E. Heat tack the geotextile overlaps as shown on the Drawings.

F. Backfill anchor trenches in accordance with Specification Section 31 23 00.

G. Place cover soil in accordance with Specification Section 31 23 00.

H. Protect geotextiles from clogging, tears, and other damage during installation.

I. Geotextile Repair:
   1. Place a patch of the same type of geotextile which extends a minimum of 12 IN beyond the edge of the damage or defect.
   2. Fasten patches continuously using a sewn seam or other approved method.
   3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
   4. Replace geotextile which cannot be repaired.

J. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.

K. Do not use staples or pins to hold the geotextile in place.

L. Do not leave geotextile uncovered for more than 14 days.

## 3.3 FIELD QUALITY CONTROL

A. Conduct destructive seam testing at locations identified by Owner.
   1. Minimum testing will be at a frequency of one test per 2,000 linear feet of seam.

B. Provide as-constructed drawing showing roll number; layout; joint locations; and destructive sample repair, and patch locations.

**END OF SECTION**

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# SECTION 31 37 00
RIPRAP

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Stone revetment (riprap) for protection of slopes and drainage ways against erosion.
      a. Channel protection.
      b. Embankment protection.
      c. Bridge abutments.
      d. Culvert outlets.
      e. Hydraulic structures.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 23 00 - Earthwork.
   2. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
   3. Section 31 25 00 - Soil Erosion and Sediment Control.
   4. Section 33 40 00 - Storm Drainage.
   5. Section 31 32 19 - Geotextiles.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
      b. D3744/D3744M, Standard Test Method for Aggregate Durability Index.
      c. D5312/D5312M, Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Freezing and Thawing Conditions.
      d. D5313/D5313M, Standard Test Method for Evaluation of Durability of Rock for Erosion Control Under Wetting and Drying Conditions.
      e. D5519, Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Certifications.
   3. Test reports.
   4. Submit all tests and certification in a single coordinated submittal.
      a. Partial submittals will not be accepted.
   5. Construction Plan.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Riprap shall be made up of durable angular quarry stone.

B. Individual stones making up the riprap shall be resistant to weathering and shall not contain cracks, non-mineralized defects, shale, unsound sandstone, or organic material.

C. Neither the width nor thickness of any stone shall be less than one-third of the stone's length.

D. Gradation of the material:
   1. Riprap gradation shall be in accordance with Section 15.5.1.2 of the Oregon Department of Transportation Hydraulics Manual.

## 2.2 MATERIAL QUALITY CONTROL

A. Geotextile:
   1. See Section 31 32 19 for geotextile requirements.

B. Riprap:
   1. Riprap material quality shall be evaluated using one of the following two methods:
      a. Specific rock properties:
         1) Quarry rock tests completed on rock that is representative of the material to be used on the project may be submitted for review if the testing was completed by a reputable testing company for State or Federal agency certification purposes within the last five years. The material testing requirements are as follows:
            a) Minimum Specific Gravity 2.5 per (ASTM C127).
            b) Durability Absorption Ratio less than 10 fails, greater than 23 passes, between 10 and 23 passes only if the Durability Index is greater than 52.
               (1) Durability Absorption Ratio = Durability Index / (PCT Absorption+1), Durability Index test ASTM D3744, Absorption test ASTM C127
            c) Maximum of 1% loss due to Wetting and Drying test ASTM D5313/D5313M.
            d) Maximum of 5% loss due to Freeze Thaw test ASTM D5312/D5312M.
      b. Ability of rock to perform.
         1) The Contractor may propose to use material from a source that has a documented track record of acceptable performance for comparable applications and exposure conditions. If requesting approval of materials using this method, provide the following information for the Engineer to review to determine if the riprap is of acceptable quality:
            a) As-built plans for a project where riprap has been in place a minimum of 20 years.
            b) Documentation of the riprap material source.
            c) Installation performance data.
            d) Available material testing data.
            e) Maintenance records for the riprap installation.
            f) Recent photos of riprap installation.
            g) Contact information for the Owner of the project.
         2) The Engineer shall review the provided information to determine whether the in place material was subjected to conditions expected for the project and if the rock performed satisfactorily as determined by the Owner and Engineer.
         3) A minimum of two months shall be allowed after the information has been submitted by the Contractor for review of data with the Owner, a site visit, and material determination.

# PART 3 - EXECUTION

## 3.1 MATERIAL ACCEPTANCE

A. Final acceptance is determined at the in-place riprap installation which shall consist of a homogenous mass with a distribution of rock sizes that meets the specified gradation. Riprap transport, handling, and placement methods shall not cause breakage of individual rocks or segregation of riprap gradation.

B. Rock quality shall be determined at the quarry. Stone with a coloration or appearance dissimilar to the accepted material shall be rejected.

C. A representative gradation sample shall be located adjacent to the stockpile locations at both the quarry and project stockpile area for the duration of the project.

D. Arriving loads of material not bearing reasonable similarity to the representative gradation sample shall be rejected. The Contractor may arrange for gradation measurements of rejected loads at the project site. If the analysis proves the rejected stone meets the project requirements, then the Contractor shall be reimbursed for the gradation measurements.

E. The representative gradation sample must be of adequate size to demonstrate compliance with the specified gradation. The Contractor may use test Method A or B as defined in ASTM D5519 to determine the gradation. The minimum sample size shall be 20 times the largest individual stone of the gradation, unless a smaller sample size is approved by the Engineer.

F. The gradation test shall be performed by the Contractor or qualified geotechnical testing company, with the Engineer present, for each class of installed riprap and repeated for every 50,000 tons of placed material. If the gradation of installed riprap is questioned, then the Engineer may use ASTM D5519 Test Method D to determine if the installed material meets the specification.

G. The riprap gradation shall be produced at the quarry and shall not be accomplished by mixing at the project site.

H. The representative gradation sample may be incorporated into the project during final placement upon notification and approval by the Engineer.

## 3.2 STOCKPILE AREAS

A. Riprap stockpiles shall be a maximum of 12 FT high and placed so rock does not roll down the slope. The stockpile areas shall have a compacted surface with a minimum 6 IN thick sand-clay-gravel or crushed stone pad to provide for storage of riprap without fines being introduced to the riprap gradation. Any riprap or stone which has become contaminated with topsoil, fines, or debris shall not be used unless the contaminating material has been removed from the riprap prior to placement at no additional cost the Owner.

## 3.3 PLACEMENT

A. Subgrade:
   1. Compact fill areas to density specified for backfill in accordance with Specification Section 31 23 00 - Earthwork.
   2. Grade subgrade to elevations indicated in the plans within plus or minus 0.1 FT in dry areas and ±0.3 FT in areas that are underwater and do not require dewatering for construction.
   3. The subgrade shall be smooth and free of topsoil, organic material, roots, sticks, debris, yielding material or other materials that would prevent meeting the specified subgrade elevation tolerance.
   4. The Contractor, at no additional cost to the Owner, may decide to not grade the subgrade to the specified tolerance and increase the riprap layer thickness. The lack of subgrade preparation shall not result in a decreased riprap layer thickness or change in the top of riprap elevation unless the change is requested in writing and approved in writing by the Engineer.

B. Geotextile Fabric:
   1. Place geotextile fabric only after inspection of subgrade by Engineer.
   2. Place geotextile fabric in accordance with manufacturer specifications.
   3. The ends of the geotextile fabric shall be buried and the placement sequence shall result in overlaps, with the upstream fabric overlapping the downstream fabric.
   4. Fabric must be secured using pins or weights to prevent displacement by water, wind, or riprap placement.
   5. Place a protective aggregate bedding layer over the geotextile fabric prior to placement of riprap to protect against punctures or tearing of the fabric.

C. Riprap:
   1. Place riprap on prepared bedding only after the Engineer has reviewed the work.

2. Place riprap on prepared foundation per line and grade shown on the plans. The riprap thickness tolerance is +0.5 FT and -0 FT as measured over an area of 200 SQFT when placed in the dry, and 400 SQFT when placed underwater.
3. Riprap material shall be placed to result in a homogenous mass with a minimum of voids. Rearranging of individual rock may be required to obtain a suitable distribution of rock sizes.
4. Riprap placement methods shall not result in the following: cause breakage of individual rocks, result in segregation of riprap gradation, result in introduction of fines, or impact the filter material.
5. Individual stones making up the riprap shall not be dropped from a height greater than 1 FT above the geotextile, unless it can be demonstrated to the satisfaction of the Engineer that the geotextile fabric will not be damaged.
6. When placing riprap on a slope, start placement from the bottom of slope and proceed to top of slope.
7. Place rock to full thickness in a single operation to avoid displacing the underlying material.
8. The top of riprap shall match adjoining grades and allow for positive drainage.
9. Maintain the riprap until acceptance at project completion.

## PART 4 - MEASUREMENT AND PAYMENT

### 4.1 METHOD OF MEASUREMENT

A. Survey:
   1. Provide surveys of the preconstruction surface, interim condition, and post construction as defined below. The survey shall be on the same horizontal and vertical control as the project plans.
   2. Pre-Construction:
      a. A pre-construction survey shall be submitted prior to the start of geotextile placement following clearing and grubbing for the area where construction is expected to occur for the next 30 days. The submittal shall include paper copies, an edited point file of the horizontal and vertical survey data, and an AutoCAD file. The survey shall consist of cross sections at 100 FT spacing with enough survey shots to define the break lines with survey shots every 25 FT at a minimum.
   3. Interim Condition:
      a. An Interim Condition survey shall be performed at a minimum of every two weeks where material is being placed to verify construction is per plan and define the subgrade fill (if applicable), granular bedding thickness, granular bedding volume, riprap thickness, and riprap volume. Only the sections altered during the two week time frame need to be included in the Interim Condition survey and shall include the surface following clearing and grubbing, water levels (if applicable), pay items, and plan surfaces for pay items. The cross sections and plan view of the surveyed area shall be submitted to the Engineer within one week of completion of the survey with paper copies, an edited point file of horizontal and vertical survey data, and an AutoCAD file.
   4. Post Construction:
      a. A post construction survey shall be submitted within two weeks of completion of riprap placement. Provide cross sections of the placed material and plan surfaces on the same axis, scale, and spacing as the construction plan set and volume difference between the pre-construction and post construction surface calculated to the nearest CUYD by the average end volume method. The placed and plan surfaces shall have different line types. The area in SQFT between the pre and post construction surfaces shall be listed on each cross section.

OR

Rock rip rap will not be measured for payment and payment will be by neat line to the thickness shown in the plans for the accepted work. If the riprap thickness is changed and approved in writing by the Engineer, a mutually agreed pre-determined payment amount will be determined prior to the work being performed.

Additional riprap volume due to inaccurate subgrade or bedding preparation will be at the Contractor's expense. Truck tickets for material delivered to

**END OF SECTION**

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# SECTION 31 66 16
SPECIAL FOUNDATION WALLS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Leveling pad.
   2. Granular backfill.
   3. Soil stabilizing and reinforcing straps.
   4. Wall Drain.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 31 19 Project Meetings
   4. Section 01 33 00 Submittals
   5. Section 31 32 19 - Geotextile
   6. Section 32 91 13 – Topsoiling and Finished Grading
   7. Section 33 41 00 - Subdrainage.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M284, Standard Specification for Epoxy Coated Reinforcing Bars.
      b. T23, Standard Specification for Making and Curing Concrete Test Specimens in the Field.
      c. T27, Standard Specification for Sieve Analysis of Fine and Coarse Aggregates.
      d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
      e. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 LB) Rammer and a 305 MM (12 in.) Drop.
      f. T104, Standard Specification for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
      g. T141, Standard Specification for Sampling Freshly Mixed Concrete.
      h. T152, Standard Specification for Air Content of Freshly Mixed Concrete by the Pressure Method.
      i. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
      j. T231, Standard Specification for Capping Cylindrical Concrete Specimens.
      k. T236, Standard Specification for Direct Shear Test of Soils under Consolidated Drained Conditions.
   2. ASTM International (ASTM):
      a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
      b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      d. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
      e. A497/A497M, Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.

f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
g. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
h. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
i. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
j. C150, Standard Specification for Portland Cement.
k. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
l. D512, Standard Test Methods for Chloride Ion in Water.
m. D516, Standard Test Method for Sulfate Ion in Water.
n. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-lbf/ft3 (600 kN-m/m3)).
o. D1004, Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
p. D1204, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
q. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
r. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-lbf/ft3 (2,700 kN-m/m3)).
s. D2729, Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
t. D2922, Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
u. D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
v. G51, Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.
w. G57, Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

3. National Institute of Building Sciences (NIBS):
   a. U. S. National CAD Standard.
4. Precast/Prestressed Concrete Institute (PCI):
   a. MNL-116S, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
   b. MNL-120, PCI Design Handbook - Precast and Prestressed Concrete.
   c. MNL-123, Design and Typical Details of Connections for Precast and Prestressed Concrete.
5. Construction standards: State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date

B. Perform precast work in accordance with requirements of PCI MNL-116S, PCI MNL-123, PCI MNL-120.

C. Fabricate structural steel in accordance with AASHTO S99-HB.

D. Perform Work in accordance with State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

E. .

## 1.3 DEFINITIONS

A. Soil Stabilizing Strap - Shop fabricated hot rolled steel strap to positively connect facing panels to compacted structural backfill.

B. Reinforced Backfill - Compacted granular structural fill placed over soil stabilizing straps and behind precast facing panels as indicated on Drawings.

## 1.4 SYSTEM DESCRIPTION

A. Mechanically Stabilized Earth Wall System: Battered wall of stepped height formed from precast concrete facing panels in straight curved configuration on concrete leveling pad with soil reinforcement elements mechanically fastened to each facing panel to anchor wall.

B. Prefabricated Modular Retaining Walls: A basic gravity Retaining Wall System type composed of solid or hollow prefabricated concrete or steel modules. Hollow modules are typically backfilled with Granular Material. Prefabricated modular retaining walls include metal and precast concrete bin, precast concrete crib, gabion, dry cast concrete block, and wet cast concrete block gravity retaining walls.

## 1.5 DESIGN REQUIREMENTS

A. General:
   1. It is the Contractor's responsibility to coordinate the wall installation and the supporting tieback or straps with surrounding utilities and other improvements.
   2. Do not change indicated horizontal and vertical alignment of retaining walls, except as specified in this section.
   3. Design retaining walls to be within specified limits of allowable foundation bearing pressures.
   4. Allow for weep hole in every other precast face panel exposed at ground elevation as indicated.
   5. Design soil stabilization and reinforcement strips for 100 year service life.

B. Successful wall system manufacturer/contractor are required to provide design for all modular concrete walls.

C. The retaining wall design engineer (contracted by the general contractor) shall affirm in writing that he or she has personally supervised the design of the retaining wall for the project, that the design considers all the design requirements of this specification, and that he or she accepts responsibility as the design engineer of record.

D. Provide engineering design performed by registered engineer, licensed to practice structural engineering in the state of Oregon.

E. Dead Loads for Wall:
   1. Unit Weight of Concrete: 150 PCF.
   2. Unit Weight of Backfill Material: 130 PCF.
   3. Equivalent Fluid Earth Pressure: 34PSF/FT.

F. Foundation Data for Wall:
   1. Allowable Bearing Pressure: 3KSF.
   2. Lateral Design Pressure: 54PSF/FT.
   3. Design Sliding Coefficient: 0.4.

G. Seismic Design Criteria:
   1. Maximum Ground Acceleration: 0.34 G.

## 1.6 PERFORMANCE REQUIREMENTS

A. Design walls for locations and to overall dimensions shown on Drawings utilizing specified backfill and foundation parameters.

B. Use no experimental or demonstration-type design concepts; or products, structures, or elements not preapproved by Architect, in design.

## 1.7 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:
   1. Temporary Support System: Detail specific load bearing falsework, underpinning, needling, or shoring layout and support members appropriate for Project conditions.

C. Design Data: Submit the following signed and sealed by professional engineer.
   1. Calculations for mechanically stabilized earth wall including size, loadings and stresses of leveling pad, precast facing panels, anchors, connections, and soil stabilizing strips in accordance with design requirements.
   2. Submit details and computations for any required temporary shoring, bracing and temporary support of excavation.

D. Test Reports: Indicate certified tests results for precast concrete at manufacturing facility, cast-in-place concrete in field, pullout strength of reinforcing strips, granular backfill.

E. Manufacturer's Installation Instructions: Submit installation instructions including construction sequence including the following information:
   1. Excavation and required bracing.
   2. Placement of leveling pad.
   3. Placement of precast concrete facing panels.
   4. Placement of backfill with soil stabilizing reinforcement straps.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate field observations and conclusions as to compliance to specifications, action items, and resolution of installation issues.

## 1.8 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual elevation of undercut base, if any, and foundation elevation and position.

## 1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing mechanically stabilized earth wall systems with minimum three years experience.

B. Installer: Company specializing in performing work of this section with minimum five years experience].

## 1.10 PRE-INSTALLATION MEETINGS

A. Section 01 31 19 - Project Meetings: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

## 1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install foundation or leveling pads when subgrade is wet or frozen.

B. Do not place concrete in forms or casting beds when ambient temperatures are below 50 DEGF (10 DEGC) or above 90 DEGF (32 DEGC).

## 1.12 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

## 1.13 COORDINATION

A. Section 01 31 19 - Project Meetings: Requirements for coordination.

B. Coordinate work with affected utility company and utility adjustments.

## PART 2 - PRODUCTS

### 2.1 FOUNDATION MATERIALS

A. Mechanically Stabilized Earth Wall System Aggregate Backfill: as specified in section 00596A.11 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

B. Prefabricated Modular Retaining Walls Aggregate Backfill: as specified in section 00596B.11 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

### 2.2 WALL SYSTEM MATERIALS

A. Furnish materials in accordance with the State of Oregon Standard Specification for Construction 2024, as amended to date.

B. Tie Strips: ASTM A1011/A1011M, Grade 50, hot dip galvanized.

C. Soil Stabilizing and Reinforcing Straps: ASTM A572/A572M Grade 65, hot dip galvanized.

### 2.3 GRANULAR BACKFILL SYSTEM

A. Mechanically Stabilized Earth Wall System Aggregate Backfill: as specified in section 00596A.11 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

B. Prefabricated Modular Retaining Walls Aggregate Backfill: as specified in section 00596B.11 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

### 2.4 ACCESSORIES

A. Fasteners and Attachment Devices:
   1. High Strength Hexagonal Bolts and Nuts: ASTM A325; mechanically galvanized.
   2. Embed Loops: ASTM A82/A82M; steel wire. Weld in accordance with ASTM A185/A185M, galvanized.
   3. Connector Bar: ASTM A82/A82M; steel wire; galvanized.
   4. Connector Pins: ASTM A36/A36M; steel; galvanized.

B. Joint Filler:
   1. Vertical Joint Filler: Flexible open cell polyurethane foam strip filler for vertical joints between panels.
   2. Horizontal Joint Filler Between Panels: ASTM D2000 preformed EPDM rubber pads or neoprene elastomeric pads having a Durometer Hardness of 80 plus or minus 5, or ASTM D1505 preformed high density polyethylene panel pads with a minimum density of 0.55 oz/cu in. (0.946 mg/cu mm).

C. Magnetically Detectable Identification Tape:
   1. Three inches wide polyethylene, suitable for direct burial with fade resistant colors, yellow background with black letters to read "Buried Reinforcing Strap", magnetically detectable.

### 2.5 MIXES - PRECAST FACING PANELS

A. Concrete Mix:
   1. Compressive Strength: ASTM C39/C39M; minimum 6,000 PSI (41 MPa) at 28 days.
   2. Air Content: ASTM C231, 6.5% in plastic state within a tolerance of plus or minus 1.5%.
   3. Water - Cement Ratio: 0.35.

### 2.6 FABRICATION

A. Use rigid molds, constructed to maintain precast unit uniform in shape, size, and finish.

B. Casting. Cast panels on flat area, front face of form at bottom. Set connection guides on rear face. Do not attach panel reinforcing steel to or allow contact with embed loops, tie strips, reinforcing steel or other devices. Hold attachment devices in place during concrete placement to maintain proper alignment. Place concrete in each unit without interruption and consolidate by use of vibrator; supplement by hand tamping as may be necessary to force concrete into corners of forms and prevent formation of honeycomb segregation, cracking or cleavage planes.
   1. Set tie straps for stabilizing elements, reinforcement bars, connecting pins and PVC tubes and handling devices in place to dimensions and tolerances indicated on shop drawings.
   2. Provide 6 IN (150 MM) minimum thickness for panels.
   3. Provide 3 IN (75 MM) minimum cover to reinforcing.

C. Shop fabricate reinforcement straps of hot rolled steel. Hot roll reinforcing straps from bars, conforming to ASTM A36/A36M or ASTM A572/A572M Grade 65, to required shape and dimensions. Hot dip galvanize reinforcing strips and tie straps after fabrication. Cut to length and tolerances indicated on shop drawings. Punch holes for bolts in location shown before galvanizing.

D. Fabricate connector pins to required diameters, lengths, thread lengths, and welded connections.

E. Curing. Cure facing panel units using water and burlap and for period of time required for concrete to obtain specified minimum compressive strength and 3 days minimum. Control curing until achieving a compressive strength of 4500 PSI (31 MPa).

F. Marking. Clearly scribe or paint with waterproof paint on rear face of each panel date of manufacture, lot production number, piece mark, and inspection date and stamp.

G. Fully support units until concrete obtains a minimum compressive strength of 3,500 PSI (241 MPa).

## 2.7 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Angular Distortion with Regard to Height. Do not exceed 0.2 IN in 5 FT.
   2. Panel Dimensions. Position panel connection devices within one inch and meet other dimensions within 3/16 IN.
   3. Panel Squareness. Determine by difference between two diagonals not to exceed 1/2 IN (13 MM).
   4. Panel Surface Finish. Measure surface defects on smooth formed surfaces measured over a length of five feet not to exceed 1/8 IN and over textured finished surfaces not to exceed 5/16 IN.
   5. Alignment of Bearing Surfaces of Embedded Wire Loops, and Depth of Placement of Loops in Panels: Plus or minus 1/32 IN maximum variation.

B. Testing and Inspection. Sample and test precast panels including slump, unit weight, temperature, entrained air in concrete mixture, and compression.

C. Sample and test concrete panels with respect to compressive strength on the basis of production lot results. Define production lot as panels a single compressive test result represents from one day's production or 20 panels, whichever is less. Select four cylinders per lot in accordance with AASHTO T141. Cure and test cylinders per AASHTO T231. Base compression test result on average of 2 cylinders, with no compressive strength result less than 5,400 PSI 90% of design strength.

D. Make completed precast panels available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least seven days before inspection is allowed.

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION

A. Mechanically Stabilized Earth Wall System Contstruction: as specified in sections 00596A.40, 00596A.41, 00596A.42, 00596A.43, 00596A.44, 00596A.45, 00596A.46, 00596A.47 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

B. Prefabricated Modular Retaining Walls Construction: as specified in sections 00596B.40, 00596B.41, 0059BA.42, 00596B.43, 00596B.44, 00596B.45, 00596B.46, 00596B.47 of the State of Oregon, Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

### 3.2 REPAIR/REPLACEMENT

A. Replace units that suffer damage in erecting or backfilling or any element that cannot be placed satisfactorily in wall.

### 3.3 FIELD QUALITY CONTROL

A. Erection Tolerances:
   1. Maximum Variation From Plane: 3/4 IN (19 MM) for vertical tolerances and horizontal alignment tolerances when measured along a 10 FT (3 M) straightedge.
   2. Maximum Allowable Offset in Any Panel Joint: 3/4 IN (19 MM).
   3. Maximum Variation From Plumb: 1/2 IN per 10 FT (13 MM per 3 M) of wall height for overall vertical tolerance of wall (top to bottom).

B. Perform site-specific field or laboratory pullout tests for fully saturated conditions in presence of Engineer.

C. Compaction Tests:
   1. Compaction Testing: In accordance with AASHTO T99.
   2. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
   3. Frequency of Compaction Testing: Two for each lift.

### 3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish manufacturer's representative at Project site to assist Contractor, and Architect until they are familiar with and confident in installation, and construction procedures.

B. Furnish monthly visits to Project site by manufacturer's representative during wall construction.

## END OF SECTION

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# DIVISION 32

## EXTERIOR IMPROVEMENTS

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# SECTION 32 12 16
## ASPHALTIC CONCRETE VEHICULAR PAVING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Asphaltic concrete vehicular paving.
   2. Line painting.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Federal Specifications (FS):
      a. TT-P-1952F, Paint, Traffic and Airfield Marking, Waterborne.
   2. Construction standards: State of Oregon, Department of Transportation, Oregon Standard Specification for Construction 2024, as amended to date.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Asphalt design mix.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Asphaltic Concrete: Perreferenced construction standards.

B. Line Paint:
   1. Nonreflective.
   2. White
      .

### 2.2 MIXES

A. Comply with mix design per Oregon Standard Specification for Construction, 2024 as amended to date.

## PART 3 - EXECUTION

### 3.1 APPLICATION

A. Construct to line, grade and section as shown on Drawings and in accordance with referenced Oregon Standard Specifications for Construction 2024.

B. Install a 6 IN compacted layer of aggregate base course, in accordance with the referenced State Specifications.

C. Install a 2 IN compacted layer of aggregate top course, in accordance with the referenced State S pecifications.

D. Tolerance of Finished Grade: +0.10 FT from required elevations.

**3.2 LINE PAINTING:**

A. Thoroughly clean surfaces which are to receive paint.

B. Dry completely before paint is applied.

C. Do not paint until minimum of five days has elapsed from time surface is completed.
   1. A longer period may be required if directed by Engineer.

D. Do not apply paint over wet surfaces, during wet or damp weather, or when temperature is below 40 DEGF.

E. Lay out markings and striping in accordance with Drawings.
   1. Width of painted lines: 4 IN.

**END OF SECTION**

# SECTION 32 15 40
## CRUSHED STONE SURFACING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Crushed Stone surfacing.
      a. Drainage outflow area.
      b. Slope rip rap.
      c. Roadways
      d. Other areas indicated and shown on the Drawings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 22 00 - Site Grading.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Construction standards: State of Oregon Department of Transportation, "Oregon Standard Specification for Construction," 2024, as amended to date.

### 1.3 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Quality Control per referenced specification section 00641.15 of State of Oregon, Department of Transportation, Oregon Standard Specification for Construction.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Crushed Stone Surfacing per referenced Specification Section 00641.10 of State of Oregon, Department of Transportation, Oregon Standard Specification for Construction

### 2.2 SOURCE QUALITY CONTROL

A. Quality Control per referenced specification section 00641.15

## END OF SECTION

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# SECTION 32 16 23
## CONCRETE SIDEWALK AND STEPS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Concrete sidewalk and steps.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 31 30 - Concrete, Materials and Proportioning.
   4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   5. Section 03 05 05 – Concrete Testing and Inspection.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M153, Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
      b. M171, Sheet Materials for Curing Concrete.
      c. M182, Burlap Cloth Made from Jute or Kenaf.
      d. M213, Preformed Expansion Joint Fillers for Concrete Paving and Structure Construction (Nonextruding and Resilient Bituminous Types).
      e. M224, Use of Protective Sealers for Portland Cement Concrete.
      f. M233, Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
   2. American Concrete Institute (ACI):
      a. 305R, Hot Weather Concreting.
      b. 306R, Cold Weather Concreting.
   3. ASTM International (ASTM):
      a. A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
      b. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      c. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      d. C33, Standard Specification for Concrete Aggregates.
      e. C150, Standard Specification for Portland Cement.
      f. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT$^3$).
      h. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      i. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   4. Federal Specification (FS):
      a. SS-S-1614, Sealants, Joint, Jet-Fuel-Resistant, Hot-Applied for Portland Cement and Tar Concrete Pavements.
      b. TT-S 00227 E(3), Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).

5. Concrete installer shall have successfully completed at least three other projects of similar size and type.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Mix design(s) in accordance with Specification Section 03 31 30 and Specification Section 03 05 05.
   4. Qualifications of concrete installer.
   5. Drawings detailing all reinforcing.
   6. Concrete cylinder test results from field quality control.

B. Samples:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Samples of fabricated jointing materials and devices.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Chemical admixtures:
      a. Sika Chemical Corporation.
      b. BASF Admixtures, Inc.
      c. Protex Industries.
      d. W. R. Grace and Company.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Portland Cement:
   1. ASTM C150, Type I or II.

B. Aggregates:
   1. ASTM C33, gradation size #67, 3/4 IN to #4.

C. Water:
   1. Potable quality.

D. Admixtures:
   1. Comply with Specification Section 03 31 30.

E. Reinforcing Bars:
   1. ASTM A615, Grade 60.

F. Welded Wire Reinforcement:
   1. ASTM A185 or ASTM A1064.
   2. Flat.
   3. Clean, free from dirt, scale, rust.

G. Preformed Joint Filler:
   1. Nonextruding cork, self-expanding cork, sponge rubber or cork rubber.
   2. Meet AASHTO M153 or AASHTO M213.

H. Hot-Poured Joint Sealing Material:
   1. FS SS-S-1614.

I. Sidewalk Joint Sealant:
   1. Two compound, polyurethane sealant.
   2. Class A, Type 1.
   3. Self-leveling.
   4. Nontracking.
   5. FS TT-S 00227 E(3).

J. Membrane Curing Compound:
   1. ASTM C309.

K. Cover Materials for Curing:
   1. Burlap:
      a. AASHTO M182.
      b. Minimum Class 2, 8 OZ material (1 YD x 42 IN).
   2. Polyethylene film:
      a. AASHTO M171.

L. Paper Subgrade Cover:
   1. Polyethylene film, AASHTO M171.

M. Concrete Treatment:
   1. Boiled linseed oil mixture.
   2. Meets AASHTO M233.

N. Forms:
   1. Steel or wood.
   2. Size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment.
   3. Free of distortion and defects.
   4. Full depth.
   5. Metal Side Forms:
      a. Minimum 7/32 IN thick.
      b. Depth equal to edge thickness of concrete.
      c. Flat or rounded top minimum 1-3/4 IN wide.
      d. Base 8 IN wide or equal to height, whichever is less.
      e. Maximum deflection 1/8 IN under center load of 1700 LBS.
      f. Use flexible spring steel forms or laminated boards to form radius bends.

### 2.3 MIXES

A. Mix design per Construction Standards: State of Oregon, Department of Transportation, "Oregon Standard Specifications for Construction", 2024 Edition, as amended to date..

B. Comply with Specification Section 03 31 30 and Specification Section 03 31 31.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Subgrade Preparation:
   1. Prepare using methods, procedures, and equipment necessary to attain required compaction densities, elevation and section.
   2. Scarify and recompact top 6 IN of fills and embankments which will be sidewalk and step areas.
   3. Remove soft or spongy areas.
      a. Replace with aggregate material.
   4. Compact to the following densities:

a. Cohesive soils: 95 PCT per ASTM D698.
b. Noncohesive soils: 75 PCT relative per ASTM D4253 and ASTM D4254.

5. Assure moisture content is within limits prescribed to achieve required compaction density.
6. Following compaction, trim and roll to exact cross section.
   a. Check with approved grading template.
7. Perform density tests on subgrade to determine that subgrade complies with the specification.

B. Aggregate Course:
1. Place material in not more than 6 IN thick layers.
2. Spread, shape, and compact all material deposited on the subgrade during the same day.
3. Compact to 75 PCT relative per ASTM D4253 and ASTM D4254.

C. Loose and Foreign Material:
1. Remove loose and foreign material immediately before application of paving.

D. Appurtenance Preparation:
1. Block out or box out curb inlets and curb returns.
2. Provide for joint construction as detailed and dimensioned on Drawings.
3. Adjust manholes, inlets, valve boxes and any other utility appurtenances to design grade.
   a. Secure to elevation with concrete.
   b. Place concrete up to 5 IN below design grade.
4. Clean and oil forms.

## 3.2 ERECTION, INSTALLATION AND APPLICATION

A. Concrete Production:
1. Comply with Specification Section 03 31 31.

B. Forms:
1. Form support:
   a. Compact soil foundation and cut to grade to support forms.
   b. Use bearing stakes driven flush with bottom of form to supplement support as necessary.
   c. Do not use earth pedestals.
2. Staking forms:
   a. Joint forms neatly and tightly.
   b. Stake and pin securely with at least three pins for each 10 FT section.
3. Clean and oil forms prior to placement of concrete.
4. Set forms sufficiently in advance of work (minimum 2 HRS) to permit proper inspection.
5. Previously finished pavement or curb and gutter contiguous with new work may serve as side form when specifically approved.

C. Reinforcing:
1. Lap mats one full space.
2. Tie end transverse member of upper mat securely to prevent curling.
3. Lap nonwelded bars 12 IN minimum.
4. Support:
   a. Place bars securely on chairs at called-for height.
   b. Place other fabric on the first of a two-course pour and cover promptly with final pour, or place fabric by a fabric-placer if procedure is reviewed and approved by Engineer.

D. Joints:
1. Hold locations and alignment to within + 1/4 IN.
2. Finish concrete surface adjacent to previous section to within + 1/8 IN, with tooled radius of 1/4 IN.
3. Metal keyway joints:
   a. Form by installing metal joint strip, left in place.
   b. Stake and support like side form.

c. Provide dowels or tie bars.

4. Weakened plane joints:
   a. Locate at 6]FT intervals.
   b. Tool groove in freshly placed concrete with tooling device.
   c. Groove dimensions shall be 3/8 IN at surface and 1/4 IN at root.
5. Install construction joints at end of day's work or wherever concreting must be interrupted for 30 minutes or more.
6. Expansion joints:
   a. Locate at 48 FT intervals and at all intersection curb returns.
   b. Stake in place load transfer device consisting of dowels.
   c. Supporting and spacing means and premolded joint filler as per Drawing details.
   d. Provide preformed joint filler at all junctions with existing sidewalks, steps, or other structures.
7. Thoroughly clean and fill joints with joint sealing material as specified.
8. Upper surface of filled joint to be flush to 1/8 IN below finish surface.

E. Place Concrete:
   1. Comply with Specification Section 03 31 31.
   2. Construct driveway openings and other features as per Drawing details.

F. Cold and Hot Weather Concreting:
   1. Cold weather:
      a. Cease concrete placing when descending air temperature in shade falls below 40 DEGF.
      b. Do not resume until ambient temperature has risen to 40 DEGF.
      c. If placing is authorized below 40 DEGF by Engineer, maintain temperature of mix between 60 and 80 DEGF.
      d. Heat aggregates or water or both.
      e. Water temperature may not exceed 175 DEGF.
      f. Aggregate temperature may not exceed 150 DEGF.
      g. Remove and replace frost damaged concrete.
      h. Salt or other antifreeze is not permitted.
      i. Comply with ACI 306R.
   2. Hot weather:
      a. Cease concrete placing when plastic mix temperature cannot be maintained under 90 DEGF.
      b. Aggregates or water or both may be cooled.
      c. Cool water with crushed ice.
      d. Cool aggregates by evaporation or water spray.
      e. Never batch cement hotter than 160 DEGF.
      f. Comply with ACI 305R.

G. Finishing:
   1. As soon as placed, strike off and screed to crown and cross section, slightly above grade, so that consolidation and finishing will bring to final Drawing elevations.
   2. Maintain uniform ridge full width with first pass of first screed.
   3. Test with 6 FT straightedges equipped with long handles and operated from sidewalk.
   4. Draw excess water and laitance off from surface.
   5. Float finish so as to leave no disfiguring marks but to produce a uniform granular or sandy texture.
   6. Broom finish after floating.
   7. Tool edges with suitable edger.
   8. Provide exposed aggregate surfaces in areas indicated on the Drawings.
   9. Provide method such as abrasive blasting, bush hammering, or surface retarder acceptable to the Engineer.

H. Curing:

1. Apply membrane curing compound complying with ASTM C309, and in accordance with manufacturer's directions but at a rate of minimum 200 SQFT per gallon.
2. Apply curing compound within 4 HRS after finishing or as soon as surface moisture has dissipated.
3. Cure for minimum of seven days.
4. When average daily temperature is below 50 DEGF, provide insulative protection of 12 IN minimum thickness loose dry straw, or equivalent, for 10 days.
5. Linseed oil sealant:
    a. For concrete sidewalk and step, seal surface with linseed oil.
    b. Apply linseed oil to clean surface as per AASHTO M224 after concrete has cured for 1 month.
    c. Apply first application at rate of 67 SQYD per gallon.
    d. Apply second application to a dry surface at rate of 40 SQYD per gallon.

I. Protection of Concrete:
1. Protect new sidewalk, steps, and their appurtenances from traffic for a minimum of 14 days.
2. Repair or replace parts of sidewalk and steps damaged by traffic, or other causes, prior to final acceptance.

J. Opening to Traffic:
1. After 14 days, area may, at Owner's discretion, be opened to traffic if job cured cylinders have attained a compressive strength of 3000 LBS per square inch when tested in accordance with ASTM standard methods.
2. Prior to opening to traffic, clean and refill joints as required with specified filler material.

K. Clean Up:
1. Assure clean-up work is completed within two weeks after sidewalk has been opened to traffic.
2. No new work will begin until clean-up work has been completed or is maintained within 2 weeks after sidewalk has been opened to traffic.

L. Handrails:
1. Provide handrails where required and as per Drawing details.

**END OF SECTION**

# SECTION 32 31 13
## CHAIN LINK FENCE AND GATES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Chain link fencing and gates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 00 - Earthwork.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
      c. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence.
      d. F552, Standard Terminology Relating to Chain Link Fencing.
      e. F567, Standard Practice for Installation of Chain-Link Fence.
      f. F626, Standard Specification for Fence Fittings.
      g. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
      h. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
      i. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
   2. American Welding Society (AWS).
   3. National Fire Protection Association (NFPA):
      a. NFPA 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL).
      a. UL 325 Door, Drapery, Gate, Louver, and Window Operators Systems

B. Qualifications:
   1. Installer bonded and licensed in the Project state.
   2. Installer shall have a minimum two years experience installing similar fencing.
   3. Utilize only AWS certified welders.
   4. Electric gate operators to be UL listed.
   5. Grounding by an electrician licensed in Project state.
   6. Electric vehicular slide gate operators:
      a. UL Listed.
      b. Installer: A minimum of three years experience installing similar equipment.
      c. Grounding by an electrician licensed in the State of Oregon.
      d. Operators shall be built to UL325 standards and be listed by a NRTL testing laboratory. Complete all electrical work according to local codes and National Electrical Code. All field work shall be performed in a neat and professional manner, completed to journeyman standards.
      e. Current safety standards require the use of multiple external sensors to be capable of reversing the gate in either direction upon sensing an obstruction.
      f. Usage classes: Classes I-IV.

### 1.3 DEFINITIONS

A. See ASTM F552.

B. NPS: Nominal pipe size, in inches.

C. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
   4. Mill certificates.
   5. Source quality control test results.
   6. Automatic gate system:
      a. Electrical circuitry and control wiring.
      b. Detector loop layout.
      c. Locking plan.

## PART 2 - PRODUCTS

### 2.1 COMPONENTS

A. Chain Link Fabric per Contract Plans

B. selvage Concrete:
   1. ASTM C150 Type I.
   2. 1 IN maximum size aggregate (ASTM C33).
   3. Clean water.
   4. Minimum 28-day compressive strength of 2500 PSI.
   5. Not less than four sacks of cement per cubic yard.
   6. 3 IN minimum slump.
   7. 2 to 4 PCT entrained air.

C. Line Post:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 2-1/2.

D. Corner or Terminal Post:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 4.

E. Brace and Rails:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 1-1/4.

F. Tension Wire:
   1. Top and bottom of fabric:
      a. ASTM A824, galvanized steel, Class 3.

G. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):

1. ASTM F626.

H. Swing Gate:
   1. ASTM F900.
   2. Materials as specified for fence framework and fabric.
   3. Hardware:
      a. Galvanized per ASTM A153/A153M.
      b. Hinges to permit 90 DEG in and out gate opening.

I. Electric Vehicular Gate Operators:
   1. Pre-wired, self-contained, gate operator, including all selected attachments and accessory equipment.
      a. Operation:
         1) Operator Type: vertical pivot lift gate.
      b. Vehicle detector loops for each side of the gate:
         1) Exit loop
         2) Inside safety loop.
         3) Outside safety loop.
      c. Access controls from external access control system:
         1) Access control system shall provide an open command, dry contact, to the operator.
         2) The gate shall automatically close at a preset time after the gate is opened.
         3) Gate shall stop upon sensing presence of vehicle in path of gate, proceed after an adjustable time delay of the following clearance of vehicle.
      d. Mechanical components:
         1) 1/3HP gear motor.
         2) High torque double reduction belt drive system.
         3) Duty cycle: continuous
         4) Spring assembly.
      e. Electrical components:
         1) Solid-state electronic motor drive system.
         2) All components shall have overload protection.
         3) Gearbox heater with thermostat.
         4) Controls:
            a) Entrapment sensor.
            b) "Warn before operate" system.
            c) Timer to close.
            d) Anti-tailgate mode.
            e) Power surge/lightning strike protection
            f) Integrated vehicle loop detectors.
         5) Input Power: 120Vac, 1-phase, 60 Hz.
         6) Input power disconnect switch.
         7) Operation time: 15 seconds maximum.
         8) Built-in backup batteries and battery charger system.
            a) Allows up to 1000 cycles from fully charged batteries.
         9) Photo electric sensors:
            a) Failsafe.
            b) If the photo beam is blocked the gate will stop and reopen. The gate will remain open until the obstruction is cleared.
            c) Secondary entrapment protection.
         10) Contact sensors.
         11) Reversing sensors, internal.
         12) Soft stop operation.
      f. Gate position limit switch:
         1) Industrial wide gap surface mount.
         2) High security biased.

3) Anodized aluminum cover.
4) Hermetically sealed reed switch.
5) Gap distance: 0.75 to 2.0 IN.
6) Three foot stainless steel armored cable.
7) Form C contact:
   a) Voltage: 30VC AC/DC maximum.
   b) Current: 0.25A maximum
   c) Power: 3.0 W maximum
8) Provide and use specific mounting hardware recommended by the switch manufacturer.

g. Provide wire and/or cable for the vehicle detector loops.
h. Functional description:
   1) The gates shall open when an open command is received from the access control system (card reader). The gates will automatically close after an adjustable time delay.
   2) The gates shall open when the Exit vehicle detector loop is activated and will automatically close after an adjustable time delay.
   3) The gates shall open when an open command is received from the Plant Control System (SCADA). The gates will remain open until the open command is removed. This contact is wired into the gate operator "FIRE" input.
i. Codes and regulatory requirements:
   1) Operators shall be built to UL325 and UL991 standards and be listed by a testing laboratory. Complete all electrical work according to local codes and National Electrical Code. All field work shall be performed in a neat and professional manner, completed to journeyman standards.

### 2.2 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:
   1. Posts and rails: ASTM F1043, Heavy Industrial.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with:
   1. Manufacturer's instructions.
   2. Lines and grades shown on Drawings.
   3. ASTM F567.

B. Do not start fence installation before final grading is complete and finish elevations are established.

C. Drill holes in firm, undisturbed or compacted soil.

D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.
   1. Correct minor irregularities in earth to maintain maximum clearance.

E. Space line posts at equal intervals not exceeding 10 FT OC.

F. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

G. Install tension bars full height of fabric.

H. Rails:
   1. Fit rails with expansion couplings of outside sleeve type.
   2. Rails continuous for outside sleeve type for full length of fence.

I. Provide expansion couplings in top rails at not more than 20 FT intervals.

J. Anchor top rails to main posts with appropriate wrought or malleable fittings.

K. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.
   1. Locate compression members at mid-height of fabric.
   2. Extend diagonal tension members from compression members to bases of posts.
   3. Install so that posts are plumb when under correct tension.

L. Pull fabric taut and secure to posts and rails.
   1. Secure so that fabric remains in tension after pulling force is released.
   2. Secure to posts at not over 15 IN OC, and to rails at not over 24 IN OC, and to tension wire at not over 24 IN OC.
   3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
   4. Bend ends of wire to minimize hazards to persons or clothing.

M. Install post top at each post.

N. Gates:
   1. Construct with fittings or by welding.
   2. Provide rigid, weatherproof joints.
   3. Assure right, non-sagging, non-twisting gate.
   4. Coat welds with rust preventive paint, color to match pipe.

O. Electric gate operators:
   1. Install electric gate operator in accordance with NFPA 70.
   2. Install per manufacturer's instructions.
   3. Install operator on concrete base.
   4. Install vehicle detector loops.

**END OF SECTION**

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# SECTION 32 91 13
## TOPSOILING AND FINISHED GRADING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Topsoiling and finished grading.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 10 00 - Site Clearing.
   4. Section 31 23 00 - Earthwork.
   5. Section 31 25 00 - Soil Erosion and Sediment Control.
   6. Section 32 92 00 - Seeding, Sodding and Landscaping.

C. Location of Work: All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work.

### 1.2 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Project Data: Test reports for furnished topsoil.

### 1.3 SITE CONDITIONS

A. Verify amount of topsoil stockpiled and determine amount of additional topsoil, if necessary to complete work.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Topsoil:
   1. Original surface soil typical of the area.
   2. Existing topsoil stockpiled under Specification Section 31 10 00.
   3. Friable, loamy soil capable of supporting native plant growth.
   4. Manufactured topsoil product that meets the following parameters:
      a. Standard Sieve Analysis per AASHTO T 88:

| Particle Size Range | Percent Retained (by Weight) |
|---|---|
| > 2" | 0 |
| 2" – 3/4" | 0 – 5 |
| 3/4" – No. 4 | 0 – 20 |
| < No. 4 | 0 - 100 |

      b. Of the fraction passing the No. 4 sieve, excluding organic material manufactured topsoil product shall conform to the following Hydrometer Analysis limits:

| Particle Size Range | Percent Retained (by Weight) |
|---|---|
| No. 4 – No. 200 | 5 – 7 (Retained) |
| No. 200 – 2 μm | 20 – 80 (Retained) |
| < 2 μm | 5 – 30 (Passing) |

   5. Manufactured topsoil product shall register at least 2 percent organic matter according to ASTM D2974.TOLERANCES

6. Finish Grading Tolerance: ±0.1 FT from required elevations.

B. Soil Conditioner:
   1. Commercially manufactured compost:
      a. Processed through thermophilic composting meeting the EPA's definition of "Process to Further Reduce Pathogens."
      b. From a commercial compost facility that holds a current Department of Environmental Quality (DEQ) composting permit or is registered with DEQ as a composting facility.
      c. Meets the requirements of the US Composting Council (USCC) and its Seal of Testing Assurance (STA) program.
      d. Contains a minimum 65 percent by volume of the following recycled plant wastes:
         1) Source-separated yard and garden wastes.
         2) Wood wastes.
         3) Agricultural crop residues.
         4) Wax-coated cardboard.
         5) Pre-consumer vegetative food wastes.
         6) Other similar source separated materials that the DEQ has determined to have a comparable low level risk in hazardous substances, human pathogens, and physical contaminants.
         7) Manure or biosolids based composts when approved.
      e. Meets the following compost particle size and media parameters:

| | Compost Type | |
|---|---|---|
| | Fine* | Medium* |
| Seive Size | Percent Passing (By Dry Weight) | |
| 3 IN | 100 | 100 |
| 1 IN | 99 – 100 | 95 – 100 |
| 3/4 IN | 99 – 100 | 95 – 100 |
| 5/8 IN | 95 – 100 | 90 – 100 |
| 1/2 IN | 80 – 100 | 70 – 100 |
| 1/4 IN | 75 – 100 | 70 – 90 |

* maximum 3 IN particle size

| Test | Test Method | Requirements |
|---|---|---|
| Physical Contaminants* | TMECC** 03.08-A | Less than 1.0% |
| Organic Matter | TMECC** 05.07-A | 35% (Minimum) |
| pH | TMECC** 04.11-A | 6.0 to 8.5 |
| Soluble Salt Concentration | TMECC** 04.10-A | 5 dS/m (Maximum) |
| Total Carbon (C) | TMECC** 04.02-D | < 25:1 C:N (Fine) |
| Total Nitrogen (N) | TMECC** 04.02-D | <30:1 C:N (Medium) |
| Stability | TMECC** 05.08-b | ≤ 8 |
| Maturity | TMECC** 05.05-A | 80% of Greater |
| Moisture Content | TMECC** 03.09-A | 35 – 60% (Wet Weight) |

* Man-made inert

** Test Methods for Evaluation of Compost and Composting

C.
   1.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Correct, adjust and/or repair rough graded areas.
   1. Cut off mounds and ridges.
   2. Fill gullies and depressions.
   3. Perform other necessary repairs.
   4. Bring all sub-grades to specified contours, even and properly compacted.

### 3.2 ROUGH GRADE REVIEW

A. Reviewed by Engineer in Specification Section 31 10 00.

### 3.3 SOIL PREPARATION

A. General:
   1. Limit preparation to areas which will be planted soon after.
   2. Provide facilities to protect and safeguard all persons on or about premises.
   3. Protect existing trees designated to remain.
   4. Verify location and existence of all underground utilities.
      a. Take necessary precaution to protect existing utilities from damage due to construction activity.
      b. Repair all damages to utility items at sole expense.
   5. Provide facilities such as protective fences and/or watchmen to protect work from vandalism.
      a. Contractor to be responsible for vandalism until acceptance of work in whole or in part.

B. Soil Preparation for Native Grass Seeding:
   1. Loosen surface to minimum depth of 4 IN.
   2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
   3. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
   4. Remove stones or other substances from surface which will interfere with turf development or subsequent mowing operations.
   5. Grade native grass seeding areas to a smooth, even surface with a loose, uniformly fine texture.
      a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
      b. Limit fine grading to areas which can be planted soon after preparation.
   6. Restore native grass seeding areas to specified condition if eroded or otherwise disturbed after fine grading and before planting.

C. Soil Preparation for Parking Lot Landscaping Plant Mix and #2 Cont. Trees:
   1. Loosen surface to minimum depth of 12 IN.
   2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
   3. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
   4. Add 3 IN thickness soil conditioner (Fine Compost) over subgrade and mix or rototill into subgrade to a depth of 12 IN.
   5. Add 12 IN thickness of Topsoil.
   6. Grade planting areas to a smooth, even surface with a loose, uniformly fine texture.
      a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
      b. Limit fine grading to areas which can be planted soon after preparation.

D. Soil Preparation for 1-1/2 IN Caliper Tree Planting Pits:
   1. Loosen surface to minimum depth of 24 IN.

2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
3. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
4. Add 3 IN thickness soil conditioner (Fine Compost) over subgrade and mix or rototill into subgrade to a depth of 12 IN.
5. Add 12 IN thickness of Topsoil.
6. Grade planting areas to a smooth, even surface with a loose, uniformly fine texture.
   a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.

E. Soil Preparation for Stream Restoration Plant Mix:
1. Loosen surface to minimum depth of 12 IN.
2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
3. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
4. Add 3 IN thickness soil conditioner (Fine Compost) over subgrade and mix or rototill into subgrade to a depth of 12 IN.
5. Grade stream restoration plant mix areas to a smooth, even surface with a loose, uniformly fine texture.
   a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
   b. Limit fine grading to areas which can be planted soon after preparation.

## 3.4 ACCEPTANCE

A. Upon completion of topsoiling, obtain Engineer's acceptance of grade and surface.

B. Make test holes where directed to verify proper placement and thickness of topsoil.

**END OF SECTION**

# SECTION 32 92 00
## SEEDING, SODDING AND LANDSCAPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Seeding, sodding and landscape planting:
      a. Soil preparation.
      b. Native grass seeding.
      c. Plants and planting.
      d. Maintenance of new and transplanted materials.
      e. Pruning and repairing existing trees.
      f. Replacement of dead or impaired materials at the end of the first growing season.
      g. Preparation of a maintenance plan for Owner.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 32 91 13 - Topsoiling and Finished Grading.
   4. Oregon Standard Specifications for Construction, 2024.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Nursery and Landscape Association/American National Standards Institute (ANLA/ANSI):
      a. Z60.1, American Standard for Nursery Stock.
   2. AOAC International (AOAC).
   3. ASTM International (ASTM):
      a. D2028, Standard Specification for Cutback Asphalt (Rapid-Curing Type).
      b. D5276, Standard Test Method for Drop Test of Loaded Containers by Free Fall.

B. Quality Control:
   1. Fertilizer:
      a. If Engineer determines fertilizer requires sampling and testing to verify quality, testing will be done at Contractor's expense, in accordance with current methods of the AOAC.
      b. Upon completion of Project, a final check of total quantities of fertilizer used will be made against total area seeded and landscaped.
      c. If minimum rates of application have not been met, Contractor will be required to distribute additional quantities to make up minimum application specified.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Signed copies of vendor's statement for seed mixture required, stating botanical and common name, place of origin, strain, percentage of purity, percentage of germination, and amount of Pure Live Seed (PLS) per bag.
      d. Type of herbicide to be used during first growing season to contain annual weeds and application rate.
      e. Source and location of plants and plant materials, as per Paragraph 3.3A.

3. Certification that each container of seed delivered will be labeled in accordance with Federal and State Seed Laws and equals or exceeds Specification requirements.

B. Samples:
   1. Mulch.

C. Maintenance Plan:
   1. Type written maintenance plan and schedule for Owner's use following Contractor's maintenance period.
   2. Submit prior to final acceptance.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Copies of invoices for fertilizer used on Project showing grade furnished, along with certification of quality and warranty.

### 1.4 SEQUENCING AND SCHEDULING

A. Installation Schedule:
   1. Provide schedule showing when trees, shrubs, groundcovers and other plant materials are anticipated to be planted.
   2. Show schedule of when native grass seeding areas are anticipated to be planted.
   3. Indicate planting schedules in relation to schedule for finish grading and topsoiling.
   4. Indicate anticipated dates Engineer will be required to review installation for initial acceptance and final acceptance.

B. Pre-installation Meeting:
   1. Meet with Engineer and other parties as necessary to discuss schedule and methods, unless otherwise indicated by Engineer.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS AND SUPPLIERS

A. Subject to compliance with the Contract Documents, the manufacturers and suppliers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Native Grass Seeding: Certified seed of locally adapted strains.
   1. Site Restoration Seeding:

| BOTANICAL NAME AND COMMON NAME | PERCENT BY WEIGHT |
|---|---|
| Festuca occidentalis (Western Fescue) | 2% |
| Festuca rubra (Red Fescue) | 8% |
| Festuca ovina (Sheep Fescue) | 3% |
| Poa sandbergii (Sandberg Bluegrass) | 4% |
| Sitanion hystrix (Squirrel-tail Grass) | 17% |
| Elymus glaucus (Wild Bluerye) | 28% |
| Bromus carinatus (California Brome) | 38% |

a. Recommended Seeding Rate: 12.36 LBS per 1 AC.
b. On grades greater than 40% (1V : 2.5 H), Site Restoration Seeding Mix may be applied in combination with cellulose mulch with tackifier at a rate of 200% of the recommended seeding rate.

2. Native Wet Area Mix:

| BOTANICAL NAME AND COMMON NAME | PERCENT BY WEIGHT |
|---|---|
| Carex densa (Dense Sedge) | 20% |
| Carex obnupta (Slough Sedge) | 35% |
| Eleocharis palustris (Creeping Spikerush) | 10% |
| Juncus patens (Spreading Rush) | 10% |
| Scirpus microcarpus (Small Fruited Bulrush) | 25% |

a. Recommended Seeding Rate: 10 LBS per 1 AC.

B. Mulch:
1. For native grass seeded areas:
a. Weed-free hay, excluding brome or bluegrass hay, used on slopes 4:1 or greater.
b. Hydraulically Applied Erosion Control Products (HECPs) made of natural plant fibers, unaltered by synthetic materials, and in a dry condition, free of noxious weeds, seeds, chemical printing ink, germination inhibitors, herbicide residue, chlorine bleach, rock, metal, plastic and other materials detrimental to plant life. HECPs shall be suitable for spreading with a hydroseeder. All HECPs shall be furnished premixed by the manufacturer with Organic Tackifier as specified in Paragraph 2.2C. The product shall be hydrated in accordance with the manufacturer's recommendations.
2. For tree, shrub and groundcover areas:
a. Arborist wood chip mulch, hardwood chips, shredded bark, or other material as approved by the Engineer.
3. For rock mulch areas:
a. Rock Mulch per Section 01040.20(d) of the Oregon Standard Specifications for Construction, 2024.

C. Organic Tackifier:
1. Organic tackifiers shall be derived from natural plant sources and shall not be harmful to plants, animals and aquatic life. Tackifier shall contain no growth or germination-inhibiting materials and shall not reduce infiltration rates. Tackifier shall hydrate in water and readily blend with other slurry materials. Tackifier shall include a mulch tracer added to aid visibility of a uniform application.

D. Water:
1. Water free from substances harmful to grass or sod growth.
2. Provide water from source approved prior to use.

E. Plants:
1. See plant list on Drawings.
2. Sound, healthy, vigorous, with normal top and root systems, free from disease, insect pests or their eggs, grown in same or colder climatic zone as project.
a. Nursery grown stock, freshly dug.
1) No heeled-in, cold storage or collected stock.
b. Species and size as indicated on Drawings.
3. Deciduous trees: Single leader, straight trunk, well-branched, free of branches up to 6 FT high, and with symmetrical growth.

4. Balled and burlapped plants (B&B): Firm, natural balls of soil.
5. Container grown plants (CG): Roots well established in soil, grown in container for at least one growing season.

### 2.3 ACCESSORIES

A. Tree Stakes: Furnish as detailed on Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF NATIVE GRASS SEEDING

A. Do not use seed which is wet, moldy, or otherwise damaged.

B. Perform seeding work from April 1 to June 1 for spring planting, and August 1 to September 1 to October 1 for fall planting, unless otherwise approved by Engineer.

C. Employ satisfactory methods of sowing using mechanical power-driven drills or seeders, or mechanical hand seeders, or other approved equipment.

D. Distribute seed evenly over entire area at rate of application rate indicated in Paragraph 2.2A, 50 PCT sown in one direction, remainder at right angles to first sowing.

E. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds excessive moisture, or other factors.
   1. Resume work only when favorable conditions develop.

F. Lightly rake seed into soil followed by light rolling or cultipacking.

G. Immediately protect seeded areas against erosion by mulching.
   1. Spread mulch in continuous blanket using application methods defined in Section 01030.48 of the Oregon Standard Specifications for Construction, 2024.

H. Protect seeded slopes against erosion with erosion control matting or other methods approved by Engineer.
   1. Protect seeded areas against traffic or other use by erecting barricades and placing warning signs.

I. If hydroseeding is used, machinery must be approved, modern, properly equipped and operated by an experienced operator.
   1. Seed at the rate specified.
   2. Use appropriate shields to protect adjacent site improvements.

### 3.2 PLANTING TREES, SHRUBS, AND GROUND COVERS

A. Notification:
   1. Notify Engineer of source of plants and plant materials at least 30 days prior to planting to permit Engineer's inspection of source qualifications.

B. Preparation:
   1. Handle plants so that roots or balls are adequately protected from breakage of balls, from sun or drying winds.
      a. Ensure tops or roots of plants are not permitted to dry out.
   2. During transportation, protect materials from wind and sun to prevent tops and roots from drying out.
   3. Protect tops of plants from damage.
      a. Plants with damaged tops will be rejected.
   4. For purpose of inspection and planting identification, attach durable, legible labels to bundle or container of plant material delivered at the planting site.
      a. State correct plant name and size of each plant in weather-resistant ink on labels.

5. Do not prune trees and shrubs at nursery.

C. Planting Season:
   1. Plant deciduous trees, evergreen trees and shrubs and ground covers any time the ground is suitable between October 1 and March 1.

D. Planting Procedure:
   1. Indicate locations of plants for approval by Engineer before excavating plant locations.
   2. In event underground construction, utilities, obstructions, or rock are encountered in excavation of plantings, secure alternate locations from Engineer.
      a. Make said changes without additional compensation.
      b. Where tree locations fall under existing overhead wires, or crowd existing trees, adjust locations as directed by Engineer.
   3. Excavate pits and beds as necessary and in accordance with ANLA/ANSI Z60.1.
      a. Loosen bottom of pits prior to planting.
      b. Excavation is unclassified, excavate all materials without additional cost.
   4. Tree and shrub pits to be circular in shape with vertical sides. Tree pits shall be 3x or no less than 1 FT greater than ball diameter, whichever is greater. Shrub pits shall be at least 1 FT greater in diameter than ball diameter.
      a. Pit to be of sufficient depth to provide 6 IN of planting soil under ball when set to natural grade.
   5. Shrub and ground cover beds:
      a. Plant shrubs used in mass plantings in individual holes of required size.
   6. Set plants straight or plumb, in locations when indicated and at such level that after settlement they bear same relationship to finished grade as they did in their former setting.
      a. Carefully tamp planting soil under and around base of balls to prevent voids.
      b. Remove burlap, rope and wires from top of balls.
      c. Do not remove burlap from sides and bottom of balls.
   7. Backfill tree pits with prepared planting soil.
      a. After planting has been completed, flood pit again so that backfill is thoroughly saturated and settled.
   8. After planting is complete, form a level saucer 3 IN high around each tree extending to limit of plant pit for watering purposes.
   9. Mulch plant pit after saucer has been shaped.
      a. Mulch to limits of pit and uniformly over ground cover beds to a depth of 3 IN.
      b. In mass plantings of shrubs, mulch entire area uniformly among shrubs to a depth of 3 IN.
      c. If mulching is delayed and soil has dried out, water plants thoroughly before spreading mulch.
   10. Staking: Stake trees immediately after planting as detailed on Drawings or in accordance with Nursery Standards.
   11. Remove dead or damaged branches.
      a. Thin deciduous material to about two-thirds of initial branching.
      b. Remove only dead or damaged branches from evergreens.
   12. Water plants during planting operations.
      a. Water each plant a minimum of once each week until final acceptance.
      b. Apply sufficient water to moisten backfill about each plant so that moisture will extend into the surrounding soil.

E. Pruning and Repairing Existing Trees:
   1. Remove dead or dying limbs, remove limbs that interfere with construction or with vehicular traffic and repair.
   2. Procedure:
      a. To prevent stripping the bark, stub cut branches that are too large to be supported by hand.

b. Coat branch cuts over 1 IN in diameter with an asphaltic varnish containing an antiseptic.
c. Where existing trees interfere with construction, prune the limb back flush to the main trunk.
    1) Maintain 7 FT vertical clearance where evergreens overhang new sidewalks.
d. Provide 10 FT vertical clearance along the main access road where the existing trees are subjected to vehicular traffic.
e. Repair bark wounds by removing injured bark, shaping the wound to an elongated ellipse, disinfecting it and applying antiseptic paint.
    1) Repair all rotten areas.

## 3.3 MAINTENANCE AND REPLACEMENT

A. General:
1. Begin maintenance of planted areas immediately after each portion is planted and continue until final acceptance or for a specific time period as stated below, whichever is the longer.
2. Provide and maintain temporary piping, hoses, and watering equipment as required to convey water from water sources and to keep planted areas uniformly moist as required for proper growth.
3. Protection of new materials:
    a. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain.
    b. Repair and pay for all damaged items.
4. Replace unacceptable materials with materials and methods identical to the original specifications unless otherwise approved by the Engineer.

B. Watering:
1. Watering shall be provided by the Contractor and shall be sufficicient to supplement natural rainfall to maintain healthy and vigorous plant matererial with no less than the following quantity and frequency:
    a. One (1) inch of water per month and applied a minimum of once per week during April, May and September.
    b. Four (4) inches of water per month and applied a minimum of once per week during June, July and August.
2. The Contractor is required to have approval of the Engineer to water less than these amounts or to apply water less often than these minimums due to weather. Additional water may be required based on weather conditions. It shall be the Contractors responsibility to monitor weather and adjust frequency and amount of water based on site conditions.

C. Planting Establishment Plan:
1. Contractor shall have an approved planting establishment plan prior to commencing with planting operations. The plan shall include at a minimum all activities to ensure the successful establishment of seeded and planted areas, including:
    a. Proposed scheduling of joint inspection meetings, activities, materials, equipment to be utilized for the first-year plant establishment/warranty. Activities and materials including:
        1) Fertilizing
        2) Watering including:
            a) Source of water
            b) Method of delivering water
                (1) If an above ground temporary system is used materials and system layout shall be submitted for review.
            c) Schedule of watering
            d) Management of system and/or repair
        3) Litter and Debris Removal
        4) Insect and Disease Control
        5) Plant Replacement

b. Supervisor/Responsible Contact Name
    1) Local address
    2) Local telephone number
c. Signature of the preparer and date the Plant Establishment Plan was prepared.

D. Native Grass Seeding:
1. Maintain all seeded areas for two years after planting is complete.
2. Native Grass Seeding is considered permanent and acceptable when a stand of native grass seeding provides uniform coverage at 70% density of the surrounding native grass area is achieved.
3. When weeds are shading out 70 PCT of (minimum 6 IN) native grass seed, shred weeds back to height of seedlings with a rotary shredder.
4. Do not allow weeds to exceed a height of 8 IN.
5. Water according to need to maintain survival of planting.
6. Regrade and replant eroded or bare areas evident at end of two year period.

E. Trees and Shrubs:
1. Maintenance includes but is not limited to watering when necessary, removing dead or dying branches, removing sprouts and suckers; tightening, repairing or replacing tree stakes and wrapping; maintaining mulch to originally specified depth; and weeding plant beds and pits.
2. Remove and replace all new plants supplied, which are impaired, dead, or dying during one year from initial acceptance.
3. Engineer will review completed planting for acceptability of installation.
    a. Approval of planting denotes initial acceptance and the beginning of the maintenance period.

F. Maintenance Requirements for Work at Ashland Creek:
1. Work areas on the immediate site shall be identified and marked to reduce damage to trees and vegetation. Temporary construction fencing shall be placed at the drip line of trees bordering the work area. No equipment maneuvering, staging, or stockpiling shall occur outside of designated work areas.
2. Trees shall not be used as anchors for stabilizing equipment.
3. Stockpiling of soil or soil mixed with vegetation, shall not be permitted in Water Resource Protection Areas on a permanent basis. Temporary storage shall employ erosion control measures to ensure sediments are not transported to adjacent surface waters.
4. Temporary erosion control measures shall be installed to prevent encroachment and flow of runoff, material, or other debris into the Water Resource. These measures shall be installed prior to the commencement of excavation, grading, site clearing, construction, or similar site work resulting in changes to the land. Access roads, staging areas, storage areas, and other areas of temporary disturbance necessary to complete the proposed activity shall be restored as soon as possible, but not more than 90 days after authorized land disturbance. Erosion control measures shall be in place concurrently with construction or establishment of the proposed activity. Temporary measures used for initial erosion control shall not be left in place permanently.
5. Replanting of the WRPZ will occur within 90 days of the completion of the culvert replacement construction.
6. Restoration/mitigation area maintenance is required for 5 years after plantings are installed and must meet the following coverage requirements: 50% coverage after one year and 90% coverage after 5 years.
7. Provisions for the ongoing removal and management of noxious or invasive vegetation and debris.
8. Erosion control material such as mulch, hay, jute-netting, or comparable material shall be applied to protect disturbed, re-planted areas. Disturbed areas shall be replanted so that landscaping shall obtain 50 percent coverage after one year and 90 percent coverage after five years.

9. Local native plant species that do not survive the first two years after planting shall be replaced.

**END OF SECTION**

# DIVISION 33

**UTILITIES**

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# SECTION 33 05 15
## PRECAST CONCRETE UTILITY STRUCTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Precast concrete utility structures, non-circular in plan, and appurtenant items.
      a. Valve and meter vaults.
   2. Design and fabrication of precast concrete utility structures.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 - Reinforcement.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   6. Section 08 31 00 - Access Doors.
   7. Section 09 96 00 - High Performance Industrial Coatings.
   8. Section 31 23 00 - Earthwork.
   9. Section 33 05 16 - Precast Concrete Manhole Structures.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. ASTM International (ASTM):
      a. C857, Standard Practice for Minimum Design Loading for Underground Precast Concrete Utility Structures.
      b. C858, Standard Specification for Underground Precast Concrete Utility Structures.
      c. C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
      d. C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
      e. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
   3. Occupational Safety and Health Administration (OSHA).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Concrete mix design(s):
      a. Include submittal information defined in Specification Section 03 31 30.
      b. Certification in accordance with ASTM C858, Section 12.
   4. Fabrication and/or layout drawings:
      a. Include detailed diagrams of utility structures showing typical components and dimensions, reinforcement, and other details.
      b. Itemize, on separate schedule, elevations or sectional breakdown of each utility structure with all components and refer to drawing identification number or notation.
      c. Indicate required penetration details for all piping entering each structure.

5. Drawings and calculations: All Drawings, including layout drawings, certifications and calculations shall be sealed by a Professional Engineer registered in the state where the project is located.
    a. Provide certification stating that calculations provided have been prepared specifically for this Project and that they match and pertain to the Shop Drawings provided.
    b. Provide a summary document as part of the above certification listing the design criteria used for precast design including:
        1) Codes and standards.
        2) Soil load.
        3) Exterior groundwater load.
        4) Live loads.
        5) Other loads.
6. Test Reports:
    a. Copies of source quality control tests, including compressive strength and air content, for units provided.

### 1.4 SITE CONDITIONS

A. Design groundwater elevation for precast structure design shall be equal to the ground surface elevation at the structure.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Access doors:
        a. Conform to requirements of Specification Section 08 31 00.
    2. Manhole rings, covers and frames:
        a. Conform to requirements of Specification Section 33 05 16 for nonpressure type frames.
    3. Manhole steps:
        a. M. A. Industries.
        b. Neenah Foundry.
        c. Deeter Foundry.
    4. Black mastic joint compound:
        a. Kalktite 340.
        b. Tufflex.
        c. Plastico.
    5. Premolded joint sealant:
        a. NPC Bidco, Inc., C-56.
        b. Ram-Nek, Henry Co.
        c. EZ-Stik, Press-Seal Gasket Corp.
        d. CS-102, Conseal.
    6. Elastomeric joint seals:
        a. Kent Seal.
    7. External joint wrap.
        a. NPC, Bidco, Inc.
        b. EZ-Wrap, Press-Seal Gasket Corp.
        c. RUBR-Nek, Henry Co.
    8. Emulsified fibrated asphalt compound:
        a. Sonneborn Hydrocide 700B Semi-Mastic.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PRECAST UTILITY STRUCTURE COMPONENTS

A. Provide utility structures with interior dimensions as shown on the Drawings.

B. Provide the following components for each utility structure:
   1. Precast base section with integral or cast in place base slab.
   2. Precast wall section(s).
   3. Precast flat top.
      a. Where reinforcement is shown for top slab, furnish slab with reinforcing as designed, but not less than reinforcing shown on Drawings.

C. Provide openings and appurtenances as shown on Drawings.
   1. Access doors:
      a. Cast access doors into top slab.
      b. Where access door frames have drainage channels, cast PVC drain lines in top slab to drain location shown on Drawings. If no drain location is shown, drain frames to outer edge of top slab.
      c. Protect doors and frames from damage during concrete placement and shipping.
      d. See Specification Section 08 31 00.
   2. Manhole frames and covers:
      a. Furnish and install in accordance with Specification Section 33 05 16.
      b. Cast frames into top slab.

D. Concrete:
   1. Conform to requirements of Specification Section 03 31 30.
   2. Conform to requirements of ASTM C858, where stricter than Specification Section 03 31 30.
      a. Minimum 28-day compressive strength 4500 PSI.
      b. All portions of precast utility structure are considered to be exposed to freeze-thaw cycles.

E. Joints:
   1. Joints of precast riser and top sections:
      a. Preformed flexible joint sealants: ASTM C990.
      b. Exterior joint wrap.
   2. Pipe and conduit entry for utility structures.
      a. In accordance with Specification Section 01 73 20.

F. Coatings:
   1. Vertical wall surfaces:
      a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type I for all vertical wall exterior surfaces.

## 2.3 DESIGN

A. General Design Requirements:
   1. Design precast units and appurtenances in accordance with ASTM C858.
      a. Notify Engineer and furnish cast-in-place structures if sizes of precast utility structures shown on Drawings can not be designed or fabricated.

B. Design loads:
   1. Design precast units for all loads and load cases described in ASTM C857, with the following values and selections:
      a. Minimum uniform live load for exposed roof slabs shall be 150 PSF.
      b. Wheel loads shall be considered.
         1) Use wheel load designation A-16 (HS20-44) as shown in ASTM C857, Table 1.
         2) Wheel loads and uniform live load do not act concurrently.
      c. Unit weight of soil W shall be taken as no less than 120 LB/CUFT.
      d. Minimum lateral soil pressure coefficient ($K_0$): 0.50.

C. Specific Design Requirements:
   1. Out-of-plane shear:
      a. Out-of-plane shear shall be shown in the calculations.
      b. Wall thickness shall be determined based on meeting design requirements for out-of-plane shear resulting from soil and groundwater loads.
      c. Wall sections shall be designed as one-way spans between corners for calculation of out-of-plane shear. Transfer of shear or bending load shall not be considered to be transferred across joints between precast units or between walls and slabs, unless unit as integrally cast together.
      d. Use of shear steel reinforcement to increase out-of-plane shear capacity shall be prohibited.
   2. The distribution of moments in adjacent walls of different lengths in rectangular structures shall be considered.
   3. Design precast units taking into account reduced cross section at openings and penetrations.
   4. Structure shall be checked for buoyancy.
      a. The minimum factor of safety for uplift with the design groundwater elevation shall be 1.25, unless a larger factor of safety is required by the local governing body or building code.
      b. If the buoyant weight of soil above base slab extensions beyond the external dimensions of the structure is used to resist uplift, the volume of soil considered to resist uplift shall be limited to soil within the vertical projection of the edge of the base slab extensions.

## PART 3 - EXECUTION

### 3.1 PRECAST UTILITY STRUCTURE CONSTRUCTION

A. General:
   1. Prepare subgrade for base as required by Specification Section 31 23 00.
      a. For precast base slabs, place and compact 6 IN of Granular Fill or Bedding Material as shown on Drawings.
      b. For cast-in-place concrete base slabs, support base section and prepare bottom joint with preformed strip-type hydrophilic waterstop in accordance with Specification Section 03 31 31.
      c. Confirm that base is level and fully supported by stable material.
   2. For structures with open pipe flow, make inverts in accordance with Section 33 05 16.
   3. Ensure accurate vertical placement and leveling prior to placement of interior grout.
      a. Provide vertical alignment tolerance of maximum 1 IN horizontal to 10 FT vertical.

B. Build each structure to dimensions shown on plans and at such elevation that pipe sections built into wall of structure will be true line of pipe extensions.

C. For all horizontal mating surfaces between precast concrete units, apply premolded flexible joint sealant to clean mating surfaces in accordance with sealant manufacturer's written instructions. Apply sufficient pressure to each concrete unit to seat unit in sealant.

D. Seal all pipe penetrations in manhole.
   1. Where post-installed seals are permitted, form pipe openings smooth and well shaped.
   2. After installation, seal exterior of penetration with non-shrink grout.
   3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.

E. Set top slab level to elevation shown on Drawings.

### 3.2 FIELD QUALITY CONTROL

A. Any proposed repairs of precast components or structures shall be submitted to Engineer for approval.

B. Structures shall be observed for signs of leakage during periods of high groundwater.

C. No leakage that includes visible flow through joints between precast concrete sections or through pipe penetrations shall be permitted.

D. Damp spots on interior wall surfaces shall be considered leakage and shall not be permitted.
   1. Damp spots shall be defined as spots where moisture from a source outside the structure can be picked up on a dry hand.
   2. Locate the source of water movement through the wall and permanently seal.

E. Dampness on the top of the base slab will not be construed as leakage.

**END OF SECTION**

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# SECTION 33 05 16
## PRECAST CONCRETE MANHOLE STRUCTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Precast concrete round manhole structures and appurtenant items.
      a. Sanitary sewer manholes and appurtenances.
      b. Drain manholes and appurtenances.
      c. Storm sewer manholes and appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 03 21 00 - Reinforcement.
   4. Section 03 31 30 - Concrete Materials and Proportioning.
   5. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48/A48M, Standard Specification for Gray Iron Castings.
      b. C150/C150M, Standard Specification for Portland Cement.
      c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
      d. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
      e. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
      f. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Fabrication and/or layout drawings:
      a. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
      b. Itemize, on separate schedule, sectional breakdown of each manhole structure with all components and refer to drawing identification number or notation.
      c. Indicate knockout elevations for all piping entering each manhole.
   4. Buoyancy uplift and structural calculations.
   5. Drawings shall be signed and sealed by a Professional Engineer registered in state corresponding to the project location.

B. Unless approved prior to submittal, submit all products from this Specification Section in one complete submittal package. Include all products and accessories together.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Manhole rings, covers and frames:
      a. Neenah Foundry and Neenah Enterprises, Inc.
      b. Deeter Foundry.
   2. Black mastic joint compound:
      a. Kalktite 340.
      b. Tufflex.
      c. Plastico.
   3. Premolded joint compound:
      a. RAM-NEK.
      b. Kent Seal.
   4. Emulsified fibrated asphalt compound:
      a. Sonneborn Hydrocide 700B.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 SANITARY SEWER, STORM AND DRAIN MANHOLE STRUCTURE COMPONENTS

A. Manhole Components:
   1. Reinforcement: ASTM C478.
   2. Minimum wall thickness: 5 IN.
   3. Minimum base thickness: 12 IN.
   4. Provide the following components for each manhole structure:
      a. Base (precast) with integral bottom section or (cast-in-place).
      b. Precast bottom section(s).
      c. Precast barrel section(s).
      d. Precast eccentric transition section.
      e. Precast adjuster ring(s).
      f. Precast concrete transition section.
      g. Precast flat top.
   5. Unless dimensioned or specifically noted on Drawings, provide manhole section with minimum 48 IN inside dimensions.

B. Nonpressure Type Frames and Cover:
   1. Cast iron frame and covers: ASTM A48/A48M, Class 35 (minimum).
   2. Use only cast iron of best quality, free from imperfections and blow holes.
   3. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 LBS.
   4. Machine all horizontal surfaces.
   5. Furnish unit with solid nonventilated lid with concealed pickholes.
      a. Letter covers "S" for all sewer collection system manholes, "D" for all drainage systems.
   6. Ensure minimum clear opening of 24 IN DIA.

C. Pressure Type Frame and Cover:
   1. Provide covers meeting the requirements of the Nonpressure Type Frames and Cover paragraph above and as modified below.
   2. Furnish frame and bolted cover of heavy-duty construction.
      a. Equip unit with six stainless steel countersunk 3/8 IN DIA by 1-1/2 IN long bolts with stainless steel washers.
   3. Provide solid lid and minimum 1/8 IN thick x 1/2 IN wide continuous strip neoprene gasket.
   4. Furnish unit with a minimum of six anchorage holes and six, 6 IN long x 3/4 IN DIA stainless steel anchor bolts.

D. Special Coatings and Joint Treatment:

1. Joints of precast sections:
   a. Black mastic compound: ASTM D4586.
2. Vertical wall surfaces:
   a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type II for all exterior and interior vertical wall surfaces.

E. Sanitary Sewer Manhole Concrete:
1. Provide all sanitary manholes constructed with Portland ASTM C150/C150M, Type I or II cement with a tricalcium aluminate content not to exceed 8 PCT.
2. Mix aggregate shall be a minimum of 50 PCT crushed limestone.
3. Provide 3000 PSI nonshrink grout.

## PART 3 - EXECUTION

### 3.1 MANHOLE CONSTRUCTION

A. General:
1. Construct cast-in-place concrete base slabs.
2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
3. On all straight runs, lay pipe through manhole and cut out top half of pipe.
   a. See detail on Drawings.
   b. If pipes deflect at manhole, shape as specified in Paragraphs 2 and 4 IN this General Paragraph.
4. Shape inverts accurately and steel trowel finish.
   a. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert using as large a radius as manhole inside diameter will permit.
   b. Pour base slab integral with bottom barrel section.

B. Build each manhole to dimensions shown on plans and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.

C. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 IN immediately prior to mating the surfaces.

D. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.

E. If PVC pipe is specified, pipe manufacturer shall install resilient O-ring gaskets centered in wall of manhole.

F. Seal all pipe penetrations in manhole.
1. Form pipe openings smooth and well shaped.
2. After installation, seal cracks with, non shrink grout.
3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.

G. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

## END OF SECTION

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# SECTION 33 11 13
## WATER MAIN CONSTRUCTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Coordination and interface with existing facilities and utilities.
   2. Connections to existing water mains.
   3. Testing, flushing and disinfection.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 32 91 13 - Topsoiling and Finished Grading.
   4. Section 33 12 19 - Fire Hydrant.
   5. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   6. Section 40 05 19 - Pipe - Ductile
   7. Section 40 05 51 - Valves - Basic Requirements.
   8. Section 40 05 61 - Gate Valves.
   9. Section 40 05 64 - Butterfly Valves.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Work Association (AWWA):
      a. B300, Standard for Hypochlorites.
      b. B301, Standard for Liquid Chlorine.
      c. C651, Standard for Disinfecting Water Mains.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Fabrication and/or layout drawings.
   4. Certifications.
   5. Test reports.

B. Submit results of the leakage tests, identifying the specific length of pipe tested, the test pressure, the duration of test and the amount of leakage.

C. Submit satisfactory bacteriological test reports on disinfection requirements.

D. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 DELIVERY, STORAGE, AND HANDLING OF PRODUCTS

A. In addition to the requirements specified in this section, see Section 01 65 50 - Product Delivery, Storage and Handling and related paragraphs in individual pipe specifications.

B. Deliver, handle and store products in accordance with manufacturer's instructions.

C. Protect pipeline sections stored at the site from damage.

D. Store all products above the ground upon platforms, pallets, skids, or other supports supplied by the Contractor.
   1. Store in a way to permit ready access for identification and inspection by the Engineer.

E. Keep products free from dirt and other foreign matter.

F. Provide suitable quantities of all lifting equipment to handle the pipe.
   1. Do not utilize any equipment that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the pipe.
   2. Do not drag or drop pipe.

G. Place pipe lain directly on the ground prior to placement on an area free of loose stones or sharp objects.

H. Repair or replace any new pipe and fittings damaged before or during installation at Contractor's expense, before proceeding further.
   1. Utilize repairs methods as recommended by the manufacturer.
   2. Replace damaged materials as directed by Owner's project representative.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Pipe: Refer to Division 40.

B. In-Line Valves:
   1. Refer to Specification Section 40 05 61 and 40 05 64.
   2. Provide adjustable valve boxes.
      a. Include price of valve boxes in price of valve installed complete.

C. Fire Hydrants: Refer to Specification Section 33 12 19.

D. Fill and Backfill: See Specification Section 31 23 33.

E. Embedment and Bedding Materials for pipelines: See Section Specification 31 23 33.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install water main to the line and grade on the Drawings.
   1. Water mains to be staked at a minimum 100 FT interval with depth of cuts monitored.

B. Field verify depth of utilities that will be crossed.
   1. Adjust water main elevation as required during construction.
   2. No separate payment will be made for field verification or adjustment of main depths as required.

C. Contractor will restore all existing structures or services damaged by Contractor's operations at no cost to Owner.

D. Install ductile iron pipe according to AWWA C600 and the manufacturer's recommendations.
   1. Curves – Lay horizontal and vertical long radius curves with standard pipe by deflecting the joints. Use standard fittings and standard pipe lengths, unless otherwise shown. If shorter pipe lengths are required, the maximum allowable pipe lengths will be shown. Do not exceed 80 percent of the manufacturer's recommendations of the amount of deflection at each pipe joint when pipe is laid on a horizontal or vertical curve. Where field conditions require deflection or curves not shown, the Engineer will determine the methods to be used.

2. Pipe Laying Procedure – When ductile iron pipe is laid on a curve, join the pipe in straight alignment and then deflect it to the curved alignment. Widen trenches on curves for this purpose as allowed or directed.

## 3.2 THRUST RESTRAINT

A. Concrete Thrust Blocks – Place concrete thrust blocks as shown. Pour concrete thrust blocks in place against solid, undisturbed earth at the sides and bottom of the trench excavation. Shape the block so as not to obstruct access to the joints of the pipe or fittings.

B. Restrained Joints –Restrain all joints at bends, tees, dead ends, crosses, and all pipe joints and fittings. Install joint restraint systems according to the manufacturer's recommendations.

## 3.3 INTERRUPTION OF SERVICE

A. Interruption of service to water users shall not exceed 8 HRS.
   1. Notify the City of Ashland a minimum of seven (7) working days in advance of any facility or pipeline shutdown dates.

## 3.4 UNDERGROUND SERVICES

A. Notify utility representative prior to construction to obtain available information on location of existing utilities.
   1. Contractor shall be responsible for locating all utilities.

B. Existing water services are not to be connected to the new water mains.
   1. Damage to existing water service to be repaired, using copper pipe and union the same size as existing service.

## 3.5 GRAVEL SURFACED DRIVES AND ROADWAYS

A. Restore all damaged gravel surfaced drives and roadways to a condition equal to or better than original.
   1. Payment to be at bid unit price for this item.
   2. Replacement gravel gradation.

## 3.6 PROTECTION OF EXISTING UTILITIES

A. Contractor to verify the location of all underground utilities.
   1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.

B. A representative of the underground utilities shall be notified 24 HRS in advance of crossings.

## 3.7 CONNECTIONS TO EXISTING WATER MAINS

A. Make necessary arrangements with the Engineer a minimum of 30 Calendar Days before making connections to existing water mains. Assemble all materials, Equipment, and labor necessary to properly complete the Work before starting.
   1. Notification - If the connection to the existing system involves temporary water system shutoff, provide written notices to the residents affected by the shutoff a minimum of 72 hours before the shutoff. Submit a draft written notification to the Engineer for approval 5 Calendar Days before providing written notice to the affected residents. The Engineer will advise which property owners are to be notified.
   2. Permission - The Work to perform the connection may need to be carried out during times other than normal working hours. Do not operate any valves on the existing system without specific permission of the Engineer.
   3. Connection Assemblies - Excavate potholes to expose existing piping at connection points before constructing the connection. If existing piping is different than shown, provide measurements of depth and a detailed sketch of existing piping configuration and alignment to the Engineer not less than 2 weeks before the expected construction.

4. Uninterrupted Service - Once Work is started on a connection, proceed continuously without interruption, and as rapidly as possible until completed. Schedule main shutoffs to ensure that mains do not remain shut off overnight, on Fridays, over weekends, or on holidays.
5. Cutting Main Lines - Remove the portions of pipe to provide for the installation of the required fittings at the points of connection. Determine the exact length of the existing water main that is to be removed. Bevel pipe ends to prevent damage to the transition coupling gasket during installation of the coupling. Clean the exterior of the existing pipe end to a sound, smooth finish before installation of the coupling.

B. Make connections to existing water mains as shown on Drawings, by attaching to existing or changed fitting.
   1. Cost for making connections shall include cost of all fittings including flexible couplings, and shall be included in the bid unit price of the water main.

C. Where the connection is made to an existing water main which can be adequately isolated from the distribution system, it shall be termed a "dry connection".

D. Contractor is responsible for controlling and disposing of water in the trench at no additional cost to the Owner.

## 3.8 SEWER CROSSINGS

A. Water mains crossing storm sewers or sanitary sewers shall be laid to provide a vertical separation of at least 18 IN between the bottom of the water main and the top of the sewer, whenever possible.
   1. A water main may be laid closer than 10 FT if the crown of the sewer is at least 18 IN below the water main invert.
   2. In the event 18 IN of vertical separation cannot be provided at a sewer crossing, the sewer shall be removed for a distance of 10 FT on each side of the water main and replaced with one 20 FT length of ductile iron pipe of the same size.

B. Concrete collars shall be provided at each end of the ductile iron pipe to connect to the existing sewer pipe as shown on the Drawings.

C. Payment for crossings shall be included in the bid unit price of the water main.

## 3.9 TREES

A. Do not remove trees without written instructions from the Engineer unless tree removal is shown on drawings.
   1. No separate payment will be made for tree removal and the cost shall be included in the bid unit price for transmission main.

## 3.10 FENCES, SIGNS, MAILBOXES, ETC.

A. Restore all damaged fences, signs, mailboxes, etc., to their original conditions.
   1. No separate payment will be made for these items.

## 3.11 EXCAVATION, BACKFILL AND COMPACITION

A. Contractor shall provide all excavation, dewatering, backfill, and compaction necessary to install pipe, fittings, hydrants, valves, and associated appurtenances in accordance with Section 31 23 33 – Trenching, Backfilling, and Compacting for Utilities.

## 3.12 FIELD QUALITY CONTROL

A. Sealing, Flushing, and Disinfection of Potable Water Systems:
   1. Maintain interior of all pipes, fittings and other accessories free from dirt and foreign material at all times.
      a. If, in the opinion of the Engineer, the pipe contains dirt that will not be removed by flushing, the pipe interior shall be cleaned and swabbed with bactericidal solution.

b. At close of day's work or whenever workmen are absent from jobsite, plug, cap or otherwise provide watertight seal from open ends of pipe to prevent ingress of foreign material.
c. If water is in trench, seal shall remain in place until trench is pumped dry.

2. After favorable performance of pressure test and prior to final acceptance, thoroughly flush the entire potable water piping system and perform disinfection as prescribed.
   a. Perform all work including preventative measures during construction in full compliance to AWWA C651.
3. Flush each segment of the system to provide a flushing velocity of not less than 2.5 FT per second.
4. Drain flushing water to location approved by the Owner.
5. Perform disinfection using one of the following forms:
   a. Application of chlorine gas-water mixture by means of solution-feed chlorinating device.
      1) Liquid chlorine shall comply with AWWA B301.
   b. Application of calcium hypochlorite, or sodium hypochlorite.
      1) Chlorine compounds shall comply with AWWA B300.
6. Disinfect pipe with chlorinated water as per AWWA C651.
   a. Method of application of chlorine shall be by continuous feed method or slug method.
   b. During disinfection procedure, ensure that initial and residual chlorine concentrations meet AWWA C651 requirements by testing by an approved method as directed by the Owner.
   c. Cost of testing shall be included in the Bid Unit Price for water mains and no separate payment will be made for this item.
7. Tag the system during the disinfection procedure.
8. Following disinfection for required contact period, neutralize chlorine residual in water by treating with reducing agent.
   a. Refer to AWWA C651.
   b. Flush all treated water from pipeline at its extremities until replacement water throughout pipe, upon test is proved comparable in quality to water in existing system.
   c. Take two samples to test for bacteriological quality as directed by Engineer.
   d. Repeat disinfection procedure until two satisfactory results are obtained.
   e. Quality of water delivered by the new water main to remain satisfactory for a minimum period of two days.
9. Secure satisfactory bacteriological reports on samples from the system.
   a. Ensure all sampling and testing procedures are in full compliance to AWWA C651, and applicable requirements of the State of Oregon.
      1) No separate payment will be made for this item.
10. The Owner will provide the water required to fill the main initially and will pay for the water required to flush the main once.
    a. Filling and flushing shall be performed during periods of low usage, between the hours of midnight and 4:00 AM.
    b. Flushing water will be based on a maximum of 8 HRS total.
    c. Any additional refilling or reflushing to be at the Contractor's expense at the City's commercial water rates.

B. Hydrostatic Testing:
   1. Field hydrostatic test all pipe as specified in Section 40 05 00.

**END OF SECTION**

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# SECTION 33 12 19
FIRE HYDRANT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Dry-barrel fire hydrant.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. C502, Standard for Dry-Barrel Fire Hydrants.
      b. M17, Installation, Operation and Maintenance of Fire Hydrants.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Acknowledgement that products submitted meet the requirements of the standards referenced.
      b. Manufacturer's installation instructions.
      c. Acknowledge and verify dimensions and provide list of integral parts and materials.
   3. Prior to submission of shop drawings, submit one copy of complete submittal information direct to City of Ashland Fire Department, Attn: Fire Chief, and request and secure written approval of hydrant selection.
      a. Incorporate copies of written approval letter with submittals.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Mueller.
   2. American Flow Control.
   3. Waterous.
   4. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 FIRE HYDRANT

A. Design and Fabrication:
   1. Conform to AWWA C502.
   2. Provide with either compression or gate design.
   3. Provide with a 5-1/4 IN valve opening, nozzle section consisting of two, 2-1/2 IN hose nozzles and one pumper nozzle to match the City of Ashland's connection requirements.
   4. Provide with water passages to permit full flow of water to minimize friction loss.
   5. Furnish with multiple weep holes for positive draining to allow water to escape readily from standpipe when hydrant valve is closed.
   6. Designed to throttle flow when partially opened.
   7. Designed to allow removal of valve and valve stem without digging up hydrant.
   8. Suitable for 5 FT of bury.
   9. Furnish with mechanical (gland type) joint inlet connections.
   10. Design to break off at ground line when struck by a vehicle.
   11. Furnish with O-ring packing only.
   12. Furnish hose and steamer nozzles with threads conforming to standard threads used by local Fire Department.
   13. Furnish with direction of opening as required by local Fire Department with direction of opening cast on dome.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install hydrants at locations indicated in accordance with AWWA M17 and the following:
   1. Remove foreign material from barrel of hydrant before placement.
   2. Install plumb and at same elevation as connecting pipe and main.
   3. Block backside of hydrant, opposite pipe connection, with concrete firmly wedged between hydrant and vertical face of undisturbed trench.
   4. Place granular bedding material around base of hydrant to the dimensions shown in the Drawings.
   5. Firmly tamp carefully compacted backfill around hydrant to surface of ground and to a distance of 5 FT in front of hydrant.

### 3.2 COATINGS AND FINISHES

A. Provide hydrant with below grade and above grade coatings as per Section 09 96 00.
   1. Paint above grade with color conforming to the requirements of the local Fire Department.

**END OF SECTION**

# SECTION 33 16 25
## WELDED STEEL WATER STORAGE TANK

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Steel water storage tanks /reservoirs with appurtenant items.
   2. Foundations.
   3. Site work.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 – General Requirements.
   2. Division 03 – Concrete.
   3. Section 09 96 00 – High Performance Industrial Coatings
   4. Section 09 96 53 – Corrosion Resistant Elastomeric Lining
   5. Section 26 42 13 – Cathodic Protection System - Sacrificial Anode.
   6. Section 31 23 00 – Earthwork.
   7. Division 26 – Electrical.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM).
   2. American Water Works Association (AWWA):
      a. C652, Standard for Disinfection of Water-Storage Facilities.
      b. D100, Standard for Welded Carbon Steel Tanks for Water Storage.
      c. D102, Standard for Coating Steel Water-Storage Tanks.
   3. Occupational Safety and Health Administration (OSHA).
   4. Oregon Occupational Safety and Health Act (OR OSHA)
   5. Building code:
      a. Oregon Structural Specialty Code (OSSC) and associated standards, 2019 Edition including all amendments, referred to herein as Building Code
   6. American Welding Society (AWS):
      a. AWS D1.1 Structural Steel Welding Code- Steel.
   7. American Iron and Steel (AIS) Requirements of the Consolidated Appropriations Act of 2014.

B. Qualifications:
   1. Welders to be ASME qualified.
   2. Manufacturers to have its own fabricating plant and have designed, fabricated and erected at least five storage tanks of capacity and type specified.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or erection drawings.
      a. Include construction details and materials of construction.
      b. Furnished equipment drawings, and electrical diagrams.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

c. Design data:
    1) Design drawings and calculations signed and sealed by a licensed structural engineer registered in the state of Oregon.
4. Certificates:
    a. Manufacturers list of five similar size and type tanks.
        1) Include location, size, configuration and Owner.
    b. Mill test reports.
    c. Affidavits of Compliance to required codes.
    d. Certified welding procedures and welder certificates per ASME Section IX.
    e. Certificates of compliance with inspection provisions of AWWA D100.
    f. AIS.
5. Test reports:
    a. Visual inspection.
    b. Radiographic inspection.
    c. Vacuum testing.
    d. Coatings reports per Section 09 96 00.

B. Operation and Maintenance Manuals:
1. See Section 01 33 04 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. PSF Industries, Inc.
2. T-Bailey, Inc.
3. HMT.
4. Matrix Service.
5. Brown-Minneapolis Tank Inc.
6. Paso Robles Tank Inc.
7. Approved Equal.

### 2.2 DESIGN REQUIREMENTS

A. Tanks meeting the following minimum requirements:
1. Project location: Ashland, Oregon.
2. Tank type: Water Storage Tank.
3. Tank Quantity: 1.
4. Min Gross Capacity: **877,000** GAL
5. Min Net Capacity: **874,000** GAL (after excluding internal piping and Structural members).
6. Height from tank base to overflow line invert: 41.5 FT.
7. Estimated seismic slosh wave height 3.50 FT.
8. Estimated structural roof beam size 10 IN (0.83 FT).
9. Shell height from tank base to the Eve: 46.5 FT.
10. Roof Dead Load: 5 psf.
11. Roof Live Load: 20 psf, unreducible.
12. Snow Load:
    a. The ground snow load is 37 PSF.
    b. Exposure Factor Ce = 1.0
    c. Thermal Factor Ct = 1.2
    d. Importance Factor Is = 1.2

13. Wind Load:
    a. Basic wind speed: 106 MPH.
    b. Exposure C
    c. Wind importance factor: Iw = 1.15
    d. Gust Factor G = 1.00
    e. Force Coefficient Cf = 1.00 or .6 (to be determined by tank designer)
14. Earthquake Load:
    a. AWWA D100 Seismic Use Group: III
    b. AWWA D100 Occupancy Category IV
    c. AWWA D100 Seismic Importance Factor 1.5
    d. Short period response acceleration $S_S$ (0.2sec) = 0.597
    e. Long period response acceleration $S_1$ (1.0 sec) = 0.339
    f. Soil Site Class C.
    g. Fa = 1.26
    h. Fv = 1.50
15. Design Metal Temperature: 15 DegF.

B. Conform to requirements of AWWA D100 - 2011

C. Tank and Roof:
    1. Material: Steel, specification no. and grade per AWWA D100 Section 14, Table 31.
    2. Thickness: As required.
    3. Minimum roof slope: 3/4 IN: 12 IN per AWWA D100.
    4. Continuous seal weld of underside and topside to include roof lap welds, rafter to roof plate laps, rafter to attachment clip and rafter to center column.

D. Overflow:
    1. Material: Steel, ASTM A36.
    2. Diameter: 30 IN
    3. Locate overflow pipe per Drawings.

E. Inlet and outlet diffusers:
    1. Material: Carbon Steel.
    2. Diameter: 24 IN.
    3. Provides pipe supports and diffuser supports.
    4. Coating: per Section 09 96 00.

F. Vent in top of tank of adequate size to handle pressure differential caused when pumping or withdrawing water at maximum rate.
    1. Overflow not to be considered in designing vent.
    2. Maximum inlet flow rate: 17 $FT^3$/SEC.
    3. Maximum outlet flow rate: 31.4 $FT^3$/SEC.

G. Tank Vent:
    1. Screen: 24 mesh stainless steel, ASTM A316, replaceable.
    2. Removable aluminum weather shroud.

H. Painter's rings around internal top of wall.

I. Interior lining: see Section 09 96 53.

J. Hinged roof hatch above interior ladder.
    1. CS Construction.
    2. Water tight seal when closed.
    3. Seal to be replaceable.
    4. Lockable opening mechanism.
    5. Open/close detection.
    6. Flush mounted hatches are not acceptable.

K. Roof drainage gutter around periphery of tank with rain leaders.

L. Ladders, Handrails and Platforms:
    1. Material: Steel, ASTM A36.

2. Design to conform to OSHA and WISHA Standards and safety devices, and requirements of the local Building Code.
3. Coordinate conduit and instrument support and installation requirements with Divisions 13 and 16.

M. Hinged Access Door:
1. Two watertight manhole access doors located at the base of the storage tank with locking device.
2. Locking device: Manufacturer's standard key type.

N. Level transmitter and level switch flanges: Provide an ANSI 150# flange connection, size as shown on the plan drawings, in the location shown on the plan drawings.

O. Electrical, grounding and Receptacles: To be provided as indicated on the Drawings and as specified in Division 26.

P. Cathodic Protection System: To be provided as indicated on the Drawings and as specified in Section 26 42 13.

Q. Nameplate: Provide a stainless steel data nameplate that lists the following:
1. Tank manufacturer.
2. Date of construction.
3. Volume to overflow level.
4. Overflow elevation (2366.50 FT MSL – NAVD 88).
5. Foundation elevation (2325.00 FT MSL – NAVD 88).

### 2.3 FABRICATION

A. Shop clean and prime steel plate in accordance with AWWA D102 and Section 09 96 00.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Foundation:
1. Excavate the footings in accordance with Section 31 23 00, Earthwork. Owner will retain the services of a Geotechnical Engineer to observe foundation excavation and placement. Before placement of the foundation, the Geotechnical Engineer will examine the areas and conditions under which the foundation and tank will be constructed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in an acceptable manner.
2. Form foundations, place reinforcing steel and place concrete in accordance with Division 3 Concrete.

B. Erection tank in accordance with AWWA D100.
1. Welding: Welding procedures and general welding requirements shall be in accordance with AWWA D100, Section 8, Welding. Welding shall only be done by ASME qualified welders. No structural welding is permitted to any steel embedded in hardened concrete, unless the weld is at least 2 ft. from the embedment interface. Grinding of weld contour shall approximate Condition D of NACE Standard RP0178.
2. Fabrication: Layout, cutting, forming, edge preparation, and workmanship for steel tank components and fabrications shall be in accordance with AWWA D100, Section 9, Shop Fabrication.

C. Butt weld steel plates.

D. Install conduit, instrument connections, and supports as required per the requirements of Division 16.

E. Ground tank in accordance with Section 26 05 26.

F. Field paint inside and outside surfaces in accordance with AWWA D102 and Sections 09 96 00 and 09 96 53.

## 3.2 FIELD QUALITY CONTROL

A. Weld Nondestructive Testing:
   1. Visual inspection by certified welding inspector of all welds for acceptance in accordance with standards set forth in AWWA D100, Section 11.4 and AWS D1.1, unless more stringent NDT is required in this Specification section.
   2. Shell: Spot radiographically examined per AWWA D100, Sections 11.5 and 11.6.
   3. Floor Opening Welds: 100% vacuum test for floor welds.
   4. Flat bottoms: Air pressure or vacuum testing per AWWA D100, Section 11.10.
   5. Shell- to- bottom joint: Prior to painting, vacuum box test the inside fillet weld per AWWA D100, Section 11.10.

B. Hydro test tank after painting is complete, in accordance with AWWA D100, Section 11.10.

C. Employ and pay for services of manufacturer's service representative(s) to:
   1. Examine installation and components to ensure installation in accordance with manufacturer's recommendation.
   2. Supervise final adjustments and field check units in installed condition.
   3. Conduct startup.
   4. Instruct Owner's personnel regarding normal and extraordinary operation and maintenance instructions.

D. Disinfect tank per Specification Section 01 74 15 or as modified below.
   1. Disinfect tank in accordance with AWWA C652, Chlorination Method 2. All interior surfaces, including piping, columns, and stairs, shall be applied by spraying and/or brushing a chlorine solution containing not less than 200 PPM of chlorine. Chlorine solution may be recirculated during disinfection. Disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 minutes. The Contractor is responsible for determining the quantity of solution required for disinfection of the tank. If the tank does not pass bacteriological and chlorine residual testing, the Contractor is responsible for disposal of water and re-disinfection. After the disinfection has been accomplished, the entire reservoir shall be completely flushed and then filled. The Contractor shall exercise special care in flushing to avoid damage to surrounding properties. Water with a chlorine residual shall be stored and aerated or otherwise neutralized until it can be safely disposed of in accordance with all applicable regulations. All disposal shall be the responsibility of the Contractor. Water containing a chlorine residual, shall not be disposed of into the water system, stormwater system, or any surface watercourse.

E. Obtain satisfactory bacteriological reports from water samples from tank in conformance with requirements of the State of Oregon.

F. The Owner will provide water for the initial testing of the tank delivered through the tank inlet piping at no cost to the Contractor. Additional water, labor, and materials required for repair, re-disinfection and retests shall be paid for by the Contractor.

G. A leakage test of the completed reservoir installation will be performed by the Contractor. There shall be no acceptable leakage rate of the reservoir specified herein. Any water appearing at the reservoir seams, bolts, foundation/wall junction, appurtenances, or under the foundation shall not be accepted. If any leak, running water, wet spots, etc., appear within the warranty period the Contractor shall be responsible for correcting any and all leaks or defects.

H. A soak test shall be performed to check the level of chemical contaminants. Following a seven day soaking period, the water in the reservoir shall be sampled to determine the level of any Volatile Organic Compounds. Samples of the water shall be analyzed by a laboratory certified by the State Department of Health.

I. A report of the test results shall be sent to the Department of Health regional office for evaluation and approval before delivering water from the reservoir. Re-testing shall be required when contamination exceeding the trigger level is found.

## 3.3 INSPECTIONS

A. The Owner shall be furnished with copies of all inspection reports and test results for tests performed by the Contractor or the Contractor's testing agency. The following inspections must be performed:
   1. Mill Testing, indicating reservoir shell plate yield stresses to be performed by an independent testing agency approved by the Owner at the Contractor's expense.
   2. Shop Painting and Paint Preparation to be performed by an independent testing agency retained and paid for by the Owner. A shop painting and preparation plan shall be submitted to the Owner for review and approval prior to fabrication.
   3. Welding, in conformance with AWWA, D100 Section 14, IBC 2018 Section 1701, and the project specifications to be performed by a representative of the Owner at the Owner's expense. The Contractor shall provide certified records that the weld qualification procedure meets the requirements of AWWA D100. Weld testing and inspection shall be performed in accordance with IBC 2018 Section 1701, AWS D1.1, and AWWA D100. Field welding and shop welding requiring inspection or testing per IBC 2018 1701 and the requirements of this specification shall be performed by a WABO-certified independent testing laboratory at the Owner's expense. This does not relieve the Contractor of the responsibility to perform their own inspections and testing to ensure proper reservoir construction.
   4. Radiographic inspections to be performed by an independent testing agency approved by the Owner at the Contractor's expense.

**END OF SECTION**

# SECTION 33 31 11
## GRAVITY SEWER PIPELINE AND MANHOLE CONSTRUCTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Installation and testing of sewer pipes, manholes, structures and appurtenances.
   2. Connections to existing sewers.
   3. Coordination and interface with existing facilities and utilities.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 00 - Earthwork.
   4. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
   5. Section 32 12 16 - Asphaltic Concrete Vehicular Paving.
   6. Section 32 91 13 - Topsoiling and Finished Grading.
   7. Section 33 05 16 - Precast Concrete Manhole Structures.
   8. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
      b. D2321, Standard Practice for Underground Installation of Thermosplastic Pipe for Sewers and Other Gravity-Flow Applications.
      c. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
      d. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
      e. F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
      f. F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
      g. F1417, Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
   2. American Water Works Association (AWWA):
      a. Polyvinyl chloride (PVC) materials:
         1) C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN Through 12 IN, for Water Distribution.
         2) C905, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 IN through 48 IN, for Water Transmission and Distribution.
   3. Occupational Safety and Health Administration (OSHA).

### 1.3 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Catalog data sheets for all materials.
c. Details of all piping system components confirming that the pipe, fittings, and appurtenances conform to the specified requirements.
d. Manufacturers' written recommendations for material handling, delivery, storage, installation, and minor repair of materials damaged in shipping.
e. Recommended details for buoyancy restraint and for manhole/pipe connections.
f. Fabrication and/or layout drawings as specified in individual pipe material specifications.

2. See individual pipe material specifications for additional required submittals.

C. Test Reports:
1. Submit results of leakage tests including the following:
a. Test procedure.
b. Pipeline segment tested.
c. Length of pipe tested.
d. Test pressure.
e. Test duration
f. Amount of leakage.
g. Corrective action, if any.

D. Contract Closeout Information:
1. Operation and Maintenance Data.

### 1.4 DELIVERY, STORAGE, AND HANDLING OF PRODUCTS

A. In addition to the requirements specified in this section, see Section 01 65 50 - Product Delivery, Storage and Handling and related paragraphs in individual pipe specifications.

B. Deliver, handle and store products in accordance with manufacturer's instructions.

C. Protect pipeline sections stored at the site from damage.

D. Store all products above the ground upon platforms, pallets, skids, or other supports supplied by the Contractor.
1. Store in a way to permit ready access for identification and inspection by the Engineer.

E. Keep products free from dirt and other foreign matter.

F. Provide suitable quantities of all lifting equipment to handle the pipe.
1. Do not utilize any equipment that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the pipe.
2. Do not drag or drop pipe.

G. Place pipe lain directly on the ground prior to placement on an area free of loose stones or sharp objects.

H. Repair or replace any new pipe and fittings damaged before or during installation at Contractor's expense, before proceeding further.
1. Utilize repairs methods as recommended by the manufacturer.
2. Replace damaged materials as directed by Owner's project representative.

I. Protect PVC pipe from UV degradation if stored outside for more than 60 days.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Pipe:
1. PVC pipe shall be rigid, unplasticized polyvinyl chloride (PVC) made of PVC plastic having a cell classification of 12454-B or 12454-C as described in specification ASTM D1784.

2. The requirements of this Specification are intended to provide for pipe and fittings suitable for non-pressure drainage of wastewater.
3. Joining systems shall consist of an elastomeric gasket joint meeting requirements of ASTM D3212 and the seals meet ASTM F-477 for elastomeric seals. Supply to the Engineer all information and sample of joining method for his evaluation.
4. Only jointing methods acceptable to the Engineer will be permitted.
5. Provide pipe and fittings meeting or exceeding the following requirements:
   a. 4-27 IN DIA: ASTM D3034 and ASTM F679, SDR 35.
6. Ensure impact strengths and pipe stiffnesses in full compliance to these Specifications.

B. Manholes: See Specification Section 33 05 16.

C. Fill and Backfill at manholes: See Specification Section 31 23 33.

D. Embedment and Bedding Materials for pipelines: See Section Specification 31 23 33.

E. Size mandrels to meet deflection requirements specified herein or in the individual pipe material specifications.

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

A. Install products in accordance with manufacturer's instructions.

B. Furnish all construction materials and equipment required for installation and backfill.

C. Install the pipeline complete, including bends, and other associated work and appurtenances, as shown on the Drawings or as herein specified.

D. Make all necessary connections to sewer lines shown on the Drawings and in accordance with the Specifications.

E. Construct all sewer piping, manholes, and structures to be free of visible ground water inflow.
1. Install sanitary sewer manholes and structures that are watertight.
   a. Repair or replace any manhole or structure showing infiltration of ground water through joined surfaces, pipe to manhole/structure connections or manhole/structure wall.
2. Install pipe with water tight pipe joints.
   a. Repair or replace any joint showing infiltration of ground water through pipe joints or pipe to manhole connections.

F. Alignment: Lay gravity sewer lines in straight alignment and uniform grade between manholes.
1. Install at grade as shown on drawings.

G. Brace and protect pipe sections to prevent deformation during installation and backfill.

H. Deflection: Pipe deflection after final backfill shall not exceed the specified limits detailed in the individual pipe specifications.
1. Remove and replace any pipe observed to be deflecting in excess of the specified limits.

I. Perform testing in accordance with requirements of this Section.

J. Provide Engineer with free access to work for inspection.
1. Such inspection shall not relieve the Contractor of his responsibility for performing Work in accordance with the Contract Documents.

### 3.2 PIPELINE INSTALLATION

A. Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.

B. Lateral shoring of the trench walls or other similar construction methods may be required.
1. Design and implement all such methods.

2. When required, install shoring in accordance with all applicable local, State and OSHA regulations.
3. Remove shoring prior to backfilling.

C. Grade bottoms of trenches such that when bedding is placed between the trench bottom and the pipe, each section of pipe is installed to the specified depth or elevation with uniform support.

D. Determine and fix alignment and grade or elevation of each pipeline from offset stakes or calibrated laser instruments.

E. Install pipelines on the line and grade shown on the drawings.
1. Calculate required elevation of each pipe joint and survey installed elevation at each joint prior to stabbing the next joint to verify grade.
2. Relay pipe to proper grade if any joint elevation deviates from the calculation by more than 0.01 FT.

F. Remove material at the bottom of the trench if determined to be unsuitable by the Engineer.
1. Backfill trench with approved subgrade material or bedding material to the specified depth or elevation as described in Specification Section 31 23 33.

G. Install only clean pipe and fittings.
1. Provide physical barriers to protect open ends of sections of pipe in place from the entrance of trench water, mud, dirt, or other foreign substances with when pipe installation is not in progress.

H. Begin pipe laying at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

I. Where the drawings require concrete encasement or flowable fill embedment and backfill, anchor pipe as required to prevent floatation.
1. Alternatively, Contractor may place concrete or flow fill materials in staged lifts allowing each lift to reach initial set prior to placing the subsequent lift to limit buoyancy effects and prevent floatation of the pipeline.

J. Pipeline may be backfilled as it is installed, provided all inspection and testing requirements are met.

K. Pipe, fittings, and special pieces will be subject to inspection by Engineer, prior to installation.
1. Report all damages not detected by Engineer but discovered by Contractor during installation to Engineer for corrective action or replacement.

L. Repair of pipe damaged during installation shall conform to the manufacturer's repair procedures; with the concurrence of Engineer.

## 3.3 RESTORATION

A. Restore all existing structures or services damaged by Contractor's operations at no cost to Owner.
1. Repair or replace culverts that are damaged, removed or interfere with the work as part of restoration at no additional cost to Owner.

B. Restore all area disturbed by installation of the pipelined in accordance with the Specifications and the Drawings,
1. Provide slope protection, re-vegetation, and road restoration as necessary.

C. Driveway Removal and Replacement:
1. All Portland cement concrete and asphalt noted for removal and replacement shall be cut prior to removal.
a. Cut by sawing, vertical cut to be 1 IN minimum.
b. The remaining depth of section may be broken out in a manner subject to Engineer's approval.

c. Width of section removed to be either a width not greater than the outside diameter of the sewer plus 4 FT-0 IN or broken out to the nearest joint.
2. Replace Portland cement concrete and asphalt equal to or better than original paving.
3. Debris resulting from the above operations shall be removed and disposed offsite.

D. Gravel Surfaced Drives and Roadways:
1. Restore all damaged gravel surfaced drives and roadways to a condition equal to or better than original.
a. Payment to be at bid unit price for this item.

E. Trees:
1. Do not remove trees without written instructions from the Engineer unless tree removal is shown on drawings.
2. No separate payment will be made for tree removal and the cost shall be included in the bid unit price sewer pipe.

F. Fences, Signs, Mailboxes, etc.:
1. Restore all damaged fences, signs, mailboxes, etc., to their original conditions.
a. No separate payment will be made for these items.

## 3.4 PROTECTION OF EXISTING UTILITIES

A. Verify the location of all underground utilities.
1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.

B. Notify utility representative prior to construction to obtain available information on location of existing utilities.
1. Contractor shall be responsible for locating all utilities.

C. Notify representative of the underground utilities 24 HRS in advance of crossings.

D. Existing water services and sewer services:
1. Repair damage to existing water service using copper pipe and union the same size as existing service.

## 3.5 FIELD QUALITY CONTROL

A. General Testing Requirements:
1. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
2. Obtain Engineer's approval of methods and the equipment used for the tests prior to testing. A low-pressure air test or hydrostatic test per these specifications are both allowable options.
3. Provide reasonable facilities and access for Engineer to inspect, test and obtain such information as required with respect to the materials used and the progress and condition of the Work and the results obtained.
a. Work that is not performed in accordance with the procedure or does not comply with the requirements of the Specifications will be rejected.
4. Coordinate testing schedules with Engineer.
a. Perform all specified tests under observation of Engineer.
b. Provide a minimum of 24 HRS advance notice prior to commencing any testing.
5. Perform testing as work progresses and as required to facilitate connections with existing sewers.
6. Obtain water for testing and cleaning at no additional cost to the Owner.
7. Test only those portions of pipes that have been installed as part of this Contract.
a. Test new pipe sections prior to making final connections to existing piping.
b. Furnish and install plugs, bulkheads, and restraints required to isolate new pipe sections.

8. Unsuccessful Tests:
    a. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
    b. Repeat testing until tests are successful at no additional cost to Owner.
9. Deflection:
    a. Check each section of pipe after backfilling for deflection by pulling a mandrel through the pipe.
    b. Conduct test after the final backfill has been in place at least 30 days.
    c. Maximum long term deflection: less than 5 PCT of the initial diameter.

B. Lamping:
1. Install each section of sewer line between manholes to be straight and uniformly graded.
2. Each section will be lamped by Engineer.
3. Furnish suitable assistants, materials and air monitoring to assist Engineer.

C. Low Pressure Air Testing:
1. Test all gravity sewer pipes with a low pressure air test.
    a. Comply with ASTM F1417.
    b. Time elapsed for a 1 PSI drop in air pressure: Per ASTM F1417.
    c. Maximum air loss: Per ASTM F1417.
2. Submit schedule to Engineer for approval prior to starting the tests.
3. If the length of sewer to be tested is fully or partially submerged in groundwater, increase test pressure as necessary to overcome the actual static pressure exerted by the groundwater.
    a. If a test pressure greater than 8 psi results, utilize water infiltration testing in lieu of air testing.
4. Locate leaks by testing short sections of pipe.
    a. Repair leaks and retest affected reach of sewer.

D. Exfiltration/Infiltration Testing:
1. Hydrostatic exfiltration and infiltration for gravity sewers (groundwater level is below the top of pipe):
    a. Pipe and joints shall sustain losses not exceeding 0.04 gallons per hour per inch diameter per 100 feet of pipe when field-tested by exfiltration methods.
    b. The hydrostatic head for test purposes shall exceed the maximum estimated groundwater level in the section tested by at least 72 inches of water column and in no case shall be less than 72 inches of water column above the inside top of the highest section of pipe in the test section, including service connections. The Engineer will make the final decisions regarding test height for the water in the pipe section being tested. The length of pipe tested by exfiltration shall be limited so that the pressure of the invert of the lower end of the section shall not exceed 28 feet of water column.
    c. The pipe test section may be filled 24 hours prior to time of exfiltration testing, if desired, to permit normal absorption into the pipe walls to take place.
    d. All service connection footage shall be taken into account in computing allowable leakage.

E. Deflection Testing: Test all flexible sewer pipes for deflection.
1. Perform the mandrel test with the Engineer in observance for all pipe sizes.
2. Deflection limits: as indicated in the individual pipe sections or as specified in article titled "General Testing Requirements" above, whichever is more stringent.
3. Conduct test after the final backfill has been in place at least 30 days.
4. Correct pipes failing deflection test and conduct second test after final backfill has been in place an additional 30 days.

F. Manhole Testing:
1. Field-test all sanitary sewer manholes for acceptance by either hydrostatic or vacuum testing after completion of backfilling, compaction and surface restoration, including paving. If the

manhole fails the test, make necessary repairs by an approved method, and retest the manhole. Repair and retest the manhole until a satisfactory test is obtained.

a. Hydrostatic Testing – Perform hydrostatic testing according to ASTM C497. Plug all inlets and outlets and fill the manhole with water. Fill each manhole to the rim at the start of the test. Leakage in each manhole shall not exceed 0.3 gallons per hour per foot of head above the invert. Determine leakage by refilling to the rim using a calibrated container. Manholes may be filled 24 hours prior to the time of testing to permit normal absorption into the manhole walls.
b. Vacuum Testing – Perform vacuum testing according to ASTM C1244. Plug and brace all pipes entering the manhole. Place the test head in or on top of the manhole ring. Draw a vacuum of 10 inches of mercury on the manhole, close the valve on the vacuum line of the test head, and shut off the vacuum pump. Measure the time for the vacuum to drop to 9 inches of mercury. The manhole is acceptable if the time for vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in ASTM C1244.

2. Visually inspect all manholes for leaks and defects prior to manhole testing.
3. Repair all leaks, defects or cracks discovered by visual inspection prior to testing.
4. Make all necessary repairs and retest the manhole.
   a. Inspect exterior of the manhole during this period for visible evidence of leakage.
   b. All repairs will be subject to acceptance by the Engineer.

**END OF SECTION**

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# SECTION 33 40 00
## STORM DRAINAGE SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Storm drainage systems.
   2. Storm drainage pipe.
   3. Inlets, headwalls, flumes and flared end sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
   4. Section 33 05 16 Precast Concrete Manhole Structures.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
      b. F2510/F2510M, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
      c. F2648/F2648M, Standard Specification for 2 to 60 IN (50 to 1500 MM) Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.
   2. Standard Specifications for Road and Bridge Construction for the State of Oregon:
      a. Standard Details.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Certifications.
   4. Test reports.
   5. Submit all tests and certification in a single coordinated submittal.
      a. Partial submittals will not be accepted.

B. Submit schedules and details for structures and joints.

### 1.4 WARRANTY

A. Warrant that the infiltration will not exceed the amount specified in the Exfiltration Test paragraph in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section during the one year correction period.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Reinforced Concrete Pipe (RCP):

1. Reinforced concrete culvert, storm drain and sewer pipe: ASTM C76, Classes III, IV, and V.

B. RCP Joint Sealer:
   1. Rubber gasket: ASTM C361.

C. Flared End Sections:
   1. Conform to State of Oregon Specifications.
   2. Bituminous coated: AASHTO M190, Type A.
   3. Jointing: Same as pipe.

D. Polyvinyl Chloride Pipe (PVC)
   1. Per ASTM D1785 for schedule 40 or 80 or ASTM D2241 for specified SDR
   2. Per ASTM D2729 for DWV
   3. Fittings, per System Type:
      a. PVC per ASTM D2466 or ASTM D2467
      b. PVC DWV fittings per D2729
   4. Joints:
      a. Solvent weld per ASTM D2855
      b. Hub and spigot with solvent weld per ASTM D2855.

E. CMP Joint Sealer:
   1. Cold applied asphalt joint compound.
   2. Preformed flexible pipe joint sealing compound.

F. Concrete and Reinforcement for Inlets, Manholes, Junction Boxes, Headwalls, and Flumes:
   1. Conform to Drawings and Details.

G. Concrete and Reinforcement for Concrete Flared End Sections:
   1. Conform to Drawings and Details.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Comply with Specification Section 31 23 33.

### 3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Comply with Specification Section 31 23 33.

### 3.3 FIELD QUALITY CONTROL

A. Verify and coordinate installation.

B. Exfiltration Test:
   1. Perform an exfiltration test on each reach of sewer between manholes.
      a. Test the first reach after backfilling and prior to installing any of the remaining pipe, or any additional reach.
      b. Single or multiple reaches may be tested thereafter, at Contractor's option.
      c. Subject each manhole to at least one test.
      d. Provide all necessary piping between the reach to be tested and the water supply, and other necessary materials and equipment.
      e. Air testing may be allowed.
         1) Submit complete information to Engineer for review describing the proposed test method, scheduling, and duration, including the method of testing manholes before beginning testing.
   2. Procedure:
      a. Block off all manhole openings, except those connecting with the reach being tested.

b. Fill the line.
    1) Average depth: 10 FT above invert, except as required by manhole depth.
    2) Depth at lower end: 25 FT maximum above crown.
    3) Depth at upper end: 5 FT minimum above crown.
c. Add and measure water as required to maintain a constant level.
    1) Exfiltration: 100 GAL maximum per inch of nominal diameter per mile per day.
    2) Manholes are considered section of 48 IN pipe.
d. Maintain test for at least 2 HRS, or as long as necessary in Engineer's opinion, to locate all leaks.

3. Repair and retest any reach that exceeds the allowable exfiltration.

C. Infiltration Test:
1. If at any time prior to expiration of the correction or warranty period infiltration exceeds 200 GAL/IN of nominal diameter/mile/day, locate the leaks and make repairs.

D. Video Test:
1. Provide video of installed storm drainage system after flow test.

E. In case of conflict, do not relocate piping without prior approval from the Engineer.

**END OF SECTION**

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# SECTION 33 41 00
SUBDRAINAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Foundation drain systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 23 00 - Earthwork.
   2. Section 31 23 33- Trenching, Backfilling, and Compacting for Utilities.
   3. Section 33 40 00 - Storm Drainage System.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M252, Standard Specification for Corrugated Polyethylene Drainage Pipe

### 1.3 SYSTEM DESCRIPTION

A. Foundation Drainage System:
   1. System which drains by gravity and drains as shown on Drawings.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. Fabrication and/or layout drawings:
      a. Layout diagram of drainage system(s).
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Type, size and manufacturer of drain pipe.
      d. Type, size and gradation of filter material.
      e. Type and manufacturer of filter fabric.
   3. Certifications.
   4. Test reports.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Filter fabric:
      a. Mirafi 140N by Mirafi Inc.
      b. US 120NW by US Fabrics, Inc.

### 2.2 DRAIN PIPE

A. Drain Pipe:
   1. Inside diameter: 6 inches.
   2. Provide fittings so that thickness, weight, material and quality correspond to that of the drain pipe approved for use.

B. Filter Material: Graded gravel or crushed stone meeting the following sieve analysis:

| SIEVE SIZE | PERCENT PASSING |
|---|---|
| 1 inches | 95 - 100 |
| 3/8 inches | 20 - 85 |
| No.10 | 0 - 10 |
| No.200 | 0 - 3 |

C. Filter Fabric:
   1. Nonwoven polypropylene fabric.
   2. Not less than 4 oz/SY.
   3. Resistant to the chemical actions of the soil and water and nonbiodegradable.
   4. Fabric to prevent the migration of soil particles into the filter material while allowing the free flow of water from the subsoil to the drain pipe.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Lay filter fabric with 12 inches minimum laps at splices.
   1. Spread filter material in same direction as fabric overlap.
   2. Patch tears and holes in fabric with piece of same fabric material large enough to cover the tear or hole plus a 12 inches overlap.

B. Lay drain pipe lines firmly bedded in filter material to true grades and alignment with invert elevation shown on Drawings.
   1. Unless indicated otherwise on Drawings, install pipes level to point of discharge with perforations down and joints closed.
   2. Make joints with sleeve type couplings or tapered couplings.
   3. Provide couplings suitable for holding pipe firmly in alignment without use of sealing compounds or gaskets.
   4. Face bells upgrade away from point of discharge.
   5. Use 1/8 bends for change in direction; use Y fittings at intersections.

C. Test drain lines with water to assure free flow before covering.
   1. Remove obstructions and retest until satisfactory.

D. Provide filter material around drain pipes of depths and thicknesses shown on Drawings.
   1. Compact filter material with vibrator tamper to density required to preclude settlement and to avoid damage to drain pipe and to filter fabric.
   2. Avoid damage to foundation.

**END OF SECTION**

# SECTION 33 44 23
## INLINE STORMWATER FILTERS

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. PerkFilter® Media Filtration System (or approved equal) – cartridge filtration for stormwater treatment provided in a concrete vault, manhole, catch basin, or large panel vault.

### 1.2 RELATED SECTIONS

A. Section 01 33 00 – Submittals

B. Section 31 23 00 – Earthwork

C. Section 31 23 33 – Trenching, Backfilling, and Compaction for Utilities

D. Section 31 25 00 – Soil Erosion and Sediment Control

### 1.3 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M105 – Standard Specification for Gray Iron Castings

B. American Society for Testing and Materials (ASTM)
   1. ASTM A48, CL.30B – Standard Specification for Gray Iron Castings
   2. ASTM A82 – Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
   3. ASTM A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
   4. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
   5. ASTM A496 – Standard Specification for Deformed Steel Wire for Concrete Reinforcement
   6. ASTM A497 – Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
   7. ASTM A615 – Standard Specification for Deformed and Plain, Carbon-Steel Bars for Concrete Reinforcement
   8. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   9. ASTM C33 – Standard Specification for Concrete Aggregates
   10. ASTM C139 – Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
   11. ASTM C150 – Standard Specification for Portland Cement
   12. ASTM C478 – Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
   13. ASTM C595 – Standard Specification for Blended Hydraulic Cements
   14. ASTM C890 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
   15. ASTM C891 – Standard Practice for Installation of Underground Precast Concrete Utility Structures
   16. ASTM C913 – Standard Specification for Precast Concrete Water and Wastewater Structures
   17. ASTM C990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
   18. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic Cement Grout (Non-Shrink)
   19. ASTM C1227 – Standard Specification for Precast Concrete Septic Tanks
   20. ASTM C1244 – Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

21. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
22. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe
23. ASTM D2466 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

C. Definitions:
1. BMP: Best Management Practices
2. TSS: Total Suspended Solids

## 1.4 SUBMITTALS

A. The following shall be submitted by contractor in accordance with Section 01 33 00 Submittal Procedures:
1. Product Data for the Media Filter:
   a. Product specifications to include but not limited to specification sheets, brochures, and performance claims.
   b. Inspection and maintenance guidelines.
   c. Submittal drawings shall be provided and annotated to indicate all materials to be used and applicable material standards, required tests of materials, and all design assumptions for structural analysis. Details of steel reinforcing size and placement shall be submitted if professional engineering stamp and calculations are required by the customer. It is the responsibility of the project's engineer-of-record to verify that the design assumptions are suitable for the proposed application.
2. Independent third-party certification or test report demonstrating conformance to applicable local or regional BMP standards before the treatment system is installed for the following, upon request:
   a. Targeted Pollutants of Concern
   b. Removal Efficiency
   c. Hydraulic Capacity
   d. Certification of adherence to applicable standard
3. Products submitted as approved equal must be approved by the Project Engineer.

## 1.5 QUALITY ASSURANCE

A. The precast concrete producer shall demonstrate adherence to the standards set forth in the plant Quality Control Manual.
1. Qualifications, Quality Control and Inspection
   a. The precast producer shall maintain a permanent quality control department.
   b. The precast concrete producer shall have a quality control program which is audited for compliance annually by persons outside that plant's employee structure.
   c. Upon request, the precast concrete producer shall supply a copy of their quality control manual.
2. Quality Control
   a. The precast concrete producer shall perform standard concrete testing and inspection.
      1) Preplacement Check
         a) All non-machine-cast products shall be inspected for accuracy prior to placing concrete. Checks shall include, but not be limited to, form condition and cleanliness, form dimensions, joints, release agent, blockouts, inserts and locations, lifting devices, reinforcing steel size, spacing, clearances and proper placement. Machine cast products shall have a minimum 5% of the production checked at random.
         b) Preplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.
      2) Postplacement Check
         a) All non-machine-cast products shall be inspected for accuracy after the concrete forms have been removed. Checks shall include, but not be limited

to, dimensional checks, finishing, insert locations, squareness, honeycombing, cracking, marking, coatings, racking, hole size and location. Postplacement checks may require a corrective action report. Machine cast products shall have a minimum of 5% of production checked at random.

b) Postplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

3) Copies of the test results and inspections above shall be available upon request.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. All treatment system components shall be delivered to the site and unloaded with handling that conforms to the manufacturer's instructions for reasonable care. Concrete and internal components shall not be rolled or dragged over gravel or rock during handling. The contractor shall take necessary precautions to ensure the method used in lifting or placing the treatment system does not induce stress fatigue in the concrete.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

A. The inline stormwater filter treatment system shall consist of an underground precast concrete structure that houses rechargeable, passive, orifice controlled, radial-flow, media-filled filter cartridges. The concrete structure may be a vault, manhole, catch basin, or large panel vault. The treatment system shall remove sediment, metals, nutrients, gross solids, trash and debris as well as petroleum hydrocarbons.

B. The stormwater filter treatment system shall be sized at a hydraulic loading rate of no more than 2.5 gpm/sf of media surface area. The water quality treatment flow rate shall be as determined and approved by the Engineer.

C. The stormwater filter treatment system shall include an inlet chamber as well as a treatment chamber for the filter cartridges. The inlet chamber shall be self-draining, unless otherwise specified, to increase the effective life of the filter media. Filtration shall begin once the treatment chamber fills to the top of the cartridges, in order to promote distribution of sediment and other captured pollutants over the entire cartridge surface.

D. The treatment system must include the capability to partition flows, directing treatment flows into the filtration chamber. Flows exceeding the treatment capacity of the unit shall be diverted around the filtration chamber to prevent resuspension and washout of previously trapped pollutants. This can be accomplished with either internal or external bypass.

E. The Contractor shall furnish and install the stormwater filtration system complete and operable as shown and as specified herein in accordance with the requirements of the plans and contract documents.

### 2.2 MATERIALS AND DESIGN

A. Concrete for precast stormwater treatment systems shall conform to ASTM A478 or ASTM C890 and C913 and meet the following additional requirements:
   1. In all cases the wall thickness shall be no less than the minimum thickness necessary to sustain HS20-44 (MS18) loading requirements as determined by a Licensed Professional Engineer.
   2. Sections shall have tongue and groove or ship-lap joints with a butyl mastic sealant conforming to ASTM C990.
   3. Cement shall be Type I, II, or III Portland cement conforming to ASTM C150.
   4. All sections shall be cured by an approved method. Sections shall not be shipped until the concrete has attained a compressive strength of 4,000 psi (28 MPa) or other designate suitable handling strength.

5. Pipe openings shall be sized to accept pipes of the specified size(s) and material(s), and shall be sealed by the contractor with hydraulic cement conforming to ASTM C595M or ASTM C1107.
6. Aggregates shall conform to ASTM C33, except that the requirement for gradation shall not apply.
7. Reinforcement shall consist of wire conforming to ASTM A82 or A496, of wire mesh conforming to ASTM A185 or A497, or Grade 40 steel bars conforming to ASTM A615.
8. Castings for manhole frames and covers shall be in accordance with ASTM A48, CL.30B and AASHTO M105. The access cover/s shall be designed for HS20-44 traffic loading and shall provide a minimum of 30-inch clear opening.
9. Brick or masonry used to build the structure or manhole frame to grade shall conform to ASTM C32 or ASTM C139 and shall be installed in conformance with all local requirements.
10. All mounting hardware for internal components shall be made of 304SS and shall conform to ASTM A240.

### 2.3 PERFORMANCE

A. Each specified stormwater treatment system shall have a General Use Level Designation (GULD) for Basic and Phosphorus Treatment from the Washington Department of Ecology and shall be approved for use with integrated high flow bypass capability. Based on the GULD, each system shall be designed for an operating rate of 1.5 gpm/ft$^2$ and shall be capable of:
   1. Greater than 80% removal of TSS and
   2. Greater than 50% removal of total phosphorus.

B. Each specified stormwater treatment system shall also have a New Jersey Corporation for Advanced Technology (NJCAT) verification and New Jersey Department of Environmental Protection (NJDEP) certification and shall be approved for use as a filtration treatment system. Based on the certification, each system shall be designed for an operating rate of 2.5 gpm/ft$^2$ and shall be capable of greater than 80% removal of TSS.

### 2.4 MANUFACTURER

A. Each stormwater filtration system shall be a PerkFilter® as manufactured by Oldcastle Infrastructure, 7000 Central Parkway, Suite 800, Atlanta, GA 30328. Phone: (800) 579-8819; or approved equal.

## PART 3 - EXECUTION

### 3.1 SURVEY

A. The installation area shall be surveyed using the work print and a checklist to identify the work to be done and to determine that the plans are correct.

B. All underground facilities and structures such as gas, water, sewer, power, telephone cable, and so forth shall be located and identified. Location markings shall be placed by the affected utilities before construction.

C. The survey shall identify obstacles such as overhead wires, building structures that will interfere with crane operations, work progress, or create a safety hazard.

D. The survey shall give consideration to the soil structure so that proper shoring, sloping, or both may be planned in advance of the excavation work.

### 3.2 PLANNING

A. Permits required to do work in accordance with the detail plans shall be secured before starting the job. All permits or a record of the permits shall be retained on the job for immediate reference.

B. All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation. Every effort shall be made to avoid damage to the facilities of others. If any damage occurs, the owner of the damaged facility shall be notified immediately.

C. Planning shall include the coordination of all responsible parties to ensure that arrangements for removal of excess and damaged material have been made.

D. Should it appear that a structure location will interfere with traffic, review the situation with the engineer and notify appropriate authorities.

E. Provide for access to call boxes, fire hydrants, etc.

## 3.3 SAFETY REQUIREMENTS

A. Safety requirements for construction shall be in accordance with all federal, state, and local regulations.

## 3.4 EXCAVATING

A. If unforeseen facilities or obstructions are encountered, stop excavation operations immediately. Expose the obstruction with wood handled digging tools and investigate them with caution. If there is any doubt as to the type of obstruction exposed, request positive identification from those suspected of owning the facility and then proceed as circumstances dictate.

B. Inspect excavations after every rainstorm or other hazard-increasing occurrence, and increase the protection against slides and cave-ins, if necessary.

C. In dewatering excavations, make certain that the discharge is carried to a suitable runoff point.

D. Excavation size shall be large enough to allow access around the structure after it is installed.

## 3.5 SHORING

A. Shoring for construction shall be in accordance with all federal, state, and local regulations

## 3.6 INSTALLATION

A. Site Access – The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage, and proper handling of the precast concrete units.

B. Vault Installation – Precast concrete units shall be installed: to the lines and grades shown on the contract documents or otherwise specified; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions. Field modifications to the product shall relieve the precast producer of liability and warranty regardless if such modifications result in the failure of the precast concrete unit.

C. Plumbing – Inlet and outlet piping, as required, shall be installed and connected in accordance with applicable piping specification. All connections shall be watertight.

D. Leak Resistance – Where leak resistance is a necessary performance characteristic of the precast concrete unit's end use, joint sealant, pipe-entry connectors and other penetrations shall be sealed according to manufacturer's requirements to ensure the integrity of the system.

## 3.7 BACKFILLING AND RESTORATION

A. Complete backfilling as soon as possible after the structure has been placed.

B. Backfill material shall be granular and free from large stones, rocks, and pavement. Expansive soil material shall not be used as backfill around the structure.

C. Backfilling shall be achieved by lifts (layers) to the required compaction.

D. Follow up inspections for settlements are required. Should settlement occur, the contractor shall be responsible for all necessary repairs.

## 3.8 FIELD QUALITY CONTROL

A. Job Site Tests – When leak resistance testing is required for a precast concrete structure, one of the following methods may be followed:
   1. Vacuum Testing
      a. Prior to backfill, vacuum test system according to ASTM C1244 for manholes and ASTM C1227 for septic tanks.
   2. Hydrostatic Testing
      a. First Backfill the structure, then fill to the normal water level, let stand for 24 hours. Refill to the original water line and measure the water level change over a 24-hour period. Leak shall not exceed 5% of volume.

B. Inspection
   1. Final field elevations and compaction properties shall be verified and documented.

## 3.9 INTERNAL COMPONENT INSTALLATION

A. Internal components may include bypass assembly(s), outlet hood, filter cartridge(s), and cartridge hold-down bar(s).

B. If the filtration system is delivered without fully pre-installed internal components, the contractor shall install internal components, as required. All internal parts shall be pre-cut, and/or preassembled by the manufacturer for installation by the contractor. Upon request, the manufacturer will provide technical assistance for installation of internal components.

## 3.10 ACTIVATION

A. The treatment system shall be protected from construction runoff and construction sediment using appropriate erosion control practices and pipe plugs, as necessary.

B. The treatment system shall not be activated until all sediment is swept from gutters and stormwater collection system piping is flushed and cleaned, as appropriate. No sediment shall be allowed to enter the treatment system during flushing or as a result of the flushing process.

C. If the inlet piping has been plugged to protect the treatment system from sediment during construction, remove the plug(s) from the inlet pipe(s) to active the treatment unit.

**END OF SECTION**

# DIVISION 40

## PROCESS INTERCONNECTIONS

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# SECTION 40 05 00
## PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
1. Process piping systems.
2. Utility piping systems.
3. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Procurement and Contracting Requirements.
2. Division 01 - General Requirements.
3. Section 09 96 00 - High Performance Industrial Coatings.
4. Section 10 14 00 - Identification Devices.
5. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
6. Section 40 05 07 - Pipe Support Systems.
7. Section 40 05 51 - Valves - Basic Requirements.
8. Section 40 41 13 - Heat Tracing Cable.
9. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760).
   b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
   d. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
2. American Iron and Steel Institute (AISI).
3. American Society of Mechanical Engineers (ASME):
   a. B16.3, Malleable Iron Threaded Fittings.
   b. B16.5, Pipe Flanges and Flanged Fittings.
   c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
   d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
   e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   f. B36.19, Stainless Steel Pipe.
   g. B40.100, Pressure Gauges and Gauge Attachments.
4. ASTM International (ASTM):
   a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   c. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   e. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   f. A197, Standard Specification for Cupola Malleable Iron.
   g. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

h. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
i. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
j. A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
k. A536, Standard Specification for Ductile Iron Castings.
l. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
m. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
n. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
o. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
p. B88, Standard Specification for Seamless Copper Water Tube.
q. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
r. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
s. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
t. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
u. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
v. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
w. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
x. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
y. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
aa. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
bb. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

5. American Water Works Association (AWWA):
   a. B300, Standard for Hypochlorites.
   b. C200, Standard for Steel Water Pipe - 6 IN and Larger.
   c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
   d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   e. C606, Standard for Grooved and Shouldered Joints.
   f. C651, Standard for Disinfecting Water Mains.
   g. C800, Standard for Underground Service Line Valves and Fittings.
6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.

7. Chlorine Institute, Inc. (CI):
    a. Pamphlet 6, Piping Systems for Dry Chlorine.
8. Cast Iron Soil Pipe Institute (CISPI):
    a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
9. International Plumbing Code (IPC).
10. National Fire Protection Association (NFPA):
    a. 54, National Fuel Gas Code.
    b. 69, Standard on Explosion Prevention Systems.
11. Underwriters Laboratories, Inc. (UL).

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

## 1.3 DEFINITIONS

A. Hazardous Gas Systems: Digester gas, chlorine gas, sulfur dioxide gas, carbon dioxide gas, lab gases.

B. HPIC: High performance industrial coating.

C. PVDF: Polyvinylidene fluoride.

## 1.4 SYSTEM DESCRIPTION

A. Piping Systems Organization and Definition:
1. Piping services are grouped into designated systems according to the chemical and physical properties of the fluid conveyed, system pressure, piping size and system materials of construction.
2. See PIPING SPECIFICATION SCHEDULES in PART 3.

## 1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
    c. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
        1) Attach technical product data on gaskets, pipe, fittings, and other components.
3. Fabrication and/or Layout Drawings:
    a. Exterior yard piping drawings (minimum scale 1 IN equals 10 FT) with information including:
        1) Dimensions of piping lengths.
        2) Invert or centerline elevations of piping crossings.
        3) Acknowledgement of bury depth requirements.
        4) Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.
        5) Acknowledge designated valve or gate tag numbers, manhole numbers, instrument tag numbers, pipe and line numbers.
        6) Line slopes and vents.
    b. Interior piping drawings (minimum scale 1/8 IN equals 1 FT) with information including:
        1) Dimensions of piping from column lines or wall surfaces.
        2) Invert or Centerline dimensions of piping.
        3) Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.

4) Location and type of pipe supports and anchors.
5) Locations of valves and valve actuator type.
6) Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
7) Acknowledgement of valve, equipment and instrument tag numbers.
8) Provisions for expansion and contraction.
9) Line slopes and air release vents.
10) Rough-in data for plumbing fixtures.

c. Schedule of interconnections to existing piping and method of connection.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Qualifications of lab performing disinfection analysis on water systems.
2. Test reports:
a. Copies of pressure test results on all piping systems.
b. Reports defining results of dielectric testing and corrective action taken.
c. Disinfection test report.
d. Notification of time and date of piping pressure tests.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe coating during handling using methods recommended by manufacturer.
1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to pipe during transit.
1. Repair abrasions, scars, and blemishes.
2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Insulating unions:
a. "Dielectric" by Epco.
2. Dirt strainers (Y type):
a. Mueller (#351).
b. Sarco.
c. Armstrong.
3. Chemical strainers (Y type):
a. Chemtrol.
b. Asahi.
4. Dry disconnect couplings:
a. Kamlock.
5. Dielectric flange kit:
a. PSI.
b. Maloney.
c. Central Plastics.
6. Pipe saddles (for gage installation):
a. Dresser Style 91 (steel and ductile iron systems).
b. Dresser Style 194 (nonmetallic systems).

7. Expansion joint at FRP and poly tanks:
   a. PROCO.
   b. Garlock, Style 215.
8. Elastomeric bellows type expansion joints:
   a. Garlock, Guardian 200/204.
   b. PROCO, equivalent model.
   c. Red Valve, equivalent model.
   d. Or equal.
9. Dismantling Joint
   a. Romac DJ400.
   b. Smith Blair 972.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PIPING SPECIFICATION SCHEDULES

A. Piping system materials, fittings and appurtenances are subject to requirements of specific piping specification schedules located at the end of PART 3 of this Specification Section.

## 2.3 COMPONENTS AND ACCESSORIES

A. Insulating Components:
   1. Dielectric flange kits:
      a. Flat faced.
      b. 1/8 IN thick dielectric gasket, phenolic, non-asbestos.
      c. Suitable for 175 PSI, 210 DEGF.
      d. 1/32 IN wall thickness bolt sleeves.
      e. 1/8 IN thick phenolic insulating washers.
   2. Dielectric unions:
      a. Screwed end connections.
      b. Rated at 175 PSI, 210 DEGF.
      c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

B. Dirt Strainers:
   1. Y-type.
   2. Composition bronze.
   3. Rated for test pressure and temperature of system in which they are installed.
   4. 20 mesh Monel screen.
   5. Threaded bronze plug in the blowoff outlet.
   6. Threaded NPT end connections.

C. Strainers for Chemical Applications:
   1. Y-type.
   2. Strainers of same material, test pressure, and temperature rating as system in which strainer is placed.

D. Reducers:
   1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
   2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

E. Protective Coating and Lining:
   1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.
   2. Field coating pipe in accordance with Specification Section 09 96 00.

F. Underground Warning Tape:
   1. See Specification Section 10 14 00.

G. Pressure Gages:
   1. See Specification Section 01 61 03 and Specification Section 40 73 00.

H. Dry Disconnect Couplings:
   1. Adapters:
      a. Male adapters: Size shown on Drawings.
      b. Adapters:
         1) Female NPT end connection for sludge and flush applications.
         2) Male NPT end connection for chemical applications.
      c. Construct adapters for sludge applications from cast iron or steel.
      d. Construct adapters for chemical and PVC system applications 3 IN and below from polypropylene.
         1) Above 3 IN size, provide stainless steel units.
   2. Couplers:
      a. Built-in valve and spring loaded poppet which close automatically when disconnected.
      b. Designed to remain with only one arm locked in closed position.
      c. Construct couplers for sludge applications fabricated from material utilized for adapters.
      d. Construct couplers for chemical and PVC system applications 3 IN and less from polypropylene with stainless steel arms and pins.
         1) Above 3 IN, provide stainless steel units.
      e. Gasket: Compatible with conveyed liquid.
   3. Dust caps: For all adapters.

I. Valves:
   1. See schematics and details for definition of manual valves used in each system.
      a. See Specification Section 40 05 51 schedule for automatic valves used in each system.
   2. See Specification Section 40 05 51.

J. Expansion Joints at FRP and Poly Tanks:
   1. Materials:
      a. Bellows: PTFE-62.
      b. Flanges: PVC.
      c. Limit bolts and nuts: 316 stainless steel.
      d. Reinforcing rings: Stainless steel.
   2. Pressure rating at 70 DEGF: 70 PSIG.
   3. Minimum axial movement: 3/8 IN.

K. Elastomeric Bellows Type Expansion Joints:
   1. Provide reducing type where indicated on the Drawings.
   2. Air piping: Refer to stainless steel Specification 40 05 23.
   3. Flanges: ANSI 125/150.
   4. Materials:
      a. Bellows:
         1) Sludge service: Natural rubber.
         2) Hot Water (over 100 DEGF): EPDM.
         3) All other: Compatible with fluid.
      b. Restraint:
         1) Provide restraint limit bolts (control rods) and nuts to restrain joint at test pressure of piping.
         2) Control rod material: 316 stainless steel.
      c. Working pressure: Equal to or greater than test pressure of connecting piping.
      d. Minimum axial movement: 3/8 IN.
   5. Arches:
      a. Sludge service: Provide single filled arches.
      b. All other service: Provide double open arches.

## PART 3 - EXECUTION

### 3.1 EXTERIOR BURIED PIPING INSTALLATION

A. Unless otherwise shown on the Drawings, provide a minimum of 3 FT and maximum of 8 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.

B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.

C. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
   1. Install second joint not more than 6 FT nor less than 4 FT from first joint.

D. Install expansion devices as necessary to allow expansion and contraction movement.

E. Laying Pipe In Trench:
   1. Excavate and backfill trench in accordance with Specification Section 31 23 33.
   2. Clean each pipe length thoroughly and inspect for compliance to specifications.
   3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
   4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
   5. Except for first two joints, before making final connections of joints, install two full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
   6. Lay pipe in only suitable weather with good trench conditions.
      a. Never lay pipe in water except where approved by Engineer.
   7. Seal open end of line with watertight plug if pipe laying stopped.
   8. Remove water in trench before removal of plug.

F. Lining Up Push-On Joint Piping:
   1. Lay piping on route lines shown on Drawings.
   2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
   3. Observe maximum deflection values stated in manufacturer's written literature.
   4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
   5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

G. Anchorage and Blocking:
   1. Provide reaction blocking, anchors, joint harnesses, restrained joint fittings, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
   2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
      a. Concrete blocks shall not cover pipe joints.
   3. Provide bearing area of concrete in accordance with drawing detail.

H. Chemical Feed Piping
   1. Lay piping on route lines shown on Drawings
   2. Provide Carrier and Chemical Feed piping as specified on Drawings
   3. Chemical feed piping to be adhesively connected inside of adhesively connected Carrier piping.

I. Install underground hazard warning tape per Specification Section 10 14 00.

J. Install insulating components where dissimilar metals are joined together.

## 3.2 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
   1. Expansion and contraction.
   2. Operation and access to equipment, doors, windows, hoists, moving equipment.
   3. Headroom and walking space for working areas and aisles.
   4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:
   1. Use methods of piping support as shown on Drawings and as required in Specification Section 40 05 07.
   2. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
      a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
   3. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.
   1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Use reducing fittings throughout piping systems.
   1. Bushings will not be allowed unless specifically approved.

H. Equipment Drainage and Miscellaneous Piping:
   1. Provide drip pans and piping at equipment where condensation may occur.
   2. Hard pipe stuffing box leakage to nearest floor drain.
   3. Avoid piping over electrical components such as motor control centers, panelboards, etc.
      a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
      b. Hard pipe drainage to nearest floor drain.
   4. Collect system condensate at drip pockets, traps and blowoff valves.
   5. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.
   6. For applications defined above and for other miscellaneous piping which is not addressed by a specific piping service category in PART 1, provide 304 stainless steel piping and fittings.
      a. Size to handle application with 3/4 IN being minimum size provided.

I. Unions:
   1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
   2. Mechanical type couplings may serve as unions.
   3. Additional flange unions are not required at flanged connections.

J. Install expansion devices as necessary to allow expansion/contraction movement.

K. Provide full face gaskets on all systems.

L. Anchorage and Blocking:
   1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

M. Equipment Pipe Connections:
    1. Equipment - General:
        a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
        b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
        c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
            1) Provide tightening torque in accordance with manufacturer's recommendations.
        d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
        e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
        f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
        g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
        h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
            1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
            2) Realign as necessary, install flange bolts and make equipment connection.
        i. Provide utility connections to equipment shown on Drawings, scheduled or specified.
    2. Plumbing and HVAC equipment:
        a. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
        b. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
        c. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
            1) Provide wheel handle stop valve at each laboratory sink water supply.
            2) Minimum size: 1/2 IN.
        d. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
            1) Size trap as required by IPC.
        e. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

N. Provide insulating components where dissimilar metals are joined together.

O. Instrument Connections:
    1. See drawing details.

## 3.3 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.

C. Undertake connections in fashion which will disturb system as little as possible.

D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

## 3.4 ACCESS PROVISIONS

A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.

B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.

C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.

D. Provide with key locks, keyed alike, in public use areas.

E. Furnish panels with prime coat of HPIC. See Specification Section 09 96 00.

F. Style and type as required for material in which door installed.

G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

## 3.5 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Make all connections from wire or cable by Thermit Cadwelding accomplished by operators experienced in this process.

C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 PCT of the straight line length.

D. After cadwelding, coat all exposed metallic surfaces with hot applied tape.

## 3.6 HEAT TRACING

A. See Specification Section 40 41 13 - Heat Tracing Cable.

## 3.7 PRESSURE GAGES

A. Provide at locations shown on the Drawings and specified.

B. See Specification Section 01 61 03.

## 3.8 FIELD QUALITY CONTROL

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping after backfilling has been complete.
   2. Utilize pressures, media and pressure test durations as specified in the PIPING SPECIFICATION SCHEDULES.

3. Isolate equipment which may be damaged by the specified pressure test conditions.
4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
   a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
   b. Notify the Engineer 24 HRS prior to each test.
5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
6. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
   1. Testing medium: Unless otherwise specified in the PIPING SPECIFICATION SCHEDULES, utilize the following test media.
      a. Process systems:

| PIPE LINE SIZE | SPECIFIED TEST PRESSURE | TESTING MEDIUM |
|---|---|---|
| 2 IN and smaller | 75 PSI or less | Water |
| 2 IN and smaller | Greater than 75 PSI | Water |
| Greater than 2 IN | 3 PSI or less | Water |
| Greater than 2 IN | Greater than 3 PSI | Water |

      b. Laboratory gases and natural gas systems: Cylinder nitrogen.
      c. Liquid systems:

| PIPE LINE SIZE (DIA) | GRAVITY OR PUMPED | SPECIFIED TEST PRESSURE | TESTING MEDIUM |
|---|---|---|---|
| Up to and including 48 IN | Gravity | 25 PSIG or less | Water |
| Above 48 IN | Gravity | 25 PSIG or less | Water |
| All sizes | Pumped | 250 PSIG or less | Water |

   2. Allowable leakage rates:
      a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage goal at the specified test pressure throughout the duration of the test.
      b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
         1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
         2) Average head is defined from groundwater elevation to average pipe crown.
         3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) equals 115 by (actual test head to the 1/2 power).
      c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
         1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
         2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 by (actual head to the 1/2 power).
      d. Large diameter (above 48 IN) gravity plant piping systems shall have a maximum exfiltration of 25 GPD per inch-mile.

e. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 PCT of the specified test pressure throughout the duration of the test.
f. For low pressure (less than 25 PSIG) air testing, the acceptable time for loss of 1 PSIG of air pressure shall be:

| PIPE SIZE (IN DIA) | TIME, MINUTES/100 FT |
|---|---|
| 4 | 0.3 |
| 6 | 0.7 |
| 8 | 1.2 |
| 10 | 1.5 |
| 12 | 1.8 |
| 15 | 2.1 |
| 18 | 2.4 |
| 21 | 3.0 |
| 24 | 3.6 |
| 27 | 4.2 |
| 30 | 4.8 |
| 33 | 5.4 |
| 36 | 6.0 |
| 42 | 7.3 |
| 48 | 7.6 |

3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the test.
      2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
      3) Provide temporary restraints for expansion joints for additional pressure load under test.
      4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
      5) Do not coat or insulate exposed piping until successful performance of pressure test.
   b. Soil, waste, drain and vent systems:
      1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
      2) Eliminate leaks before proceeding with work or concealing piping.
      3) Minimum test heights shall be 10 FT above highest stack inlet.
   c. Larger diameter (above 36 IN) gravity plant piping:
      1) Plug downstream end of segment to be tested.
         a) Provide bracing as required.
      2) Fill segment and upstream structure to normal operating level as per hydraulic profile.
      3) Allow 24 HRS for absorption losses.
         a) Refill to original level.
      4) Provide reservoir to maintain constant head over duration of test.
      5) Record reservoir water volume at beginning and end of test.
4. Natural gas systems - testing methodology:
   a. Maintain specified test pressure until each joint has been thoroughly examined for leaks by means of soap suds and glycerine.
   b. Wipe joints clean after test.

5. Air testing methodology:
    a. General:
        1) Assure air is ambient temperature.
    b. Low pressure air testing:
        1) Place plugs in line and inflate to manufacturer's designated seal pressure.
        2) Check plugs for proper sealing.
        3) Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water or allowable limits of ASTM F1417.
            a) Use test gage conforming to ASME B40.100 with 0 to 15 PSI scale and accuracy of 1 PCT of full range.
        4) Allow 2 minutes for air pressure to stabilize.
        5) After stabilization period (3.5 PSIG minimum pressure in pipe) discontinue air supply to line segment.
        6) Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:
1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

## 3.9 CLEANING, DISINFECTION AND PURGING

A. Cleaning:
1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
    a. Pig high pressure air piping before connecting to valves or instruments.
4. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
    a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
    b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
5. Purge all neat liquid polymer tubing or piping between the neat polymer storage tank or tote and the polymer blending units with mineral oil to remove residual water prior to introducing neat polymer. Following purging, drain as much of the mineral oil out of the system as possible. Dispose of purged fluids and waste mineral oil in accordance with local environmental regulations.

B. Disinfection of Potable Water Systems:
1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300.
4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
5. Drain flushing water to sanitary sewer.
    a. Do not drain flushing water to receiving stream.
6. Use continuous feed method of application.
    a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.

8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
    a. Repeat entire disinfection procedures until satisfactory results are obtained.
9. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
    a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of Oregon.

## 3.10 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

## 3.11 PIPE INSULATION

A. Insulate pipe and pipe fittings in accordance with Specification Section 40 42 00.

## 3.12 EDIT TABLE BASED ON PROJECT NEEDS.

## 3.13 PIPING SYSTEM SCHEDULES

A. SPECIFICATION SCHEDULE - SYSTEM 2
1. General:
    a. Piping symbol and service:
        1) BWS - Backwash Supply.
        2) BWW - Backwash Waste.
        3) FE - Filter Effluent.
        4) FTW - Filter To Waste.
        5) OF – Overflow.
        6) PD – Process Drain
        7) RW – Raw Water.
        8) SW - Settled Water.
    b. Test requirements:
        1) Test medium: Water.
        2) Pressure: 125 PSIG.
        3) Duration: 6 HRS.
    c. Gaskets:
        1) Flanged, push-on, and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2. System components:
    a. Pipe size 3 IN through 48 IN:
        1) Exposed service:
            a) Material:
                (1) Flanged: Ductile iron, Class 53.
                (2) Grooved type joint system: Use pipe thickness per AWWA C606.
            b) Reference: AWWA/ANSI C115/A21.15.
            c) Lining: Cement.
            d) Coating: HPIC; See Specification Section 09 96 00.
            e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
            f) Joints: AWWA/ANSI C115/A21.15 flanged joints with flanges at valves and structure penetrations.
        2) Exposed service alternate (at Contractor's Discretion):
            a) Material: Steel, fabricated pipe.

b) Reference: AWWA C200.
c) Lining: Cement.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: AWWA C208.
f) Joints: Butt welded or flanged.

3) Buried service:
a) Materials: Ductile iron, Class 52.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Fully restrained push-on joints per 40 05 19 with restrained joint fittings and valves or mechanical (stuffing box type) joints with thrust restraint at fittings and valves.

B. SPECIFICATION SCHEDULE - SYSTEM 3
1. General:
a. Piping symbol and service:
1) MSD- Microsand
b. Test requirements:
1) Test medium: Water.
2) Pressure: 125 PSI.
3) Duration: 6 HRS.
c. Gaskets:
1) Flanged, push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2) Grooved coupling joints (ductile and steel): Rubber, AWWA C606.
2. System components:
a. Pipe size 3 IN through 24 IN:
1) Exposed service:
a) Material:
(1) Flanged: Ductile iron, Class 53.
(2) Grooved type joint system: Use pipe thickness per AWWA C606.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Glass.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron, long radius.
f) Joints:
(1) Flanged or grooved type mechanical coupling (AWWA C606) joints.
(2) With both systems, provide screwed-on flanges at equipment, valves and structure penetrations.

2) Buried service:
a) Materials: Ductile iron, Class 52.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Glass.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron, long radius.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN, long radius.
f) Joints: Push-on with mechanical (stuffing box type) joints at fittings and valves.

C. SPECIFICATION SCHEDULE - SYSTEM 6
1. General:
   a. Piping symbol and service:
      1) CWR - Chilled Water Return.
      2) CWS - Chilled Water Supply.
   b. Test requirements:
      1) Test medium: Water.
      2) Pressure: 1.5 x working pressure.
      3) Duration: 6 HRS.
   c. Gaskets and O-rings: EPDM. Silicon for Hot Water applications.
2. System components:
   a. Pipe size through 26 IN:
      1) Exposed service:
         a) Material:
            (1) Threaded: Steel, Grade B, black, Schedule 40.
            (2) Grooved type joint system: Use pipe thickness per AWWA C606.
         b) Reference: ASTM A53.
         c) Lining: Galvanized.
         d) Coating: HPIC; See Specification Section 09 96 00.
         e) Fittings: Malleable iron or steel meeting ASME B16.3 and ASTM A234.
         f) Joints:
            (1) Threaded or grooved type mechanical coupling (AWWA C606) joints.
            (2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.

D. SPECIFICATION SCHEDULE - SYSTEM 7
1. General:
   a. Piping symbol and service:
      1) ALM – Aluminum Sulfate.
      2) ALMS – Alum. Sidestream
      3) CD - Chemical Drain.
      4) CHV - Chemical Vent.
      5) COF - Chemical Overflow.
      6) CTH - Calcium Thiosulfate.
      7) FAP – Filter Aid Polymer.
      8) PW – Potable Water.
      9) SCL – Sodium Carbonate (Liquid).
      10) SPC - Settling Aid Polymer.
   b. Test requirements pressure lines:
      1) Test medium:
         a) All but FAP and SPC
            (1) Water.
         b) FAP and SPC
            (1) Mineral Oil.
      2) Pressure: 125 psig.
      3) Duration: 6 HRS.
   c. Gaskets and O-rings:
      1) Viton
2. System components:
   a. Pipe size 12 IN and smaller:
      1) Exposed service:
         a) Material: PVC, Type 1, Grade 1, Schedule 80.
         b) Reference: ASTM D1785.
         c) Lining: None.

d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Solvent welded socket type complying with ASTM D2467.
f) Joints: Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
g) Containment: Place in PVC or CPVC containment pipe, when above walking areas or electrical equipment.

2) Buried service:
a) Double contained (tubing inside carrier)
(1) Carrier: Minimum 3-inch PVC, Schedule 40.
(2) Tubing: NSF compliant polyethylene rated for 150 psi.
b) Double contained (piping inside carrier)
(1) Carrier: Minimum 4-inch PVC, Schedule 40.
(2) Piping: PVC, Schedule 40.
c) Reference: ASTM F441.
d) Lining: None.
e) Coating: None
f) Fittings:
(1) Carrier: solvent welded socket type complying with ASTM D2467.
(2) Tubing: Barbed
(3) Piping: solvent welded socket type complying with ASTM D2467.
g) Joints:
(1) Tuning: Barbed with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
(2) Carrier: solvent welded.
(3) Piping: solvent welded.

E. SPECIFICATION SCHEDULE - SYSTEM 8
1. General:
a. Piping symbol and service:
1) SHY - Sodium Hydroxide.
2) SHC – Sodium Hypochlorite
b. Test requirements:
1) Test medium: Water.
2) Pressure: 125 psig.
3) Duration: 6 HRS.
c. Gaskets and O-rings: Polypropylene.
2. System components:
a. Pipe size 12 IN and smaller:
1) Exposed service:
a) Material: CPVC, Schedule 80.
b) Reference: ASTM F441.
c) Lining: None.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Solvent welded socket type complying with ASTM F439.
f) Joints:
(1) Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
(2) For sodium hydroxide, provide pipe joint primer IPS-70 and pipe joint solvent cement IPS-724.
g) Containment: Place in PVC or CPVC containment pipe, when above walking areas or electrical equipment.

2) Buried service:
a) Double contained (tubing inside carrier)
(1) Carrier: Minimum 3-inch PVC, Schedule 40.
(2) Tubing: NSF compliant polyethylene rated for 150 psi.
b) Reference: ASTM F441.
c) Lining: None.
d) Coating: None
e) Fittings:
(1) Carrier: solvent welded socket type complying with ASTM F439.
(2) Tubing: Barbed
f) Joints:
(1) Tuning: Barbed with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
(2) Carrier: provide pipe joint primer IPS-70 and pipe joint solvent cement IPS-724.

F. SPECIFICATION SCHEDULE - SYSTEM 9
1. General:
a. Piping symbol and service:
1) NPW - Nonpotable Water.
2) FSP - Fire Water.
3) SPD - Sump Pump Discharge.
4) SVW - Service/Process Water.
b. Test requirements:
1) Test medium: Water.
2) Pressure: 1.25 x working pressure.
3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) O-rings: Neoprene or rubber.
2) Flanged, push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
3) Flanged joints (steel): Rubber, AWWA C207.
2. System components:
a. Pipe size to 1 IN:
1) Exposed service:
a) Materials: Stainless steel tubing, TP-304L.
b) Reference: ASTM A269.
c) Lining: None.
d) Coating: None.
e) Fittings: Stainless steel 304L compression type tube fittings.
f) Joints: Compression type couplings, unions at equipment and valves.
g) Minimum wall thickness:
(1) 1/16 IN OD: 0.010 IN.
(2) 1/8 to 1/4 IN OD: 0.028 IN.
(3) 5/16 to 1/2 IN OD: 0.049 IN.
(4) 5/8 to 1 IN OD: 0.065 IN.
b. Pipe size 1 IN to 3 IN:
1) Exposed service:
a) Materials:
(1) Threaded: Steel, Grade B, black, Schedule 40.
b) Reference: ASTM A53.
c) Lining: None.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Malleable iron or steel meeting ASME B16.3 and ASTM A234.

f) Joints:
(1) Threaded joints.
(2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.

2) Buried service:
a) Materials: Steel, Schedule 40, Grade B.
b) Reference: ASTM A53.
c) Lining: None.
d) Coating: Bituminous.
e) Fittings: Malleable iron meeting ASME B16.3.
f) Joints: Threaded.

c. Pipe size 3 IN through 24 IN:
1) Exposed service:
a) Materials:
(1) Flanged: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
f) Joints:
(1) Flanged joints.
(2) With both systems, provide screwed-on flanges at valves, equipment and structure penetration.

2) Buried service:
a) Materials: Ductile iron, Class 52.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Fully restrained push-on joints per 40 05 19 with restrained joint fittings and valves or mechanical (stuffing box type) joints with thrust restraint at fittings and valves.

d. Pipe size greater than 24 IN:
1) Exposed service:
a) Material: Steel, fabricated pipe.
b) Reference: AWWA C200.
c) Lining: Cement.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: AWWA C208.
f) Joints: Butt welded with rigid AWWA C207 flanges at equipment, valves, and structure penetrations.

2) Buried service:
a) Material: Steel, fabricated pipe.
b) Reference: AWWA C200.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings: AWWA C208.
f) Joints: Butt welded.

G. SPECIFICATION SCHEDULE - SYSTEM 10
1. General:
a. Piping symbol and service:
1) CW - Potable Cold Water.
2) DHW - Potable Water Hot.
3) DHWR - Potable Water Hot, Recirculating.
4) DWT - Potable Water Tepid.
5) PW – Potable Water.
6) PWC – Potable Water Crowson.
7) PWG – Potable Water Granite.
b. Test requirements:
1) Test medium: Water.
2) Pressure: 125 psig.
3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) O-rings: Neoprene or rubber.
2) Flanged, push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
3) Flanged joints (steel): Rubber, AWWA C207.
d. Pipe, tube, fittings, solvent cement, thread sealants, solders, and flux used in potable water systems shall comply with NSF/ANSI/CAN 61 and local plumbing code.
2. System components:
a. Pipe size to 3 IN:
1) Exposed service:
a) Material: Copper tubing, Type L.
b) Solder: Cadmium and lead-free solder compatible with tubing and fittings materials.
c) Reference: ASTM B88.
d) Lining: None.
e) Coating: HPIC; See Specification Section 09 96 00.
f) Fittings: Wrought copper or bronze fittings meeting ASME B16.22.
g) Joints: Soldered or brazed with unions at valves and equipment.
2) Buried service:
a) Material: Copper tubing, Type K.
b) Reference: ASTM B88.
c) Lining: None.
d) Coating: None.
e) Fittings: AWWA C800.
f) Joints: Flared.
b. Pipe size 3 IN through 30 IN:
1) Exposed service:
a) Materials:
(1) Flanged: Ductile iron, Class 53.
(2) With both systems, provide screwed on flanges at equipment, valves and structural penetrations.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: HPIC; See Specification Section 09 96 00.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
f) Joints:
(1) Flanged joints.
(2) With both systems, provide screwed-on flanges at valves, equipment, and structure penetration.
2) Buried service:
a) Materials: Ductile iron, Class 52.

b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 to 16 IN.
f) Joints: Fully restrained push-on joints per 40 05 19 with restrained joint fittings and valves or mechanical (stuffing box type) joints with thrust restraint at fittings and valves.

3. Install drain tees with capped nipples of IPS brass 3 IN long at low points.
   a. If low point occurs in concealed piping, provide approved flush access panel.
   b. These drains are not shown on Drawings.
4. Slope water lines down to drain points not less than 1 IN in 60 FT.
5. All domestic water piping serving plumbing fixtures intended to supply drinking water shall comply with NSF 61.
6. Install all threaded piping with clean-cut tapered threads and with ends thoroughly reamed after cutting to remove burrs.
   a. Pipe joint cement permitted only on external threads.
7. For screwed nipples for connections to flush valves, lavatory supplies, and other equipment with threaded connections use iron, copper, or brass pipe.
8. Install ball, butterfly and plug valves where indicated or required to adequately service all parts of system and equipment.
   a. Install valves on each branch serving restroom.
   b. Install valves on inlet and outlet connections of heat exchangers and on other equipment connected to water lines.
9. Install unions between valves and connections to each piece of equipment, and install sufficient number of unions throughout piping system to facilitate installation and servicing.
   a. On copper pipe lines, install wrought, solder-joint, copper to copper unions for lines 2 IN and smaller and, for lines 2-1/2 IN and over install brass flange unions.
10. Construct and equip plumbing fixtures and equipment with anti-siphon devices as to entirely eliminate any danger of siphoning waste material into potable water supply system.
11. Where exposed pipes 6 IN in size and smaller pass through floors, finished walls, or finished ceilings, fit with nickel or chrome-plated plates large enough to completely close hole around pipes.
    a. Secure plates to pipe by set screw in approved manner.
12. Size supply branches to individual fixtures as scheduled or indicated on Drawings.
13. Install piping so as to be free to expand with proper loops, anchors and joints without injury to system or structure.
14. Provide branches to wall hydrants or hose bibbs in exterior locations with interior shutoff and drain valves.
15. Provide approved type vacuum breaker and backflow preventer installations indicated or as required by Code.
16. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

H. SPECIFICATION SCHEDULE - SYSTEM 11
1. General:
   a. Piping symbol and service:
      1) CA - Compressed Air.
      2) IA - Instrument Air.
   b. Test requirements:
      1) Test medium: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
      2) Pressure: 150 PSIG.

3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) O-ring and flanged joints: Rubber or neoprene, 250 DEGF.
2) Grooved coupling joints (steel): AWWA C606, rubber, 250 DEGF.
2. System components:
a. Pipe size to 1 IN for A, 3/8 IN to 1 IN for IA:
1) Exposed service:
a) Material: Stainless steel tubing, TP-304L.
b) Reference: ASTM A269.
c) Lining: None.
d) Coating: None.
e) Fittings: Stainless steel 304L, compression type tube fittings.
f) Joints: Compression type couplings, unions at equipment and valves.
b. Pipe size 1 IN to 4 IN:
1) Exposed service:
a) Materials:
(1) Threaded: Stainless Steel TP-304L, Schedule 40.
(2) Grooved type joint system: Use pipe thickness per AWWA C606.
b) Reference: ASTM A312.
c) Coating: None.
d) Fittings: conforming to ASTM A351, ASTM A182, and ASTM A403 as applicable.
e) Joints:
(1) Threaded.
(2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.
2) Buried service:
a) Materials: Stainless Steel TP-304L, Schedule 40.
b) Reference: ASTM A312.
c) Coating: None or petrolatum.
d) Fittings: conforming to ASTM A403.
e) Joints: Welded, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.
3. Slope all piping mains approximately 1:100 toward points of drainage.
4. Provide driplegs at low points:
a. Provide ball type isolation valve.
b. Route dripleg to nearest wall or column and terminate 4 FT above finished floor.

I. SPECIFICATION SCHEDULE - SYSTEM 12
1. General:
a. Piping symbol and service:
1) LPA - Low Pressure Process Air.
b. Test requirements:
1) Test medium: Air.
2) Pressure: 20 PSIG.
3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) O-rings and flanged joints: Silicone.
d. Temperature:
1) Normal: 170 DEGF.
2) Maximum: 250 DEGF.
2. System components:
1) Pipe size through 2 IN:
a) Material: Stainless steel 304L, Schedule 40.

b) Reference: ASTM A778.
c) Lining: None.
d) Coating: None.
e) Fittings: Seamless steel 304L meeting ASTM A774.
f) Joints:
(1) Butt welded with unions at equipment and valves.
(2) Harnessed compression sleeve couplings where indicated on Drawings.

2) Pipe size above 2 IN:
a) Material: Stainless steel 304L, Schedule 10.
b) Reference: ASTM A778.
c) Lining: None.
d) Coating: None.
e) Fittings: Seamless steel 304L meeting ASTM A774.
f) Joints:
(1) Butt welded with flanges at equipment and valves.
(2) Harnessed compression sleeve couplings where indicated on Drawings.

J. SPECIFICATION SCHEDULE - SYSTEM 15
1. General:
a. Piping symbol and service:
1) SD – Storm Drain.
b. Test requirements:
1) See the FIELD QUALITY CONTROL Article in PART 3 of Section 33 40 00 – Storm Drainage System.
c. Materials:
1) Refer to Section 33 40 00 – Storm Drainage System.

K. SPECIFICATION SCHEDULE - SYSTEM 17
1. General:
a. Piping symbol and service:
1) FOD - Foundation Drain.
b. Test requirements:
1) Test medium: Water.
2) Pressure: None, observed for free flow.
3) Duration: 6 HRS.
2. System components:
a. Pipe size 4 IN to 15 IN:
1) Buried service:
a) Material: PVC, perforated.
b) Reference: AASHTO M278.
c) Lining: None.
d) Coating: None.
e) Fittings: AASHTO M278.
f) Joints: Elastomeric gasket, ASTM D3212.
b. Pipe size 12 IN through 24 IN:
1) Buried service:
a) Material: Corrugated polyethylene.
b) Reference: AASHTO M294.
c) Lining: None.
d) Coatings: None.
e) Fittings: Corrugated, AASHTO M294.
f) Joints: Split or snap type couplings.

L. SPECIFICATION SCHEDULE - SYSTEM 19
1. General:
a. Piping symbol and service:

1) RFGT - Refrigerant.

b. Test requirements:

1) Test medium: Refrigerant type used for testing shall match refrigerant type in the system.

2) Pressure: Normal full load operating pressures as specified by cooling equipment manufacturer.

3) Duration: 6 HRS.

4) Leak location method: Test all fittings with bubble solution followed by Halide torch or electronic platinum diode meter.

2. System components:

a. Pipe size up to 2 IN:

1) Exposed service:

a) Material: Factory pre-charged copper line sets sized per manufacturer recommendations for 2 DEGF line loss.

b) Solder: High temperature (melting point not less than 1000 DEGF) silver solder compatible with tubing and fittings.

c) Lining: None.

d) Coating: HPIC; See Specification Section 09 96 00.

e) Fittings: Copper, as required to adapt line sets to equipment.

f) Joints: Soldered.

M. SPECIFICATION SCHEDULE - SYSTEM 21

1. General:

a. Piping symbol and service:

1) RL - Rain Leader.

2) SRL - Secondary Rain Leader.

3) D - Drain.

4) SAN - Sanitary Sewer.

5) V - Vent.

b. Test requirements:

1) Test medium: Water.

2) Pressure: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

3) Duration: 6 HRS.

c. Gaskets: Rubber, ASTM C564.

2. System components:

a. Pipe size 1-1/4 IN and 1-1/2 IN:

1) Exposed service.

a) Material: Galvanized steel, Schedule 40.

b) Reference: ASTM A53.

c) Lining: Galvanized.

d) Coating: HPIC; See Specification Section 09 96 00.

e) Fittings: Cast iron drainage.

(1) ASTM A126, Class B.

f) Joints: Threaded.

b. Pipe size 2 IN and larger:

1) Exposed service.

a) Material: Cast iron soil pipe.

b) Reference: ASTM A74, CISPI 301.

c) Lining: None.

d) Coating: HPIC; See Specification Section 09 96 00.

e) Fittings: ASTM A74.

f) Joints: No-hub with elastomeric sealing sleeve and stainless steel clamp assembly conforming to CISPI 301.

2) Buried service (to 5 FT outside of structure):

a) Material: Cast-iron soil pipe.
b) Reference: ASTM A74.
c) Lining: None.
d) Coating: Bituminous.
e) Fittings: ASTM A74.
f) Joints: Hub and spigot.

3) Buried service (Sanitary sewer beyond 5 FT outside of structure)
a) Material: Refer to Section 33 31 11 – Gravity Sewer Pipeline and Manhole Construction.
b) Test requirements: See the FIELD QUALITY CONTROL Article in Part 3 of Section 33 31 11 – Gravity Sewer Pipeline and Manhole Construction.

3. Soil and Waste Piping Installation:
a. Install horizontal soil or waste lines with a slope of not less than 1/4 IN/FT or 2 PCT toward the point of disposal.
b. Install as close to construction as possible to maintain maximum head room.
c. Make changes of direction with 1/8 bends and junctions with wye fittings.
d. Use short wye fittings in vertical pipe only.
e. Install handhole test tee at base of each stack.
f. Install cleanouts at dead ends, at changes of direction and at 50 FT intervals on horizontal runs.
1) Where cleanouts occur in concealed spaces, provide with extensions to floors above or to walls as required.
g. Install piping true to grade and alignment.
1) Begin at the system low point.
h. Locate vertical extensions of underground piping below partition walls for concealment in wall.
1) In locations where hubs are wider than partition, set hubs 1 IN below final floor.
i. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.
j. For hub and spigot joints, install hub facing flow.

4. Vent Piping Installation:
a. Run vent stack parallel to each soil or waste stack to receive branch vents from fixtures.
b. Originate each vent stack from soil or waste pipe at its base.
c. Where possible, combine soil, waste or vent stacks before passing through roof so as to minimize roof openings.
d. Offset pipes running close to exterior walls away from such walls before passing through roof to permit proper flashing.
e. Provide pipes passing through roofs with cast iron increasers minimum of 12 IN below roof one size larger than pipe but in no case less than 4 IN.
f. Terminate each vent with approved frostproof jacket.
g. Carry vent stacks 4 IN and larger full size through roof.
1) Extend vent stacks at least 12 IN above roofing.
h. Pipe vents from pressure regulating devices in compliance with local codes.
i. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

N. SPECIFICATION SCHEDULE - SYSTEM 27
1. General:
a. Piping symbol and service:
1) SMP - Sample.
2) IRR – Irrigation.
b. Test requirements pressure lines:
1) Test medium: Water.
2) Pressure: 100 PSIG.
3) Duration: 6 HRS.

c. Gaskets and O-rings:
    1) O-rings and flanged joints: Neoprene or rubber.
2. System components:
    a. Pipe size 12 IN and smaller:
        1) Exposed service:
            a) Material: PVC, Type 1, Grade 1, Schedule 80.
            b) Reference: ASTM D1785.
            c) Lining: None.
            d) Coating: HPIC; See Specification Section 09 96 00.
            e) Fittings: Solvent welded socket type complying with ASTM D2467.
            f) Joints: Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
        2) Buried service:
            a) Material: PVC, Type 1, Grade 1, Schedule 40 (Schedule 80 for IRR line).
            b) Reference: ASTM D1785.
            c) Lining: None.
            d) Coating: None.
            e) Fittings: Solvent welded socket type complying with ASTM D2466.
            f) Joints: Solvent welded.

O. SPECIFICATION SCHEDULE - SYSTEM 28
1. General:
    a. Piping symbol and service:
        1) GOX - Gaseous Oxygen.
        2) LOX - Liquid Oxygen.
        3) OG - Offgas (Ozone).
        4) OZG - Ozone Gas.
        5) OZS - Ozonated Sidestream.
        6) OZW - Ozononated Water.
    b. Test requirements:
        1) Test medium: Cylinder nitrogen.
        2) Pressure: 100 PSIG.
        3) Duration: 6 HRS.
    c. Gaskets and O-rings:
        1) Viton – With manufacturer's statement that the submitted product has excellent compatibility with ozone gas and dissolved ozone in water
2. System components:
    a. Pipe size 2-1/2 IN and smaller:
        1) Exposed and buried service:
            a) Material: Stainless steel pipe, Type 316L, Schedule 40.
            b) Reference: ASTM A312.
            c) Lining: None.
            d) Coating: None.
            e) Fittings: Stainless steel 316L meeting ASTM A774.
            f) Joints: Butt welded with flanges at equipment and valves.
    b. Pipe size 3 IN and larger:
        1) Exposed service:
            a) Material: Stainless steel pipe, Type 316L, Schedule 10.
            b) Reference: ASTM A778.
            c) Lining: None.
            d) Coating: None.
            e) Fittings: Seamless stainless steel 316L meeting ASTM A774.
            f) Joints: Butt welded with flanges at equipment and valves.

2) Buried service:
   a) Material: Stainless steel pipe, Type 316L, Schedule 40.
   b) Reference: ASTM A778.
   c) Lining: None.
   d) Coating: None.
   e) Fittings: Seamless stainless steel 316L meeting ASTM A774.
   f) Joints: Butt welded.

**END OF SECTION**

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# SECTION 40 05 07
## PIPE SUPPORT SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.
   2. Design of Pipe Support Systems as specified.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 81 10 - Wind and Seismic Design Criteria
   4. Section 03 15 19 - Anchorage to Concrete.
   5. Section 05 50 00 - Metal Fabrications.
   6. Section 09 96 00 - High Performance Industrial Coatings.
   7. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.3, Process Piping.
   2. ANVIL International (ANVIL).
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
      e. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
      f. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
      g. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   4. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
      b. D1.6, Structural Welding Code - Stainless Steel.
   5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

B. Responsibility:
   1. Support systems for piping greater than 12 IN DIA, or with internal pressure over 100 PSI, or piping with product temperatures over 200 DEGF, are shown on the Drawings and are not to be designed by Contractor unless indicated in Contract Documents.
   2. Design complete support systems for piping 12 IN and smaller where supports are not shown on the Drawings.
   3. Provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.

4. General piping support details may be indicated on the Drawings in certain locations for pipe 12 IN DIA and smaller.
5. Incorporate those details with requirements of this Specification Section to provide the piping support system.

C. Each type of pipe hanger or support shall be the product of one manufacturer.

D. Qualifications:
1. Pipe support designer:
   a. Licensed Professional Engineer registered in the state the project is located in.
   b. Minimum of five years experience designing pipe supports for projects of similar size and complexity.

### 1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
   d. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
   e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
   f. Where Contract Documents indicate contractor is to design pipe support systems, submit detail design calculations and scaled drawings signed by Pipe support designer..
3. Certifications.
   a. Pipe support designer qualifications

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. General:
1. Galvanized components:
   a. Electro-galvanized components:
      1) Bar, forged or cast fabrications: ASTM B633, SC4.
      2) Rolled sheet fabrications: ASTM A917 and ASTM A918, 50N50NU.
   b. Hot-dipped galvanized components: See Specification Section 05 50 00.
2. Dissimilar metals protection:
   a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
   b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.

B. Hanger Rods:
1. Material:
   a. ASTM A36.
   b. ASTM A575, Grade M1020.
   c. ASTM A576, Grade 1020.

d. Minimum allowable tensile stress of 12,000 PSI at 650 DEGF per MSS SP-58.
2. Continuously threaded.
3. Electro-galvanized or cadmium plated after threads are cut.
4. Load limit:

| NOMINAL ROD DIAMETER | MAXIMUM SAFE LOAD, (LBS) |
|---|---|
| 3/8 IN DIA (min) | 610 |
| 1/2 IN DIA | 1,130 |
| 5/8 IN DIA | 1,810 |
| 3/4 IN DIA | 2,710 |
| 7/8 IN DIA | 3,770 |
| 1 IN DIA | 4,960 |

C. Hangers:
1. Hangers for use directly on copper pipe: Copper or cadmium plated.
2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
3. Hanger type schedule:

| APPLICATION | PIPE SIZE | HANGER TYPE |
|---|---|---|
| All except noted | 4 IN and less | ANVIL Figure 108 with Figure 114 |
| All except noted | Over 4 IN | ANVIL Figure 590 |
| Steam, condensate and hot water | All | ANVIL Figure 181, Figure 82 |
| Service in chemical storage areas and as indicated on drawings for corrosion resistance | All | CorPro CP - Hanger or equal |

D. Concrete Inserts for Hanger Rods:
1. Continuous slots: Unistrut #P1000.
2. Individual inserts: ANVIL Figure 281.
3. See Specification Section 03 15 19, mechanical anchors.

E. Beam Clamps for Hanger Rods:
1. Standardduty.
2. ANVIL Figure 133].

F. Trapeze Hangers for Suspended Piping:
1. General:
   a. Material: Steel.
   b. Galvanized.
   c. Angles, channels, or other structural shapes.
   d. Curved roller surfaces at support point corresponding with type of hanger required.
2. In chemical storage and feed areas and as indicated on the drawings:
   a. Materials: FRP.
   b. Unistrut fiberglass channel or equal.

G. Vertical Pipe Supports:
1. At base of riser.
2. Lateral movement:
   a. Clamps or brackets:
      1) ANVIL Figure 62, Galvanized.

H. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

I. Pipe Support Saddle:
   1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
   2. ANVIL Figure 264.

J. Pipe Support Risers:
   1. Schedule 40 pipe.
   2. Galvanized.
   3. Size: As recommended by saddle manufacturer.

K. Pipe Support Base Plate:
   1. 4 IN larger than support.
   2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
   3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
   4. Collar welded to floor plate.
   5. Edges ground smooth.
   6. Assembly hot-dipped galvanized after fabrication.

L. Pipe Covering Protection Saddle:
   1. For insulated pipe at point of support.
   2. ANVIL Figure 167, Type B.

M. Wall Brackets:
   1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
   2. ANVIL Figure 199.

N. Pipe Anchors:
   1. For locations shown on the Drawings.
   2. 1/4 IN steel plate construction.
   3. Hot-dipped galvanized after fabrication.
   4. Designed to prevent movement of pipe at point of attachment.

O. Seismic Restraints:
   1. Galvanized steel aircraft cables or steel angles or channels.
   2. Prestretch steel aircraft cables to establish a certified minimum modulus of elasticity.
      a. Design cable restraints to resist seismic tension loads.
      b. Design steel restraints to resist both tension and compression loads with a minimum safety factor of 2.
   3. Design restraint and connection steel assemblies that swivel to the final installation angle.
   4. Do not mix cable and steel angle restraints to brace the same system.
   5. Clamp steel angles to the threaded hanger rods at the seismic sway restraint locations utilizing a minimum of two ductile iron clamps.
   6. Provice transverse bracing at 40 FT-0 IN maximum spacing unless noted otherwise.
   7. Provide longitudinal bracing at 80 FT-0 IN maximum spacing unless noted otherwise.
   8. Provide fuel gas piping with transverse bracing 20 FT-0 IN OC maximum and longitudinal bracing 40 FT-0 IN OC maximum.
   9. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser.
      a. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 30 FT-0 IN OC.

P. Pipe Guides:
   1. For locations on both sides on each expansion joint or loop.
   2. To ensure proper alignment of expanding or contracting pipe.

3. ANVIL Figure 256.

## 2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58 and MSS SP-69.
   3. Except where modified by this Specification.

E. For hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.1.
   2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

H. Place hangers are to be installed on outside of pipe insulation.
   1. Use a pipe covering protection saddle for insulated pipe at support point.
   2. Insulated piping 1-1/2 IN and less:
      a. Provide a 9 IN length of high density perlite or high density calcium silicate at saddle.
      b. See Specification Section 40 42 00.
   3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of high density perlite or high density calcium silicate at saddle.

I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

J. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
      c. Provide at least one support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron pipe support schedule:

| PIPE SIZES - IN | MAXIMUM SPAN - FT |
|---|---|
| 1-1/2 and less | 5 |
| 2 thru 4 | 10 |
| 5 thru 8 | 15 |
| 10 and greater | 20 |

   3. Copper pipe support schedule:

| PIPE SIZES - IN | MAXIMUM SPAN - FT |
|---|---|
| 2-1/2 and less | 5 |
| 3 thru 6 | 10 |
| 8 and greater | 15 |

4. PVC pipe support schedule:

| PIPE SIZES - IN | MAXIMUM SPAN - FT |
|---|---|
| 1-1/4 and less | 3 |
| 1-1/2 thru 3 | 4 |
| 4 and greater | 5 |

* Maximum fluid temperature of 120 DEGF.

5. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:
      1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
7. Provide continuous support for nylon tubing.
8. For PVC, FRP and copper piping:
   a. Provide Unistrut Unicushion wrap of pipe at each support.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Seismic Restraints:
   1. Provide seismic restraints on all piping with the exception of the following:
      a. Piping less than 1 IN DIA when used for gas and compressed air.
      b. Piping less than 2-1/2 IN DIA for all other cases.
      c. Piping suspended by individual hangers where the distance from the top of the pipe to the bottom of the support for the hanger is 12 IN or less.
      d. Provide fuel gas piping with transverse bracing 20 FT-0 IN OC maximum and longitudinal bracing 40 FT-0 IN OC maximum.
      e. These restraints shall be capable of resisting seismic loads as defined in the Building Code.

C. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.
   3. AWS D1.6 for stainless steel supports.

D. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

E. Inspect hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

F. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

G. Anchorage to Concrete- reference Section 03 15 19.

H. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

I. Welding:
   1. Welding rods: ASTM and AWS standards.
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

J. Field Painting:
   1. Comply with Specification Section 09 96 00.

**END OF SECTION**

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# SECTION 40 05 17
## PIPE - COPPER

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Copper piping, fittings, and appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   5. Section 40 05 07 - Pipe Support Systems.

C. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
      b. B16.23, Cast Bronze Solder Joint Drainage Fittings - DWV.
      c. B16.26, Cast Bronze Alloy Fittings for Flared Copper Tubes.
   2. ASTM International (ASTM):
      a. B32, Standard Specification for Solder Metal.
      b. B42, Standard Specification for Seamless Copper Pipe, Standard Sizes.
      c. B88, Standard Specification for Seamless Copper Water Tube.
      d. B306, Standard Specification for Copper Drainage Tube (DWV).
   3. American Welding Society (AWS):
      a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.

### 1.2 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 40 05 00.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Copper Tubing:
   1. Pressure non-buried: ASTM B88, Type L hard.
   2. Pressure buried: ASTM B88, Type K.
   3. Non-pressure: ASTM B306.

B. Copper Pipe: ASTM B42, regular strength.

C. Fittings:
   1. Pressure non-buried: ASME B16.22.
   2. Pressure buried: ASME B16.22 or ASME B16.26.
   3. Non-pressure: ASME B16.23

D. Soldering and Brazing:
   1. Non-buried:
      a. ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux up to 180 DEGF water temperature.

b. At 180 DEGF and above, use brazing alloy with melting temperature above 1000 DEGF and suitable flux.

2. Buried: Silver solder per AWS A5.8M/A5.8.

E. See Piping Schedules in Specification Section 40 05 00.

F. Unions:
1. Pipe sizes 2 IN and smaller: Copper, ground joint.
2. Pipe sizes 2-1/2 IN and larger: Brass flanged unions.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with Specification Section 40 05 00.

### 3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Specification Section 40 05 00.

B. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.

C. Support exposed piping in accordance with Specification Section 40 05 00 and Specification Section 40 05 07.

D. Install buried piping in accordance with Specification Section 31 23 33 and Specification Section 40 05 00.

**END OF SECTION**

# SECTION 40 05 19
PIPE - DUCTILE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Ductile iron piping, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. ASTM International (ASTM):
      a. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   3. American Water Works Association (AWWA):
      a. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
      b. C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe.
      c. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C105/A21.5, Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
      c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      e. C150/A21.50, Standard for Thickness Design of Ductile-Iron Pipe.
      f. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
      g. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 00.
   3. Certification of factory hydrostatic testing.
   4. If mechanical coupling system is used, submit piping, fittings, and appurtenant items which will be utilized to meet system requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ductile Iron Pipe (Non-Restrained Joint, Flanged)
      a. Pipe:
         1) American Ductile Iron Pipe.
         2) US Pipe.
         3) Or equal.
      b. Fittings:
         1) American Ductile Iron Pipe.
         2) US Pipe.
         3) Tyler Union.
         4) Sigma Corporation.
         5) Or equal.
   2. Ductile Iron Pipe (Restrained Joint)
      a. Pipe:
         1) American Ductile Iron Pipe:
            a) Flex-Ring (4 IN to 48 IN)
         2) US Pipe:
            a) TR-Flex (4 IN to 36 IN).
         3) Or equal.
      b. Fittings:
         1) American Ductile Iron Pipe:
            a) Fastite with Fast-Grip Gasket (4 IN to 30 IN)
            b) MJ Coupled Joint (4 IN to 48 IN)
         2) US Pipe:
            a) TR-Flex (4 IN to 36 IN)
            b) MJ Field-Lok (4 IN to 16 IN)
            c) Field-Lok (4 IN to 24 IN)
         3) Or equal.
   3. Flanged adaptors:
      a. Rockwell (Style 913 (steel)) (Style 912 (cast)).
      b. Dresser (Style 128 (steel)) (Style 127 (cast)).
   4. Compression sleeve coupling:
      a. Rockwell (Style 431 (cast)).
      b. Dresser (Style 153 (cast)).
   5. Mechanical coupling:
      a. Victaulic (Style 31).
      b. Tyler.
   6. Glass lining:
      a. Ceramic Coating (Non-Stick Glass Lining).
      b. Permutit (SG-14 Glass Lining).
   7. Insulating couplings:
      a. Rockwell (Style 416).
      b. Dresser (Style 39).
   8. Reducing couplings:
      a. Rockwell (Style 415).
      b. Dresser (Style 62).
   9. Transition coupling:
      a. Rockwell (Style 413).
      b. Dresser (Style 62).
   10. Polyethylene encasement tape:
      a. Chase (Chasekote 750).

b. Kendall (Polyken 900).
c. 3 M (Scotchrap 50).

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. Ductile Iron Pipe:
1. AWWA/ANSI C115/A21.15.
2. AWWA/ANSI C150/A21.50.
3. AWWA/ANSI C151/A21.51.

B. Fittings and Flanges:
1. AWWA/ANSI C110/A21.10.
2. AWWA/ANSI C115/A21.15.
3. Flanges drilled and faced per ASME B16.1 for both 125 and 250 PSI applications.

C. Nuts and Bolts:
1. Buried: Malleable Iron, Cor-Ten, or Stainless Steel.
2. Exposed: Mechanical galvanized ASTM B695, Class 40.
3. Heads and dimensions per ASME B1.1.
4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 IN beyond nuts.

D. Gaskets: See individual piping system requirements in Section 40 05 00.

E. If mechanical coupling system is used, utilize pipe thickness and grade in accordance with AWWA C606.

F. Polyethylene Encasement: See AWWA/ANSI C105/A21.5.

G. See Piping Schedules in Section 40 05 00.

## 2.3 MANUFACTURED UNITS

A. Couplings:
1. Flanged adaptors:
a. Unit consisting of steel or carbon steel body sleeve, flange, followers, Grade 30 rubber gaskets.
b. Provide units specified in the MANUFACTURERS Article.
c. Supply flanges meeting standards of adjoining flanges.
d. Rate entire assembly for test pressure specified on piping schedule for each respective application.
2. Compression sleeve coupling:
a. Unit consisting of steel sleeve, followers, Grade 30 rubber gaskets.
b. Provide units specified in the MANUFACTURERS Article.
c. Supply flanges meeting standards of adjoining flanges.
d. The working pressure rating of the entire assembly shall be greater than or equal to the test pressure specified on piping schedule for each respective piping application.
e. Provide field coating for buried couplings per AWWA C203.
3. Mechanical couplings:
a. Use of mechanical couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 40 05 00.
b. Utilize units defined in the MANUFACTURERS Article.

## 2.4 FABRICATION

A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.

B. Furnish cast parts with lacquer finish compatible with finish coat.

## 2.5 LININGS AND COATINGS

A. Cement Mortar Lining: Per AWWA C104.

B. Glass Lining:
   1. Minimum two-coat process.
      a. Base coat heated to solidly fuse glass to pipe surface.
      b. Subsequent coat(s) heated to form integral bond with preceding coat.
   2. Final finish parameters:
      a. Thickness: 8-12 MILS.
      b. Hardness: Above 5 on MOHS scale.
      c. Density: 2.5-3.0 grams per cubic centimeter.
      d. Metal to lining bonding: Capable of withstanding strain of 0.0001 IN/IN without damage to lining.
   3. Complete compatibility between fittings and piping.

## 2.6 SOURCE QUALITY CONTROL

A. Factory Test:
   1. Subject pipe to hydrostatic test of not less than 500 PSI with the pipe under the full test pressure for at least 10 seconds.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Joining Method - Push-On Mechanical (Gland-Type) Joints:
   1. Install in accordance with AWWA/ANSI C111/A21.11.
   2. Assemble mechanical joints carefully according to manufacturer's recommendations.
   3. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint.
   4. Do not overstress bolts.
   5. Where piping utilizes mechanical joints with tie rods, align joint holes to permit installation of harness bolts.

B. Joining Method - Push-On Joints:
   1. Install in accordance with AWWA/ANSI C151/A21.51.
   2. Assemble push-on joints in accordance with manufacturer's directions.
   3. Bevel and lubricate spigot end of pipe to facilitate assembly without damage to gasket.
      a. Use lubricant that is non-toxic, does not support the growth of bacteria, has no deteriorating effects on the gasket material, and imparts no taste or odor to water in pipe.
   4. Assure the gasket groove is thoroughly clean.
   5. For cold weather installation, warm gasket prior to placement in bell.
   6. Taper of bevel shall be approximately 30 DEG with centerline of pipe and approximately 1/4 IN back.

C. Joining Method - Flanged Joints:
   1. Install in accordance with AWWA/ANSI C115/A21.15.
   2. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
   3. Make flange faces flat and perpendicular to pipe centerline.
   4. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
   5. Allow one flange free movement in any direction while bolts are being tightened.
   6. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.

7. Gradually tighten flange bolts uniformly to permit even gasket compression.

D. Joining Method - Mechanical Coupling Joint:
   1. Arrange piping so that pipe ends are in full contact.
   2. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
   3. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Flange Adaptors 12 IN and Less:
   1. Locate and drill holes for anchor studs after pipe is in place and bolted tight.
   2. Drill holes not more than 1/8 IN larger than diameter of stud projection.

F. Cutting:
   1. Do not damage interior lining material during cutting.
   2. Use abrasive wheel cutters or saws.
   3. Make square cuts.
   4. Bevel and free cut ends of sharp edges after cutting.

G. Support exposed pipe in accordance with Section 40 05 00.

H. Install buried piping in accordance with Section 40 05 00.

I. Install restrained joint systems where specified in Section 40 05 00 under specific piping system.

## 3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

**END OF SECTION**

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# SECTION 40 05 23
## PIPE - STAINLESS STEEL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Stainless steel tubing, piping, fittings and appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
      b. B31.1, Power Piping.
   2. ASTM International (ASTM):
      a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      b. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      c. A312, Standard Specification for Seamless, Welded, and Heavy Cold Worked Austenitic Stainless Steel Pipes.
      d. A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
      e. A530, Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
      f. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
      g. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 00.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   4. Fabrication details and welding procedure specifications for all work to be done under this Specification Section.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Tubing:
   1. ASTM A269.
   2. Filler material: Extra low carbon (ELC) with 0.03 PCT maximum carbon.

B. Pipe, unless noted otherwise on individual piping system in Specification Section 40 05 00:

1. ASTM A778.
2. ASTM A312.

C. Pipe Fittings:
1. ASTM A774.

D. Flanges, unless noted otherwise on individual piping system in Specification Section 40 05 00:
1. Flat faced.
2. Welding neck or slip on type.
3. ASTM A182, Type 316L.

E. Nuts, Bolts and Washers, unless noted otherwise on individual piping system in Specification Section 40 05 00:
1. ASTM A320, Type 316.
2. Two (2) nuts provided for 1 IN DIA bolt applications and larger.

F. Elastomeric Bellows Type Expansion Joint (for hot air service):
1. Refer to Section 40 05 00 for expansion joints for liquid service.
2. Manufacturers:
a. Mercer Series 500 or equal.
3. Two Arch construction.
4. Material: EPDM (tube and cover)
5. Restraint: Provide control rods sized to restrain joint at test pressure.
a. Materials: 316 stainless steel.
6. Allow for minimum of 1 IN of lateral movement.
7. Pressure Rating: Working pressure of joint equal or greater than test pressure of connecting piping. Provide minimum 25 PSIG rating.

G. Gasket Material, unless noted otherwise on individual piping system in Specification Section 40 05 00:
1. Rubber or neoprene.
2. Temperature rating of 250 DEGF.

H. Flexible Metal Hose:
1. General: Braided stainless steel flexible hose.
2. Connections: Provide ANSI 125 flanged connections.
3. Length: Minimum 12 IN or as noted on the Drawings.
4. Pressure: Working pressure of hose equal or greater than test pressure of connecting piping.

## 2.2 FABRICATION

A. All tube, piping, fitting product to be immersion pickled subsequent to manufacturing and fabrication operations and prior to shipping.
1. Pickling solution of 6-10 PCT nitric acid and 3 - 4 PCT hydrofluoric acid.
2. Temperature and exact concentrations to be such only a modest etch is produced but all oxidation and ferrous contamination is removed from metal surface.
3. All pickling solution residues are to be neutralized after pickling.

B. Diameter tolerance and wall thickness tolerance are to conform to ASTM A530.

C. Joints:
1. Shop welded circumferential buttweld joints.
2. ASME B16.1, Class 150.

D. Elastomeric Bellows Type Expansion Joints:
1. Ensure aerial travel in expansion joints of 3.1 IN minimum for 15,000 cycles or 5.2 IN for 1000 cycles.
2. Furnish each assembly with a minimum of two control tie rods.
3. Fabricate with 125 LB flanged end connections.

E. Expansion Joints:

1. Fabricate for 15 PSI internal pressure and 250 DEGF operation.
2. Ensure aerial travel in expansion joints of 3.1 IN minimum for 15,000 cycles or 5.2 IN for 1000 cycles.
3. Furnish each assembly with minimum four control tie rods.
4. Fabricate with 125 LB flanged end connections.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Prior to installation, inspect and verify condition of piping and appurtenances.
   1. Installation constitutes installer's acceptance of condition for satisfactory installation.

### 3.2 PREPARATION

A. Correct defects or conditions which may interfere with or prevent a satisfactory installation.

B. Ensure ends of pipe to be fitted with flanges have all protrusions ground flush.

### 3.3 INSTALLATION

A. Ensure all pipe cutting, threading and jointing conforms to requirements of ASME B31.1.
   1. Lubricate all pipe threads with Teflon tape.

B. Welding:
   1. Provide welds sound and free from embedded scale or slag, and tensile strength at weld not less than pipe.
   2. Perform butt welds only with an inert gas shielded process.
   3. Adequate inert gas protection is to be provided to the top and under or backside of the weld to protect from atmospheric contamination.
   4. Filler metal is to be applied to all manually-performed welds appropriate for the base material being welded.
   5. Only inert gas shielded welding processes are to be used for spool fabrication.
   6. Provide butt welds with 100 PCT penetration to the interior or back side of the weld joint.
   7. Weld reinforcement on both sides of the weld are to be smooth, uniform and no more than 1/16 IN in height.

C. Joining Method - Flanges:
   1. Leave 1/8 IN to 3/8 IN flange bolts projecting beyond face of nut after tightening.
      a. Coordinate dimensions and drillings of flanges with flanges for valves, equipment, and other systems.
      b. Tighten bolts evenly around pipe until following range of torques is achieved:

| BOLT SIZE, IN | RANGES OF TORQUE, FT/LBS |
|---|---|
| 5/8 | 40 - 60 |
| 3/4 | 60 - 90 |
| 1 | 70 - 100 |
| 1-1/4 | 90 - 120 |

D. Expansion Joints:
   1. Install in accordance with manufacturer's instructions.
   2. Apply anti-seize compound to all exposed steel threads.

### 3.4 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Specification Section 40 05 00.

## 3.5 CLEANING

A. Clean in accordance with Specification Section 40 05 00.

**END OF SECTION**

# SECTION 40 05 24
PIPE - STEEL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Steel pipe, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B1.2, Gages and Gaging for Unified Inch Screw Threads.
      c. B16.3, Malleable Iron Threaded Fittings.
      d. B16.5, Pipe Flanges and Flanged Fittings.
      e. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
      f. B16.11, Forged Steel Fittings, Socket Welding and Threaded.
      g. B31.1, Power Piping.
      h. B31.3, Process Piping.
      i. B31.9, Building Services Piping.
      j. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
      d. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      e. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
      f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
      g. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
      h. B6, Standard Specification for Zinc.
   3. American Water Works Association (AWWA):
      a. C200, Standard for Steel Water Pipe - 6 IN and Larger.
      b. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel water Pipeline - Enamel and Tape - Hot Applied.
      c. C205, Standard for Cement-Mortar Lining and Coating for Steel Water Pipe - 4 IN and Larger - Shop Applied.
      d. C206, Standard for Field Welding of Steel Water Pipe.
      e. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.

f. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
g. C209, Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
h. C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
i. C606, Standard for Grooved and Shouldered Joints.
j. M11, Steel Pipe - A Guide for Design and Installation.

4. Society of Automotive Engineers (SAE):
   a. AMS-QQ-P-416, Cadmium Plating Electro deposited.

B. Qualifications:
1. Application of coal tar lining and coating materials including preparation of surfaces, priming, and lining and coating of pipe, fittings, and specials, in shop, repairs of any damage to lining or coating occurring during shipment or any other time, and field lining and coating of ends where linings or coatings have been held back for welded field joints, shall be done by established and recognized pipe company acceptable to Engineer.
2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

### 1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 40 05 00.
3. Factory test reports.
4. If mechanical grooved type coupling system is used, submit piping, fittings, and appurtenant items which will be utilized.
5. Coating manufacturer's qualifications.
6. Welders certificates.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Flanged adaptors:
   a. Rockwell (Style 912 (cast)).
   b. Dresser (Style 127 (cast)).
2. Insulating couplings:
   a. Rockwell (Style 416).
   b. Dresser (Style 39).
3. Reducing couplings:
   a. Rockwell (Style 415).
   b. Dresser (Style 62).
4. Transition coupling:
   a. Rockwell (Style 413).
   b. Dresser (Style 62).
5. Compression sleeve coupling:
   a. Rockwell (Style 431 (cast)).
   b. Dresser (Style 53 (cast)).
6. Mechanical couplings and fittings:
   a. Victaulic (Style 07 or 77).
   b. S.P. Fittings.
7. Vibration isolation equipment connections for natural gas:

a. Flexonics (Model 401H).

8. Flexible connectors for hot water equipment:
   a. Flexonics (FLG Series).
   b. Thermo Tech (F/J/R Series).
9. Factory-applied plastic or epoxy coatings:
   a. "Encoat" Division of Energy Coating Company.
   b. "Scotchkote" Division of 3M Company.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 MATERIALS

A. All materials used in steel piping systems defined in Section 40 05 00 shall meet or exceed pressure test requirements specified for each respective system.

B. Steel Pipe (Fabricated Type):
   1. AWWA C200:
      a. ASTM A36, Grade C steel plate.
      b. ASTM A283, Grade D steel plate.
      c. ASTM A572, steel plate.
      d. ASTM A1011, steel sheet.

C. Steel Pipe (Mill Type): ASTM A53, Type E or S.

D. Fittings (For Fabricated Pipe): AWWA C208.

E. Fittings (For Mill Type Pipe):
   1. ASTM A234.
   2. ASME B16.3, ASME B16.5, ASME B16.9, ASME B16.11.

F. Flanges (Fabricated Pipe):
   1. Flange material: ASTM A283, Grade C or D, ASTM A181, Grade 1.
   2. Flange finish: Flat faced.

G. Flanges (Mill Type Pipe):
   1. ASME B16.5.
   2. Flat faced.
   3. Slip-on flanges.

H. Nuts and Bolts:
   1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application
   2. Exposed: Mechanical galvanized ASTM B695, Class 40.
   3. Heads and dimensions per ASME B1.1.
   4. Threaded per ASME B1.1.
   5. Project ends 1/4 to 1/2 IN beyond nuts.

I. Gaskets: See individual piping systems in Section 40 05 00.

## 2.3 MANUFACTURED UNITS

A. Couplings:
   1. Flanged adaptors:
      a. Steel or carbon steel body sleeve, flange, followers and Grade 30 rubber gaskets.
      b. Provide units specified in Article 2.1.
      c. Flanges meeting standards of adjoining flanges.
      d. Tie bolt assembly.
         1) For pipe 14 IN and larger.
         2) Minimum four (4) bolts equally spaced around the pipe and extending from cast steel lugs welded on the pipe to lugs welded on the coupling middle ring.

e. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.

2. Compression sleeve coupling:
   a. Steel sleeve, followers Grade 30 and rubber gaskets.
   b. Provide units specified in Article 2.1.
   c. Flanges meeting standards of adjoining flanges.
   d. Tie bolt assembly.
      1) For pipe 14 IN and larger.
      2) Minimum four (4) bolts equally spaced around the pipe and extending from cast steel lugs welded on the pipe to lugs welded on the coupling middle ring.
   e. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
   f. Provide field coating for buried couplings per AWWA C203.
3. Mechanical coupling joint:
   a. Use of mechanical grooved (AWWA C606) type couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 40 05 00.
   b. Utilize units defined in Article 2.1.

## 2.4 FABRICATION

A. Provide piping (mill or fabricated) for use in this Project with minimum wall thicknesses as follows:
   1. 1/8 - 5 IN DIA pipe: Schedule 40.
   2. 6 - 10 IN DIA pipe: 3/16 IN.
   3. 12 - 14 IN DIA pipe: 7/32 IN.
   4. 16 - 48 IN DIA pipe: 1/4 IN.
   5. 54 - 60 IN DIA pipe: 5/16 IN.
   6. 66 - 72 IN DIA pipe: 3/8 IN.
   7. Sizes through 24 IN are nominal OD.
      a. Sizes greater than 24 are ID.
   8. Wall thicknesses indicated are for standard weight pipe.
      a. Design pipe in accordance with operating pressures shown in Piping Schedules for a design stress limited to 50 PCT of yield.

B. Furnish cast parts with lacquer finish compatible with finish coating.

C. Furnish without outside coating of bituminous material any exposed pipe scheduled to be painted.

D. Fabricated Fittings:
   1. AWWA C208.
   2. Assure ratio of radius of bend to diameter of pipe equal to or greater than 1.0.

E. Taper cement mortar linings as required for valve interfacing.

F. Protective Coatings and Linings:

G. Pipe Linings:
   1. Cement-mortar in accordance with AWWA C205.

H. Pipe Coatings:
   1. High Performance Industrial Coatings in accordance with Section 09 96 00.
   2. Provide cement mortar lining in accordance with AWWA C205.

## 2.5 SOURCE QUALITY CONTROL

A. Testing:
   1. Shop hydrostatic test fabricated steel pipe and fittings.
   2. Field hydrostatic test all pipe as specified in Section 40 05 00.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Joining Methods - Flanges:
   1. Facing method:
      a. Insert slip-on flange on pipe.
      b. Assure maximum tolerances for flange faces from normal with respect to axis of pipe is 0.005 IN per foot of flange diameter.
      c. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.
   2. Joining method:
      a. Leave 1/8 to 3/8 IN of flange bolts projecting beyond face of nut after tightening.
      b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
      c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
         1) Allow one flange free movement in any direction while bolts are being tightened.
      d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
      e. Gradually tighten flange bolts uniformly to permit even gasket compression.
      f. Do not overstress bolts to compensate for poor installation.

C. Joining Method - Welded Joints:
   1. Perform welding in accordance with AWWA C206 and this Section.
   2. For flange attachment perform in accordance with AWWA C207.
   3. Have each welding operator affix an assigned symbol to all his welds.
      a. Mark each longitudinal joint at the extent of each operator's welding.
      b. Mark each circumferential joint, nozzle, or other weld into places 180 DEG apart.
   4. Welding for all process piping shall conform to ASME B31.3.
      a. Welding of utility piping 125 PSI and less shall be welded per ASME B31.9.
      b. Utility piping above 125 PSI shall conform to ASME B31.1.
   5. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications.
   6. Weldolets may be used for 5 IN and larger pipe provided all slag is removed from inside the pipe.
   7. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer.
   8. Use all long radius welding elbows for expansion loops and bends.
   9. Use long radius reducing welding elbows 90 DEG bends and size changes are required.

D. Joining Method - Couplings:
   1. Compression sleeve:
      a. Install coupling to allow space of not less than 1/4 IN but not more than 1 IN.
      b. Provide harnessed joint.
         1) Use joint harness arrangements detailed in AWWA M11.
      c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 40 05 00 and allow for expansion of pipe.
      d. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type.
      e. Grind smooth welds the length of one coupling on either side of joint to be fitted with any coupling.
      f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.

2. Mechanical coupling:
    a. Arrange piping so that pipe ends are in full contact.
    b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
    c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Support exposed piping in accordance with Section 40 05 00.

F. Install buried piping per Section 40 05 00.

## 3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

**END OF SECTION**

# SECTION 40 05 26
## PIPE - CAST-IRON SOIL

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Cast-iron soil piping, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. See Section 40 05 00.

B. Provide joint type specifically approved by applicable plumbing code.

C. Referenced Standards:
   1. ASTM International (ASTM):
      a. A74, Standard Specification for Cast-Iron Soil Pipe and Fittings.
      b. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
   2. Cast Iron Soil Pipe Institute (CISPI):
      a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
      b. 310,Standard for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   3. Federal Specifications (FS):
      a. QQ-C-40, Calking: Lead Wool and Lead Pig.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Section 40 05 00.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Pipe (General Application):
   1. ASTM A74.
      a. SV service.
   2. No hub: CISPI 301.

B. Joints (General Application):
   1. Standard:
      a. Oakum.
      b. Lead, FS QQ-C-40 Type 1.
   2. Compression joint: Neoprene gasket, ASTM C564.
   3. Mechanical: No hub, CISPI 310.

C. See Piping Schedules in Section 40 05 00.

### 2.2 FABRICATION

A. Cast-Iron Soil Pipe:
   1. SV service rated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Observe manufacturer's recommendation for handling, cutting, jointing, installing, and testing.

B. Install products in accordance with CISPI.

C. Support exposed piping in accordance with Section 40 05 00.

D. Install buried piping in accordance with Section 40 05 00.

E. If "standard joint" is used, assure lead is run in one continuous pour.
   1. No second pouring or driving of lead is permitted.
   2. Provide minimum of 12 OZ of lead per inch of pipe diameter per joint.

### 3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

**END OF SECTION**

# SECTION 40 05 31
PIPE - PLASTIC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Plastic pipe.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. See Specification Section 40 05 00.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. PVC (polyvinyl chloride) materials:
         1) D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
         2) D1785, Standard Specification for Poly(Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
         3) D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
         4) D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
         5) D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
         6) F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
         7) F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
         8) F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
         9) F949, Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
      b. Installation:
         1) D2321, Standard Practice for Underground Installation of Thermosplastic Pipe for Sewers and Other Gravity-Flow Applications.
   2. American Water Works Association (AWWA):
      a. PVC (polyvinyl chloride) materials:
         1) C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN Through 12 IN, for Water Distribution.
         2) C905, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 IN through 48 IN, for Water Transmission and Distribution.
      b. Polyethylene (PE) materials:
         1) C901, Standard for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 IN through 3 IN, for Water Service.
   3. NSF International (NSF).

### 1.3 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 40 05 00.

## PART 2 - PRODUCTS

### 2.1 PVC PRESSURE PIPING (EXPOSED)

A. General:
   1. Provide Schedule 80 pipe with Schedule 80 fittings and appurtenances to locations shown on Drawings.
   2. Furnish materials in full compliance to following material specifications:
      a. Manufacture pipe, fittings and appurtenances from polyvinyl chloride (PVC) compound which meets the requirements of Type 1, Grade 1 (12454-B) Polyvinyl Chloride as outlined in ASTM D1784.
      b. Manufacture pipe, fittings and valves from materials that have been tested and approved for conveying potable water by the NSF.

B. Pipe:
   1. Furnish pipe meeting requirements of ASTM D1785.
   2. Pipe 2 IN and less to be solvent welded.
   3. Pipe larger than 2 IN may be either flanged or solvent welded unless shown otherwise on Drawings.

C. Fittings: Provide ASTM D2467 PVC socket type fittings having the same pressure and temperature rating as the pipe.

D. Flanges/Unions:
   1. Furnish flanges and unions at locations shown on Drawings.
   2. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
   3. For pipe larger than 2 IN, provide 150 LB socket type PVC flange.
   4. For pipe 2 IN and less, provide socket type PVC union with Buna O-rings.
   5. Use flat, full faced natural rubber gaskets at flanged connections.
      a. Furnish heavy hex head bolts, each with one heavy hex nut, ASTM F593 Type 316 stainless steel.
   6. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.

E. Installation:
   1. Field threading PVC will not be permitted.
      a. Perform required threaded connections or attachments by the use of factory molded socket by threaded adapters.
      b. Female adapters are not acceptable.
   2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
      a. Continuously support PVC piping at liquid operating temperatures in excess of 100 DEGF.
      b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
      c. Support riser clamps on spring hangers.
      d. Do not clamp PVC tightly or restrict movement for expansion and contraction.

### 2.2 CPVC PRESSURE PIPING (EXPOSED)

A. General:
   1. Provide Schedule 80 pipe with Schedule 80 fittings and appurtenances to locations shown on Drawings.
   2. Furnish materials in full compliance to following material specifications:

a. Manufacture pipe, fittings and appurtenances from chlorinated polyvinyl chloride (CPVC) compound which meets or exceeds the requirements of ASTM D-1784, Type IV, Grade 1, cell classification 23447B
b. Pressure pipe used in fabrication must be listed by the National Sanitation Foundation (NSF) for potable water applications
c. All solvent cements used, to conform to ASTM F493, listed by NSF for potable use applications.

B. Pipe:
1. Furnish pipe meeting requirements of ASTM D1784.
2. Pipe 2 IN and less to be solvent welded.
3. Pipe larger than 2 IN may be either flanged or solvent welded unless shown otherwise on Drawings.

C. Fittings: Provide ASTM F439 CPVC socket type fittings having the same pressure and temperature rating as the pipe.

D. Joints:
1. Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
2. Provide pipe joint primer IPS-70 and pipe joint solvent cement IPS-724

E. Flanges/Unions:
1. Furnish flanges and unions at locations shown on Drawings.
2. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
3. For pipe larger than 2 IN, provide 150 LB socket type CPVC flange.
4. For pipe 2 IN and less, provide socket type CPVC union.
5. Use flat, full faced natural rubber gaskets at flanged connections.
a. Furnish heavy hex head bolts, each with one (1) heavy hex nut, ASTM F593 Type 316 stainless steel.
6. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.

F. Installation:
1. Field threading CPVC will not be permitted.
a. Perform required threaded connections or attachments by the use of factory molded socket by threaded adapters.
b. Female adapters are not acceptable.
2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
a. Continuously support CPVC piping at liquid operating temperatures in excess of 100 DegF.
b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
c. Support riser clamps on spring hangers.
d. Do not clamp CPVC tightly or restrict movement for expansion and contraction.

## 2.3 PVC DRAINAGE, SEWER PIPING

A. Materials:
1. Furnish materials in full compliance to the following material specification.
2. PVC pipe shall be rigid, unplasticized polyvinyl chloride (PVC) made of PVC plastic having a cell classification of 12454-B or 12454-C as described in specification ASTM D1784.
3. The requirements of this Specification are intended to provide for pipe and fittings suitable for non-pressure drainage of wastewater and surface water.

4. Joining systems shall consist of an elastomeric gasket joint meeting requirements of ASTM D3212.
5. Supply to the Engineer all information and sample of joining method for his evaluation.
   a. Only jointing methods acceptable to the Engineer will be permitted.
6. Provide pipe and fittings meeting or exceeding the following requirements:
   a. 4-27 IN DIA: ASTM D3034 and ASTM F679, SDR 35.
   b. 8-30 IN DIA: ASTM F794.
   c. 4-18 IN DIA: ASTM F949.
7. Ensure impact strengths and pipe stiffnesses in full compliance to these Specifications.

B. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
   1. Provide for a maximum deflection of not more than 5 PCT.

C. Infiltration and Exfiltration The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
   1. For exfiltration, all the pipe and fittings shall exceed performance requirements by an air test procedure as specified in Section 40 05 00.
   2. Observe full instructions of the Engineer for carrying of testing procedures.
      a. Perform tests only during presence of the Engineer or his authorized representative.
   3. Should any test on any section of pipe line disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.

D. Deflection:
   1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
   2. Pipe with deflection exceeding 5 percent of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 percent.
   3. Any repaired pipe shall be retested.

### 2.4 NYLON BRAIDED PVC TUBING

A. General: Provide nylon tubing with fittings and appurtenances as shown on Drawings.

B. Materials:
   1. Furnish clear outer braided tubing with braid outside the walls.
   2. Have tubing manufactured of nylon with working temperatures from 5 to 180 DEGF.
   3. Design tubing with a minimum safety factor of 4 to 1 ratio of burst pressure to working pressure at maximum temperature.
   4. Provide tubing with working pressure of 75 PSI at 180 DEGF.
   5. Ensure that tubing is self-extinguishing and fire resistant.

C. Fittings:
   1. Install tubing with nylon fittings and connectors.
   2. Use barbed type adapters with stainless steel clamps.
   3. Provide fittings capable of withstanding temperatures from a -70 to 250 DEGF.
   4. Ensure fittings have the same pressure and temperature rating as the tubing.

## PART 3 - EXECUTION

### 3.1 IDENTIFICATION

A. Identify each length of pipe clearly at intervals of 5 FT or less.
   1. Include manufacturer's name and trademark.

2. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

## 3.2 PVC DRAINAGE AND SEWER PIPING

A. Installation: Install pipe and fittings in accordance with ASTM D2321 and as recommended by the manufacturer.
   1. Provide for a maximum deflection of not more than 5 PCT.

B. Infiltration and Exfiltration:
   1. The maximum allowable infiltration measured by test shall not exceed 100 GAL per inch of pipe diameter per mile per 24 HRS.
   2. For exfiltration, all the pipe and fittings shall exceed performance requirements by the test procedure as specified in Section 40 05 00.
   3. Observe full instructions of the Engineer for carrying of testing procedures.
      a. Perform tests only during presence of the Engineer or his authorized representative.
   4. Should any test on any section of pipe line disclose either infiltration rates greater than allowed or disclose air loss rate greater than that permitted, locate and repair the defective joints or pipes at no cost to Owner and retest until requirements stated are met.

C. Deflection:
   1. After backfilling, each section of pipe shall be checked for deflection by pulling a mandrel through the pipe.
   2. Pipe with deflection exceeding 5 PCT of the inside diameter shall have backfill removed and replaced to provide a deflection of less than 5 PCT.
   3. Any repaired pipe shall be retested.

## 3.3 PVC TUBING

A. Fittings:
   1. Install tubing with nylon fittings and connectors.
   2. Use barbed type adapters with stainless steel clamps.
   3. Provide fittings capable of withstanding temperatures from a -70 to 250 DEGF.
   4. Ensure fittings have the same pressure and temperature rating as the tubing.

B. Trays:
   1. Flat smoothed bottom tray for supporting flexible hoses when there is a chance that the hoses may pulse or move.

**END OF SECTION**

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# SECTION 40 05 51
## VALVES - BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Valving, actuators, and valving appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 09 96 00 - High Performance Industrial Coatings.
   5. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   6. Section 40 05 52 - Miscellaneous Valves.
   7. Section 40 05 61 - Gate Valves.
   8. Section 40 05 63 - Ball Valves.
   9. Section 40 05 64 - Butterfly Valves.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose.
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
      c. D638, Standard Test Method for Tensile Properties of Plastics.
      d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
      e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
      f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
      b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      c. C504, Standard for Rubber-Seated Butterfly Valves.
      d. C507, Standard for Ball Valves, 6 IN through 48 IN (150 MM through 1200 MM).
      e. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      f. C550, Standard for Protective Coatings for Valves and Hydrants.
      g. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   6. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

### 1.3 DEFINITIONS

A. The following are definitions of abbreviations used in this Specification Section or one of the individual valve sections:
   1. CWP: Cold water working pressure.
   2. SWP: Steam working pressure.
   3. WOG: Water, oil, gas working pressure.
   4. WWP: Water working pressure.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Valve pressure and temperature rating.
      d. Valve material of construction.
      e. Special linings.
      f. Valve dimensions and weight.
      g. Valve flow coefficient.
      h. Wiring and control diagrams for electric or cylinder actuators.
      i. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.
   3. Test reports.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Verification from valve actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the valve actuator responds correctly to the valve position command.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

### 2.2 MATERIALS

A. Refer to individual valve Specification Sections.

### 2.3 VALVE ACTUATORS

A. Valve Actuators - General:
   1. Provide actuators as shown on Drawings or specified.
   2. Counter clockwise opening as viewed from the top.
   3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
   4. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 FT-pounds torque on the operating nut.

5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
6. Extension stem:
    a. Install where shown or specified.
    b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
    c. Pin all stem connections.
    d. Center in valve box or grating opening band with guide bushing.

B. Buried Valve Actuators:
1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum diameter, 3/16 IN minimum thickness, and identifying cast iron cover rated for traffic load.
2. Box base to enclose buried valve gear box or bonnet.
3. Provide 2 IN standard actuator nuts complying with AWWA C500, Section 3.16.
4. Provide at least two tee handle keys for actuator nuts, with 5 FT extension between key and handle.
5. Extension stem:
    a. Provide for buried valves greater than 4 FT below finish grade.
    b. Extend to within 6 IN of finish grade.
6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.

C. Plastic Valve Vault:
1. Provide in non-traffic areas only on valve applications 3-1/2 IN and less.
2. Nominal 7-1/2 IN DIA top section.
3. Design unit for screw type extension section having nominal 9 IN DIA bell.
4. Cast iron ring and lid.
5. Constructed of injection molded polyolefin compound with fibrous inorganic component reinforcing and UV stabilization.
6. Armor Access Boxes.

D. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric or cylinder actuators.
2. Provide handwheels for gate and globe valves.
    a. Size handwheels for valves in accordance with AWWA C500.
3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN DIA and smaller.
    a. Lever actuators for butterfly valves shall have a minimum of five intermediate lock positions between full open and full close.
    b. Provide at least two levers for each type and size of valve furnished.
4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 IN DIA and larger.
5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
    a. Cadmium-plated chain looped to within 3 FT of finish floor.
    b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
    c. For smaller valves with lever or handle operators, provide offset tee handles with attached chain for operation from the operating floor.
8. Provide cast iron floor stands where shown on Drawings.
    a. Stands to be furnished by valve manufacturer with actuator.
    b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

E. Electric Actuators (480 V, 3 PH):
1. General Requirements:

a. Provide electric valve actuators with integral control devices and a remote pushbutton station, unless valve actuator control station is more than 6 FT above an operating floor; then provide a remote control station.
b. The actuators shall be intelligent, non-intrusive type, suitable for use on a nominal 480 volt and 3 phase power supply and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self-contained, sealed enclosure.
c. Setting of the torque levels, position limits and configuration of the indication contacts, etc. shall be carried out using a programming tool without the removal of any actuator covers over an Infrared or Bluetooth wireless interface or through the use of local control knobs, push buttons, etc.
    1) Provision shall be made to disable Bluetooth communications or only allow a Bluetooth connection initiated by an Infrared command for maximum security.
    2) The programming tool shall enable the user to extract and store actuator configuration and data logger files within the tool.
    3) The programming tool shall store up multiple configuration and data logger files. Stored configuration and data logger files shall also be able to be uploaded to both the actuators and to diagnostic software provided by the actuator manufacturer.
d. Conform to AWWA C542.
e. Suitable for full 90-degree rotation of quarter-turn valves or for use on multi-turn valves.
f. Torque:
    1) Size to 1-1/2 times the required operating torque.
    2) Motor stall torque shall not exceed torque capacity of valve.
g. Furnish electric actuator integral with valve consisting of:
    1) Motor.
    2) Gearing.
    3) Handwheel.
    4) Limit and torque switches.
    5) Lubricants.
    6) Heating elements.
    7) Wiring.
    8) Terminals for motor power and controls.
    9) Drive nut.
h. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes. See Section 01 61 03 for information on how to determine the available fault current, such that, the SCCR rating meets or exceeds the available fault current.

2. Housing/enclosure:
    a. Provide cast iron gear housing and cast iron load bearing enclosure.
    b. Non load bearing enclosure and housing: Aluminum or cast iron.
    c. Rated for area classification shown on Drawings.
    d. Provide O-ring seals for covers and entries.
    e. Terminal and limit switch compartment covers are to be fastened to gear housing by stainless steel fasteners with capture device to prevent loss.
3. Motors:
    a. The motor shall be an integral part of the actuator, designed specifically for valve actuator applications.
    b. The motor design shall be a low inertia high torque.
    c. Motor protection shall be done via two thermostats or three thermo-switches embedded in the motor end windings.
    d. The motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve or gate.
    e. Lost phase protection.

f. For ON/OFF duty, Class F insulated with a time rating of at least 15 minutes at 104 DegF (40 DegC) or twice the valve stroking time, whichever is longer, at an average load of at least 33 percent of maximum value torque.
g. For MODULATING duty, the electric motor shall be suitable for up to 1200 starts per hour with a duty in accordance with ICE 34-1 to S4 50 percent shall include a solid state starter. Removal of the motor should be possible without draining the lubricant from the actuator.
h. Provide motors that are totally enclosed, high torque design made expressly for valve actuator service and capable of operating the valve under full differential pressure for complete open-close and reverse cycle of travel at least twice in immediate succession without overheating.
i. Design motors in accordance with NEMA MG 1 standards, with Class B insulation, and to operate successfully at any voltage within 10 percent above or below rated voltage.
j. Provide positive method to ensure motor bearings are permanently lubricated.
k. Motor housing:
    1) Aluminum or cast iron.
    2) Totally enclosed non-ventilated.
    3) Enclosure:
        a) Actuators shall be double O-ring sealed, watertight to IP66/IP68 at a minimum of 26 FT for 96 hours, NEMA 4, 6. Removal of the terminal cover shall not change the actuator NEMA ratings. Actuator must be able to operate at least ten times during submersion. Breathers, heaters, and drains shall not be permitted. External conduit connections from motor to actuator controller shall not be permitted.
        b) NEMA 7 explosion proof actuator enclosure ratings shall be provided if shown on the drawings and/or required by the site conditions.
        c) Temporary site storage without the need for electrical supply connection at an ambient of 22 DegF to 158 DegF.
l. Provide motor capable of operating in any position.
m. Provide motor sealed from gearcase to allow any mounting position.
n. Provide motors suitable for 480 V, 3 phase, 60 Hz.
o. Reversing motor starter with built-in overload protection.
p. Starters shall provide electrical overload protection of the motor by sensing high current draw or high motor winding temperature. Overloads shall be the automatic reset type.

4. Gearing:
    a. The actuator gearing shall be totally enclosed in an oil-filled or grease-filled gearcase suitable for operation at any orientation. Thrust bearings shall be at the base of the actuator to eliminate gearcase stress. This shall also permit the removal of the actuator, without the removal of the thrust base from the valve or gate. The design should be such as to permit the opening of the gearcase for inspection or disassembled without releasing the stem thrust or taking the valve or gate out of service. Thrust bearing shall be sealed for life and the base shall be capable of withstanding five times the rated thrust of the actuator.
    b. Provide power gearing consisting of heat treated steel helical gears, carburized and hardened alloy steel worm, and alloy bronze worm gear, all grease or oil bath lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter.
    c. Provide gearing mechanism constructed to permit field changes of reduction gear ratio.
    d. Design actuators so that motor comes up to speed before stem load is encountered in either opening or closing operation.
    e. Limit switch gearings and feedback device reduction gearing:
        1) Steel or bronze.
    f. Support rotating shafts with anti-friction bearings.
    g. Provide separate drive nut/thrust bearing assembly:

1) The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.
2) Mounted to base of actuator.
3) High tensile bronze.
4) Quarter turn actuator: Worm gearboxes where required, shall be supplied with full 360 degree bronze or ductile iron worm wheels and end-of travel mechanical stops. Designs with segmented worm gears shall not be permitted.
5) Provide grease fitting on drive assembly.

5. Handwheel:
   a. A handwheel shall be provided for emergency operation. Motor drive shall be restored automatically by starting the motor. The hand auto level shall be padlockable in both hand and automatic positions. The clockwise rotation of the handwheel shall provide a clockwise rotation of the drive output. It should be possible to select hand operation while the actuator handwheel drive must be mechanically independent of the motor drive.
   b. The handwheel drive must be mechanically independent of the motor drive, and any gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in the job specification.
   c. Permanently attached for manual operation.
   d. Positive declutch mechanism to engage and disengage handwheel.
   e. Handwheel shall not rotate during motor operation.
   f. Inoperable motor shall not prevent manual operation.
6. Torque monitoring:
   a. Torque and turns limitation shall be adjustable without removing any actuator covers via Bluetooth connectivity.
   b. Torque sensing shall be from direct measurement of force at the output of the actuator, governed by a solid-state torque sensor that directly measures the output torque of the actuator to protect the valve and actuator from damage and possible obstructions. Methods of determining torque using either mechanical torque switches or data derived from the motor such as motor speed, current, flux, etc. are not acceptable.
   c. The actuator shall be equipped with torque sensing responsive to overloads encountered in either the opening or closing direction.
   d. Torque monitoring shall be electronically sensed and shall not rely on mechanical torque switches.
   e. Torque sensing switches shall be independently adjustable for both the opening and closing directions.
   f. The torque protection feature shall operate during the complete valve cycle.
   g. The torque switch shall be configured to disengage the actuator motor in the event excessive loads are encountered during travel and/or for torque seating of valves as recommended by the manufacturer.
7. Limit Switches:
   a. Each valve actuator shall have a minimum of two transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   b. Position measurement shall be contactless with no more than five moving parts and be single fault tolerant. Technologies such as LEDs or potentiometers for position measurement are considered unreliable and therefore are not acceptable. Position setting range shall be 2.5 to 8000 turns, with resolution to 7.5° of actuator output. Position setting range shall be via a solid-state absolute position encoder that eliminates the use of counting gear trains or potentiometers.
   c. Position monitoring shall be electronically sensed and shall not rely on mechanical limit switches.

d. Contacts shall be configurable through the actuator microprocessor controller to allow flexibility of adjustment.
e. Housed in actuator enclosure.

8. The control package shall incorporate a digital microprocessor controller. The control unit shall include the following features as a minimum:
   a. A phase discriminator shall ensure proper rotation direction of the motor regardless of the connection of the power phase leads to the operator.
   b. All settings of the microprocessor shall be password protected.
   c. All adjustments of the microprocessor shall be configurable by either portable handheld Bluetooth Setting Tool or from a personal computer.
   d. Configuration adjustments from either the portable programmer or the personal computer shall be made without opening the operator enclosure via optical (or similar) data coupling technology.
   e. Personal computer configuration: Microsoft Windows 10 compatible software, and interface module required to allow operator configuration and diagnostics from a personal computer via Bluetooth shall be furnished by the operator manufacturer:
      1) The personal computer shall be furnished by the OWNER.
      2) The configuration software shall allow setup, adjustment and monitoring of all parameters in the operator microprocessor controller.
   f. The operator shall have an integral LED display that includes indication of the following data as a minimum:
      1) Valve position in percent of open in 1percent increments.
      2) Malfunction/diagnostics messages.
      3) Full open, full close and in transition LED indicators.
      4) Five (5) output contacts configurable for position indication.
      5) One (1) output contact configured for operator controller switch in the REMOTE position (i.e. Monitor Relay).

9. Open-close actuator controls:
   a. The actuator shall incorporate local controls. It shall be possible to select maintained or non-maintained local control. The local controls and display shall be rotatable through increments of 90 degrees to suit valve.
   b. Provide control assembly with necessary holding relays, reversing starter, control transformers of sufficient capacity to provide control power, space heating element power and valve position transmitter.
   c. Provide control assembly in an enclosure rated for the defined area classification.
   d. Controls for open/close actuator:
      1) Local operator controls of the valve shall be integral to the valve actuator, unless otherwise shown.
      2) Provide the following operator controls and interface devices:
         a) Open knob or pushbutton.
         b) Close knob or pushbutton.
         c) Stop knob or pushbutton.
         d) Remote/local/control knob or pushbutton.
         e) Full open light – Configurable LEDs: green, red and yellow.
         f) Full close light – Configurable LEDs: green, red and yellow.
         g) Digital display for valve percent open indication.
         h) Open and close relays as required.
      3) Provide control enclosure to accept:
         a) Remote open/close switches.
      4) Provide dry, relay contacts in control enclosure for interface to the Plant Control System:
         a) REMOTE contact.
         b) Full OPEN contact.
         c) Full CLOSE contact.
         d) FAULT contact.

5) Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.
6) Four separate contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall operate when all external power to the actuator is isolated.
    a) The contacts shall be rated for 5mA to 5A, 120V AC, 30V DC.
    b) Contacts shall be programmable to signal 40 actuator status conditions at a minimum, including at least the following data:
        (1) Control:
            (a) Open/Stop /Close
            (b) Desired Valve Position Control 0-100 percent
        (2) Status:
            (a) Motor Running Open Direction
            (b) Motor Running Closed Direction
            (c) Fully Open
            (d) Fully Closed
            (e) Percentage Open
            (f) Percentage Torque
            (g) Namur conditions
            (h) ESD Active
            (i) Remove/Local selected
        (3) Alarms:
            (a) Communications Failure
            (b) Actuator Alarm
            (c) Valve Alarm
            (d) Battery Low Alarm
            (e) Scheduled maintenance due
            (f) Lost phase
            (g) Torque trip

10. Local Position Indication
    a. The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 0.1 percent increments.
    b. Blinking yellow LED indicator shall be used to show the following conditions:
        1) Actuator service interval exceeded.
        2) Actuator fault.
        3) Actuator output torque within 10 percent of torque setting.
    c. Mechanical Dial Position Indicator (MDPI) shall be supplied.
    d. The actuator display shall include a fully configurable dot-matrix display element with a minimum pixel resolution of 168 x 132 to display information. The text display shall be selectable between English and other languages.
11. Additional requirements for modulating valve actuators:
    a. Proportional position servo-amplifier mounted integral with the actuator control compartment.
    b. Solid-state reversing starters for modulating duty.
    c. Positioning of valve shall be proportional to a 4-20 mA signal input to the position servo-amplifier when remote control has been selected.
    d. Servo-amplifier adjustments shall include zero, span, gain, and dead-band.
    e. Quarter turn actuator: Provide 90 degree mounting intervals.
    f. Integral controls for modulating actuator:
        1) AC motor with reversing starter or dc motor with solid state reversing controller, and build-in overload protection. Controller capable of 1,200 starts per hour.
        2) Size motors suitable for up to 1,200 starts per hour with a duty in accordance with IEC34-1 to S4 50 percent.

3) Feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.
4) Duty cycle limit timer and adjustable band-width to prevent actuator hunting.
5) Valves shall fully close upon loss of position command signal.
6) Operator control devices:
   a) Open knob or pushbutton.
   b) Close knob or pushbutton.
   c) Stop knob or pushbutton.
   d) Remote/local/stop knob or pushbutton.
   e) Full open light.
   f) Full close light.
   g) Digital display for valve percent open indication.
   h) Open and close relays as required.
7) Provide contacts in control enclosure:
   a) Remote contact.
   b) Full open contact.
   c) Full close contact.
   d) Fault contact.
8) Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.
9) Provide 4-20 mA signal position control as shown on the drawings that interfaces with the position control/position feedback instrumentation wiring to and from the Plant Control System PLC.
10) Valve position output converter that generates a 4-20 ma signal in proportion to valve position, and is capable of driving into loads up to 500 ohms at 24 VDC.

12. Manufacturers:
    a. RoTork IQ/IQT.
    b. Limitorque MXa
    c. AUMA Actuators SA/SG.
    d. No like, equivalent or "or-equal" item is permitted.

F. Electric Actuators (120 V, 1 PH):
1. General:
   a. Self contained including motor, gearing, torque switch, limit switches and cast housing.
   b. Electrical enclosure: NEMA 4 or NEMA 7 to comply with area rating classification shown on Drawings.
   c. Factory assembled requiring only field connection of power and control wires.
   d. Comply with Section 01 61 03.
2. Motors:
   a. Produce 1.5 times the required torque.
   b. Sized for two complete open-close cycles without overheating.
   c. One fully closed to fully open cycle to occur within 60 SEC.
   d. Class F insulation.
   e. Operate at plus or minus 10 PCT voltage.
   f. 120 Volt, single phase, 60 Hz.
   g. Provide thermal cutout switch and internal heater for actuator enclosure.
   h. Control wiring as shown on Drawing control diagrams.
3. Remote pushbutton station:
   a. Enclosure: NEMA 4 stainless steel.
   b. Control relays shall include:
      1) Open relay.
      2) Closed relay.
      3) PLC interface relay.
   c. Push-to-test indicating lights shall include:
      1) Open.

2) Closed.
3) Remote.

d. Selector switches shall include:
1) Local-Remote.
2) Open-Close.

e. Space heater for enclosure.
f. Control wiring as shown on control diagrams.
g. Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.

4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes. See Section 01 61 03 for information on how to determine the available fault current, such that, the SCCR rating meets or exceeds the available fault current.

G. Pneumatic Actuators:

1. Manufacturers:
a. Kinetrol USA, Inc.
b. K-Tork International, Inc.

2. General:
a. AWWA C541.
b. Self contained unit including actuator and controls.
c. Electrical enclosure to meet area classification shown on Drawings.
d. Factory assembled requiring field supply connection and control wires.

3. Actuators:
a. Vane-type design with only one moving part. Actuator shaft and vane shall be a single machined part.
b. Shaft: stainless steel or zinc plated spheroidal annealed iron.
c. Housing: corrosion resistant zinc alloy to ILZRO 16 or cast LM25 grade aluminum coated with baked epoxy enamel.
1) Internal surfaces: Teflon impregnated or corrosion resistant baked enamel coating.
d. Vane seals: dual lip polyurethane design
1) Spring: stainless steel expanders.
e. Supply air shall be 80 to 100 psi.
1) Threads: ANSI.
f. Visual position indicator: manufacturer's standard.
g. Travel stops and fasteners: Stainless steel threaded travel stops allowing adjustment at each end of actuator stroke. All fasteners shall be stainless steel.

4. Limit Switches:
a. Enclosure: NEMA 4, pressure die-cast zinc.
1) Coatings: baked epoxy enamel
b. Microswitches: Two (2) modulating SPDT with resistive load rating of 15 amps @125 VAC and 10 amps up to 24 VDC.
c. Position: ISO 9002 certified and manufactured by actuator manufacturer.

5. Solenoid Valves:
a. Manufacturer: Numatics Inc., ASCO, or approved equal.
b. NEMA 4 rated
c. Shall have manual override to allow manual operation.
d. Speed control devices shall allow independent adjustment of open and close cycling speed.
e. Valves shall include exhaust mufflers
f. Directly mounted to actuator with the option of remote mounting.

## 2.4 FABRICATION

A. End Connections:

1. Provide the type of end connections for valves as required in the Piping Schedules presented in Section 40 05 00 or as shown on the Drawings.
2. Comply with the following standards:
   a. Threaded: ASME B1.20.1.
   b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
   c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
   d. Soldered: ASME B16.18.
   e. Grooved: Rigid joints per Table 5 of AWWA C606.

B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

C. Nuts, Bolts, and Washers:
1. Wetted or internal to be bronze or stainless steel.
   a. Exposed to be zinc or cadmium plated.

D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.

E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with Section 09 96 00 for High Performance Industrial Coatings.

C. Setting Buried Valves:
1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
2. Set valves and valve boxes plumb.
3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
4. Install in closed position.
5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.

D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

E. For grooved coupling valves, install rigid type couplings or provide separate support to prevent rotation of valve from installed position.

F. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

G. For threaded valves, provide union on one side within 2 FT of valve to allow valve removal.

H. Install valves accessible for operation, inspection, and maintenance.

### 3.2 ADJUSTMENT

A. Adjust valves, actuators and appurtenant equipment to comply with Section 01 75 00.
1. Operate valve, open and close at system pressures.

B. For all 120 VAC and 480 VAC electric actuators, employ and pay for services of valve actuator manufacturer's field service representative to:

1. Inspect valve actuators covered by this Specification Section.
2. Supervise adjustments and installation checks:
   a. Open and close valves electrically under local manual and demonstrate that all limit switches are properly adjusted and that switch contacts are functioning properly by verifying the inputs are received at the remote input/output (RIO) panels or local control panel as appropriate.
   b. Position modulating valves electrically under local manual control and demonstrate that the valve position feedback potentiometer is properly adjusted and that the feedback signal is received at the RIO panels or local control panel as appropriate.
   c. Simulate a valve position command signal at the RIO panel or local control panel as appropriate and demonstrate that the valve is controlled to the desired position without excessive hunting.
3. Provide Owner with a written statement that the valve actuator manufacturer has verified that the actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted and that the valve actuator responds correctly to the valve position command.

## 3.3 SCHEDULES

A. The following schedule is for actuated valves. See Drawings for manual valves.

| Equipment Number | Service | Size, Inches | Electric /Pneumatic | Voltage/Phase | Operation | Notes |
|---|---|---|---|---|---|---|
| ARV-1201 | RW | 12 | NA | | | |
| ARV-1201 | RW | 12 | NA | | | |
| FCV-1501 | RW | 14 | Electric | | Modulating | |
| FCV-1502 | RW | 14 | Electric | | Modulating | |
| BV-2001 | OZG | 2 | Electric | | Open/Close | Supplier |
| BV-2002 | OZG | 2 | Electric | | Open/Close | Supplier |
| BFV-2101 | RW | 4 | Electric | | Open/Close | Supplier |
| BFV-2201 | RW | 4 | Electric | | Open/Close | Supplier |
| BV-2104 | OZW | 2.5 | Electric | | Open/Close | Supplier |
| BV-2203 | RW | 2.5 | Electric | | Open/Close | Supplier |
| PRV-3000 | OZW | 2 | NA | | | |
| PV-3216 | MSD | 4 | Electric | 480 | Open/Close | |
| PV-3226 | MSD | 4 | Electric | 480 | Open/Close | |
| SV-4111 | V | 2 | Electric | | Open/Close | |
| BFV-4611 | BWW | 24 | Pneumatic | | Open/Close | |
| BFV-4011 | SW | 24 | Pneumatic | | Open/Close | |
| BFV-4111 | LPA | 10 | Pneumatic | | Open/Close | |
| BFV-4411 | BWS | 24 | Pneumatic | | Open/Close | |
| BFV-4311 | FTW | 12 | Pneumatic | | Open/Close | |
| BFV-4212 | FE | 12 | Pneumatic | | Open/Close | |
| BFV-4211 | FE | 12 | Pneumatic | | Modulating | High Performance |
| ARV-4411 | BWS | 2 | NA | | | |
| SV-4121 | V | 2 | Electric | | Open/Close | |
| BFV-4621 | BWW | 24 | Pneumatic | | Open/Close | |

| Equipment Number | Service | Size, Inches | Electric /Pneumatic | Voltage/Phase | Operation | Notes |
|---|---|---|---|---|---|---|
| BFV-4021 | SW | 24 | Pneumatic | | Open/Close | |
| BFV-4121 | LPA | 10 | Pneumatic | | Open/Close | |
| BFV-4421 | BWS | 24 | Pneumatic | | Open/Close | |
| BFV-4321 | FTW | 12 | Pneumatic | | Open/Close | |
| BFV-4222 | FE | 12 | Pneumatic | | Open/Close | |
| BFV-4221 | FE | 12 | Pneumatic | | Modulating | High Performance |
| SV-4131 | V | 2 | Electric | | Open/Close | |
| BFV-4631 | BWW | 24 | Pneumatic | | Open/Close | |
| BFV-4031 | SW | 24 | Pneumatic | | Open/Close | |
| BFV-4131 | LPA | 10 | Pneumatic | | Open/Close | |
| BFV-4431 | BWS | 24 | Pneumatic | | Open/Close | |
| BFV-4331 | FTW | 12 | Pneumatic | | Open/Close | |
| BFV-4232 | FE | 12 | Pneumatic | | Open/Close | |
| BFV-4231 | FE | 12 | Pneumatic | | Modulating | High Performance |
| SV-4141 | V | 2 | Electric | | Open/Close | |
| BFV-4641 | BWW | 24 | Pneumatic | | Open/Close | |
| BFV-4041 | SW | 24 | Pneumatic | | Open/Close | |
| BFV-4141 | LPA | 10 | Pneumatic | | Open/Close | |
| BFV-4441 | BWS | 24 | Pneumatic | | Open/Close | |
| BFV-4341 | FTW | 12 | Pneumatic | | Open/Close | |
| BFV-4242 | FE | 12 | Pneumatic | | Open/Close | |
| BFV-4241 | FE | 12 | Pneumatic | | Modulating | High Performance |
| BFV-4511 | LPA | 10 | Pneumatic | | Open/Close | |
| SV-4810 | D | ½ | Electric | | Open/Close | |
| PV-4701 | DR | 12 | Electric | 480/3 | Open/Close | |
| PV-4702 | DR | 12 | Electric | 480/3 | Open/Close | |
| MV-4701 | SAN | 6 | Electric | | Open/Close | Extension Stem, Floor Mount Pedestal, and Supports. See Drawings for Details |
| MV-4702 | SAN | 6 | Electric | | Open/Close | Extension Stem, Floor Mount Pedestal, and Supports. See Drawings for Details |
| BV-2111 | GOX | 1.5 | Electric | | Open/Close | |
| BV-2121 | GOX | 1.5 | Electric | | Open/Close | |
| BV-2201 | GOX | 1.5 | Electric | | Open/Close | Slow Closing |
| PRV-2202 | GOX | 1.5 | NA | | | |

| Equipment Number | Service | Size, Inches | Electric /Pneumatic | Voltage/Phase | Operation | Notes |
|---|---|---|---|---|---|---|
| PRV-2203 | GOX | 1.5 | NA | | | |
| BV-2411 | GOX | 3/4 | Electric | | Open/Close | |
| BV-2413 | CWS | 1 | Electric | | Open/Close | |
| BV-2417 | OG | 3/4 | Electric | | Open/Close | |
| BV-2418 | OZG | 3/4 | Electric | | Open/Close | |
| BV-2421 | GOX | 3/4 | Electric | | Open/Close | |
| BV-2423 | CWS | 1 | Electric | | Open/Close | |
| BV-2427 | OG | 3/4 | Electric | | Open/Close | |
| BV-2428 | OZG | 3/4 | Electric | | Open/Close | |
| ARV-2510 | CWR | 2 | NA | | | |
| ARV-2511 | CWS | 2 | NA | | | |
| BV-2510 | CWR | 1.5 | Electric | | Open/Close | |
| BV-2511 | CWR | 1.5 | Electric | | Open/Close | |
| BV-2611 | OG | 3 | Electric | | Open/Close | |
| BV-2621 | OG | 3 | Electric | | Open/Close | |
| SV-7211 | SVW | 1 | Electric | | Open/Close | Supplier |
| SV-7311 | SVW | 1 | Electric | | Open/Close | Supplier |
| ARV-5011 | FE | 1 | NA | | | |
| ARV-5012 | FE | 1 | NA | | | |
| ARV-5013 | FE | 1 | NA | | | |
| ARV-5001 | FE | 1 | NA | | | |
| PSV-5200 | PW | 16 | NA | | Pressure Sustaining | |
| PRV-5411 | BWS | 16 | NA | | Pressure Regulating | |
| BFV-5411 | BWS | 24 | Pneumatic | | Modulating | High Performance |
| ARV-6000 | PWC | 2 | NA | | | |
| ARV-6001 | PWC | 2 | NA | | | |
| ARV-6011 | PWC | 2 | NA | | | |
| ARV-6002 | PWC | 2 | NA | | | |
| ARV-6012 | PWC | 2 | NA | | | |
| ARV-6003 | PWC | 2 | NA | | | |
| ARV-6013 | PWC | 2 | NA | | | |

**END OF SECTION**

# SECTION 40 05 52
## MISCELLANEOUS VALVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Diaphragm valves.
   2. Air release and vacuum relief valves.
   3. Automatic control valves:
      a. Flow Control Valves.
   4. Pinch valves.
   5. Mud valves.
   6. Float-operated valves (2 IN and smaller).
   7. Pressure-reducing valves (2 IN and smaller).
   8. Pressure relief valves (1 IN and smaller).
   9. Solenoid valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 09 96 00 – High Performance Industrial Coatings
   5. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
      b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.
   3. Canadian Standards Association (CSA).
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 DIAPHRAGM VALVES FOR CHEMICAL SERVICE

A. Material:
   1. Body: PVC conforming to ASTM 1784.
   2. Diaphragm – EPDM backed Teflon.
   3. Bolts and other external hardware – 304 SST.
   4. Indicating Rod – 304 SST.
   5. Bonnet – PVC conforming to ASTM 1784.
   6. O-rings – EPDM
   7. Hand wheel – Polypropylene.
   8. Gas barrier – PVDF conforming to ASTM D3222 cell classification Type 11.

B. End Connections:
   1. Air Operated Valves – Flanged.
   2. All Others –Flanged or true union.

C. Valve Style
   1. Weir.
   2. Adjustable travel stops.

D. Accessories
   1. Locking handle covers

## 2.3 AIR RELEASE VALVES

A. General: Conform to AWWA C512.

B. Alternate 1:
   1. Water
      a. Air Release Valve:
         1) Acceptable manufacturers:
            a) APCO 200A.
            b) GA Industries, Figure 920.
         2) Materials:
            a) Body and cover: Cast iron or semi-steel.
            b) Float: Stainless steel.
            c) Linkage and trim: Bronze or stainless steel.
         3) Design requirements:
            a) Size: 1 IN.
            b) Working pressure: 75 PSI.
            c) Release 10 CUFTM at 10 PSI differential at 150 PSI line pressure.
      b. Combination Air Release and Vacuum Valve:
         1) Acceptable manufacturers:
            a) GA Industries, Figure 945
            b) APCO Series S-140C (1 IN-4 IN)
         2) Materials:
            a) Body and cover: Cast iron.
            b) Float, linkage and hardware: Stainless steel.
            c) Seat: Buna-N.
         3) Design requirements:
            a) Size: As shown.
            b) Working pressure: 100 PSI.
            c) Release 10 CUFTM at 10 PSI differential at 150 PSI line pressure.
            d) Provide isolation valve, type as shown.

e) Provide control for slow release of air through valve to prevent valve slamming shut from excessive air or water velocity through the valve.

## 2.4 AUTOMATIC CONTROL VALVES FOR WATER SERVICE

A. Basic Valve:
1. Type:
a. Diaphragm-actuated hydraulically operated.
1) Acceptable manufacturers (Model as shown for specific valve):
a) Cla-val.
b) No approved equals allowed
2) Materials:
a) Body: Ductile iron.
b) Seat insert: Stainless steel.
c) Disc: Buna-N.
d) Diaphragm: Nylon fabric bonded with synthetic rubber.
3) Design requirements: Do not use diaphragm as seating surface.

B. Design criteria:

| Tag Number | Valve Type | Valve Size (in) | Process Flow Stream | Minimum Flow (gpm) | Maximum Flow (gpm) | Minimum Operating Pressure (psig) | Maximum Operating Pressure (psig) |
|---|---|---|---|---|---|---|---|
| FCV-1501 | Flow Control | 14 | RW | 1180 | 6950 | 77 | 86 |
| FCV-1502 | Flow Control | 14 | RW | 1180 | 6950 | 77 | 86 |

C. Control:
1. Type:
a. Electronic Flow Control:
1) Acceptable manufacturers:
a) Cla-val, Model 131.
2) Design requirements: Modulate valve to maintain raw water influent flow rate by bypassing or relieving excess pressure.
3) Cavitation Index: The estimated upstream and downstream pressures along with the Cavitation Index for each flow possible flow condition are shown below.

| Flow Condition | Upstream Pressure (psi) | Downstream Pressure (psi) | Cavitation Index |
|---|---|---|---|
| 0.6 MGD, Clean Auto Strainers | 84.02 | 20.04 | 0.54 |
| 0.6 MGD, Dirty Auto Strainers | 75.02 | 20.04 | 0.62 |
| 1.7 MGD, Clean Auto Strainers | 83.70 | 20.26 | 0.54 |
| 1.7 MGD, Dirty Auto Strainers | 74.70 | 20.26 | 0.63 |
| 3.3 MGD, Clean Auto Strainers | 82.75 | 21.14 | 0.57 |
| 3.3 MGD, Dirty Auto Strainers | 73.75 | 21.14 | 0.67 |
| 5 MGD, Clean Auto Strainers | 81.14 | 23.99 | 0.67 |
| 5 MGD, Dirty Auto Strainers | 72.14 | 23.99 | 0.79 |
| 7.5 MGD, Clean Auto Strainers | 78.94 | 23.92 | 0.69 |
| 7.5 MGD, Dirty Auto Strainers | 69.94 | 23.92 | 0.83 |
| 10 MGD, Clean Auto Strainers | 75.19 | 26.83 | 0.85 |
| 10 MGD, Dirty Auto Strainers | 66.19 | 26.83 | 1.04 |

4) Flow Control/Metering:
   a) The metering valve control system shall consist of a hydraulic control valve with two positioning solenoids that can be normally open or normally closed or any combination of the two. It shall be further equipped with a valve position transmitter and a pressure differential transmitter with 4-20 mA feedback signals. These signals will be processed in the electronic controller that will convert them into a flow rate with an accuracy of plus or minus 3 percent. If power failure occurs then the valve will hydraulically close. The time to hydraulically close the valve from fully open to fully closed, shall not be less than 180 seconds.
   b) The controller shall modulate the main valve position and serve as an interface between the valve and a remote SCADA computer. The controller shall accept differential pressure and position signals for control of the valve.
   c) Flow controller shall be equipped with remote set point and local set-point control. Full manual control of control valve solenoids shall also be provided on the controller panel for local control. Digital inputs shall be provided for individual specific flow rates.
   d) The electronic controller shall provide the interface between remote SCADA and the control valve. It is equipped with remote set point and local set point control. Digital direct linkage communication inputs will be provided to place the controller under the command of remote SCADA set points. Manual control of control valve solenoids is also provided on the controller panel for local control.
   e) The controller shall compare the set point and the process variable flow signal and adjust the valve to achieve the set point by activating the appropriate opening or closing solenoid on the control valve utilizing a duplex algorithm and PID control. One relay energizes when the process variable is below the set point while the other energizes when it is above the set point. These outputs shall be wired direct or through intermediate relays to the opening and closing solenoids on the control valve. Separate solenoid output indicator lights, located in the front display, shall illuminate when either solenoid is activated.
   f) The controller shall contain a discretionary adjustable ramp-to-set point function that will limit the rate of change of the set point. When the ramping function is activated, the controller will internally establish a series of time-based set points between the original set point and the new target set point. The ramp to set point is activated by one of three conditions:
      (1) Upon power up, the set point will ramp from the process variable value to the set point value at the specified rate.
      (2) Upon a transfer from manual to automatic control, the set point will ramp from the process variable value to the set point at the specified rate.
      (3) Upon any set point change, the set point will ramp from the current set point to the new target set point.
   g) When time proportional control is selected, the total cycle time between each pulse shall be programmable between 1 and 120 seconds. The duration of each pulse shall be directly proportional to the deviation from set point outside of an adjustable dead band. The time-proportioned outputs shall be independently adjustable when above and below the set point to properly tune valve response. The time proportional output bandwidth shall be independently programmable between 1 and 99.9 percent of full scale. When on/off control is selected, the solenoid will remain on continuously until set point is achieved or is within an adjustable dead band zone.
   h) The controller shall also have the capacity of causing the main valve to open, close or maintain position in the event of a loss of the process variable signal.

i) A vacuum fluorescent display of process variable and set point status in scalable engineering units shall be provided. The operator interface shall consist of two rows of alphanumeric characters to display numeric values and units. Color-coded alarm, status and mode indicators shall inform the operator of operating conditions. Security key codes shall protect against undesired changes to the controller. All programming shall be menu driven.

j) The controller shall be all solid-state construction with the internal chassis capable of being removed for inspection and adjustment. An internal lithium battery rated for 10-year life shall protect all program memory including set points and tuning parameters.

k) Remote communications shall be accepted through a 4-20 mA DC analog signal. When remote SCADA operation is selected, the controller shall monitor and implement the remote set point signal. When local control is selected, the set point shall be changed at the controller keypad. Selection of local or SCADA setpoint operation shall be available at both the local control and SCADA control by remote digital communications.

2. Design requirements:
   a. Assembles all control features and hardware on basic valve at factory.
   b. Use corrosion-resistant metal for all exposed portions of the control.
   c. Include with valve control:
      1) Stop valves.
      2) Strainer.
      3) Valves for opening and closing speed control.
      4) Pilot valves.
      5) Solenoid valves.
      6) Pressure switches as necessary to provide control function.
   d. Electric components:
      1) 110 V, 1 PH.
      2) In weatherproof enclosure unless shown otherwise on the Drawings.

D. Control:
   1. Type:
      a. Pressure-reducing control.
         1) Acceptable manufacturers:
            a) Cla-val, Model 90-01.
            b) GA Industries, Figure 4500D.
            c) Watts ACV 115 Series.
            d) Singer 106-PR.
         2) Design requirements: Modulate basic valve to maintain a uniform downstream pressure as set on control pilots.
         3) Design conditions:
            a) Size: 16inches
            b) Operating pressure:
               Upstream: 45psi.
               Downstream: 10psi
            c) Flow range:
               Normal maximum: 7150gpm
               Normal minimum: 1625gpm.
      b. Pressure-sustaining control.
         1) Acceptable manufacturers:
            a) Cla-val, Model 50-01.
            b) GA Industries, Figure 6700DR.
            c) Watts ACV 116 Series.
            d) Singer, Model 106-RPS

2) Design requirements: Modulate basic valve to maintain constant upstream pressure by bypassing or relieving excess pressure.
3) Design conditions:
   a) The valve will be used to add 10 psi pressure to the system.
   b) Flow range:
      Maximum: 7150gpm
      Minimum:

## 2.5 PRESSURE-REDUCING VALVES (2 IN AND SMALLER)

A. Water Pressure Regulators:
   1. Acceptable manufacturers:
      a. Fisher, Type 75A.
      b. Watts Series 25AUB-Z3.
   2. Materials:
      a. Body: Bronze.
      b. Strainer body: Bronze.
      c. Strainer screen: Stainless steel.
   3. Design requirements:
      a. Self-contained diaphragm operated.
         1) Spring loaded.
         2) Field adjustable.
      b. Strainer: Y-type on supply.
      c. Size as shown in Schedule or size equal to connecting line size with 125 PSI inlet and 50 PSI outlet pressure.

## 2.6 SOLENOID VALVES (1 IN AND SMALLER)

A. General Service (Air - Water):
   1. Acceptable manufacturer:
      a. ASCO.
   2. Materials:
      a. Body: Brass.
      b. Seat: Buna-N.
      c. Insulation: Class F.
   3. Design requirements:
      a. 110 VAC.
      b. Two-way, normally closed.
      c. Enclosure: Compatible with area classifications indicated on Drawings.
      d. Working pressure, air and water: 125 PSIG.
   4. Accessories: Provide strainer on supply.

## 2.7 MUD VALVES

A. Manufacturers:
   1. Trumbull.
   2. Troy Valve.
   3. Clow.
   4. M&H.

B. Materials:
   1. Yoke: Cast iron (ASTM A126B.
   2. Frame: Cast iron (ASTM A126B)
   3. Stem: Bronze (ASTM B62).
   4. Thrust nut: Bronze (ASTM B62).
   5. Operating nut: Cast iron (ASTM A126B).
   6. Plug: Cast iron (ASTM A126B).

7. Seat: SBR or Buna N.
8. Seat ring: Bronze (ASTM B62).

C. The Mud Valve shall be of the flanged type and designed to provide a positive seal under both seating and unseating head conditions.
   1. Provide with rising stem.

D. Accessories:
   1. Provide floor stand assembly for mud valves with stems adjacent to basin walkways.
   2. Provide extension stems, floor stands and stem guides extending to next working platform.
   3. Provide factory epoxy coating which meets the requirements of Specification Section 09 96 00.

### 2.8 ACCESSORIES

A. Furnish any accessories required to provide a completely operable valve.

### 2.9 FABRICATION

A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.

B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

### 2.10 SOURCE QUALITY CONTROL

A. Shop hydrostatically test to unit test pressure.

### 2.11 MAINTENANCE MATERIALS

A. Provide one set of any special tools or wrenches required for operation or maintenance for each type valve.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General: See Specification Section 01 61 03 and Specification Section 40 05 51.

B. Air Release, Vacuum Relief, and Pressure Relief Valves:
   1. Pipe exhaust to a suitable disposal point.
   2. Where exhausted to a trapped floor drain, terminate exhaust line 6 IN minimum above floor.

### 3.2 FIELD QUALITY CONTROL

A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.

B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

**END OF SECTION**

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# SECTION 40 05 59
## WATER CONTROL GATES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Fabricated Stainless Steel Slide Gates.

B. Equipment Numbers:
   1. SLG-4711

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 09 96 00 - High Performance Industrial Coatings.
   5. Section 10 14 00 - Identification Devices.
   6. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. C561, Fabricated Stainless Steel Slide Gates.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Sanitation Foundation International (NSF):
      a. 61, Drinking Water System Components - Health Effects.
   4. Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 5/NACE No. 1, White Metal Blast Cleaning.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 61 03.
   2. Product technical data including:
      a. Acknowledgment that products submitted meet the requirements of standards referenced.
      b. Calculations that demonstrate compliance with the deflections, stress and factor of safety specified.
      c. Certified drawings and material specifications for all components.
      d. Test records.
         1) Performance Test
         2) Leakage Test

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Affidavit of Compliance: See AWWA C561.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. RW Gate Company
   2. Whipps.
   3. Aquanox / Fontaine
   4. Hydro-Gate.
   5. Golden Harvest.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 EQUIPMENT – SLIDE GATES

A. General: Provide gates, stems, lifts and other appurtenances of size, type, material and construction shown on the Contract Drawings and as specified herein.

B. Comply with requirements of Specification Section 01 61 03.

C. Gates: Meet all requirements of AWWA C561 as modified per this Specification Section.

D. Materials:
   1. Materials subject to dezincification or dealuminization prohibited.
   2. "L" grades for all welded components.
   3. Frame, guides, slide, yoke and stem guides:
      a. Stainless steel, Type 304 and Type 304L.
   4. Gear housing:
      a. Cast iron, steel or ductile iron.
   5. Actuator pedestal:
      a. Stainless steel, Type 316.
   6. Rising stem thrust nuts:
      a. Stainless steel, Type 316.
   7. Stem couplings:
      a. Stainless steel, Type 316.
   8. Stem guide bushings:
      a. Cast or extruded UV stabilized UHMW-PE.
   9. Stems:
      a. Stainless steel, Type 316.
   10. Seals:
      a. UV stabilized UHMW-PE.
   11. Anchor bolts and fasteners: Stainless steel, Type 316.
   12. Flush-bottom sill retainer: Stainless steel, Type 316.
   13. Wedges and Pressure Pads: UV stabilized UHMW-PE if required.

E. Fabrication: One-piece frames.
   1. One-piece frame: Conventional pedestal mounted.
   2. Flush bottom seals: Easily replaceable without disassembly of the gate.
   3. Side and top seals of gate: Replaceable without removing gate or without dewatering.

### 2.3 GATE OPERATORS AND LIFTS

A. General: Provide lifts in accordance with AWWA C541 and C542, or as modified in this Specification Section.

B. Rising Stem: Provide clear butyrate plastic stem cover with Mylar open-close indicator.

C. Manual Operators:
   1. Equip the lift mechanism with a pedestal, torque tube, or baseplate, machined and drilled for mounting the lift housing and ready for bolting to the operating floor, top wall mounting bracket, or gate yoke, as shown on Drawings or specified.
   2. Centerline of crank or handwheel: Approximately 36 IN above operating floor.

### 2.4 FABRICATION

A. Specified in AWWA C561.

B. Welded Stainless Steel: Passivated after fabrication.

### 2.5 SOURCE QUALITY CONTROL

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. For identification and tagging, and for warning or caution signs, comply with Specification Section 10 14 00.

### 3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
   4. Conduct initial start-up of equipment, perform operational checks, and supervise acceptance testing.
   5. Provide, through Contractor, a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   6. Instruct Owner's personnel on operation and maintenance of furnished equipment.
   7. Field Leakage Test for Stainless Steel Slide Gates: Test gate under design seating head and adjust to maximum leakage specified.

### 3.3 GATE SCHEDULE:

A. The following table is a schedule of the fabricated slide gates.

| GATE EQUIPMENT ID# | SIZE WxH (IN) | DESIGN HEAD, (FT) [a] SEATING | UNSEATING | OPENING DIRECTION [b] | TYPE OF CLOSURE [c] | TYPE OF LIFT MECHANISM [d] | RISING OR NON-RISING STEM [e] | THIMBLE REQUIRED [f] |
|---|---|---|---|---|---|---|---|---|
| SLG-4711 | 24x24 | 23 | 23 | Up Op | FM | Ped | R | No |

Abbreviations:
- a Design Head: Measured from surface of water to centerline of gate, in feet.
- b Opening Direction: Dn Op = Downward Opening; Up Op = Upward Opening.
- c Type of Closure: W = Weir Service; FB = Flush Bottom (Embedded); FM = Face Mounted.
- d Type of Lift Mechanism: Ped = Pedestal; Elec = Electric; Hdwl = Handwheel; Hyd = Hydraulic, CH = Crank Handle, SQN = Square Nut.
- e Rising or Nonrising Stem: R = Rising; NR = Nonrising.
- f Thimble Required: Wall Thimble is required = YES; Wall Thimble is not required = No.

**END OF SECTION**

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# SECTION 40 05 61
GATE VALVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Gate valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. American Water Works Association (AWWA):
      a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      b. C504, Standard for Rubber-Seated Butterfly Valves.
      c. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
      b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
      c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

### 1.3 DEFINITIONS

A. OS&Y: Outside Screw and Yoke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 VALVES: WATER, , AIR; 2-1/2 IN AND SMALLER

A. Class 125 bronze gate valve.

B. Comply with MSS SP-80.

C. Materials:
   1. Body, bonnet, wedge: Bronze.
   2. Stem: Silicon bronze.
   3. Packing: Aramid fibers with graphite (Kevlar®).

D. Design Requirements:
   1. 125 PSI steam, 200 PSI non-shock WOG.
   2. Screw in bonnet, non-rising stem, solid wedge.

E. Manufacturers:
   1. Nibco.
   2. Stockham.

## 2.3 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, AND NON-POTABLE)

A. Resilient Wedge Gate Valves, 2 to 48 IN (Water Application):
   1. Comply with AWWA C509.
   2. Materials:
      a. Stem and stem nut: Bronze.
         1) Wetted bronze parts in low zinc bronze.
         2) Aluminum bronze components: Heat treated per AWWA C504.
      b. Body, gate: Ductile iron.
      c. Resilient wedge: Fully encapsulated rubber wedge. .
   3. Design requirements:
      a. Minimum 200PSIG working pressure.
      b. Buried: NRS, O-ring stem seal, 2 IN square operating nut.
      c. Exposed: NRS, O-ring, stem seal, handwheel.
      d. Counter clockwise open rotation.
      e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
         1) Comply with AWWA C550.
         2) Wetted bronze parts in low zinc bronze.
         3) Aluminum bronze components: Heat treated per AWWA C504.
   4. Acceptable manufacturers:
      a. Clow.
      b. Mueller.
      c. American Flow Control.
      d. M & H.

## 2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 51 for actuator requirements.

## 2.5 FABRICATION

A. General:
   1. Provide valves with clear waterways the full diameter of the valve.

B. Spot valves in accordance with MSS SP-9.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Specification Section 40 05 51.

B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.

C. Do not install gate valves inverted or with the stems sloped more than 45 DEG from the upright unless the valve was ordered and manufactured specifically for this orientation.

**END OF SECTION**

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# SECTION 40 05 63
BALL VALVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Ball valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   2. American Water Works Association (AWWA):
      a. C507, Standard for Ball Valves, 6 IN through 48 IN.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-110, Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

### 1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

B. PTFE: Polytetrafluoroethylene.

C. RPTFE: Reinforced PolyTetraFluoroEthylene.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 51.
   3. Test results for AWWA valves.
   4. Acknowledgement letter stating:
      a. All of the chemicals on the project.
      b. The wetted materials are compatible with the respective system.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 METALLIC BALL VALVES 1/4 TO 3 IN DIA

A. Comply with MSS SP-110.

B. Manufacturers:
   1. Apollo.
   2. Jamesbury.
   3. Watts.
   4. Stockham.
   5. Nibco.

C. Materials (All Stainless Steel):
   1. Body: Three-part stainless steel, ASTM A351 CF8M.
   2. Ball: Stainless steel ASTM A276.
   3. Seats: RPTFE..
      a. All wetted components to be compatible with the service chemical.

D. Design Requirements:
   1. Rated for a minimum of:
      a. 500 PSI CWP.
      b. 150 PSI of saturated steam.
      c. 29 IN vacuum.
   2. Two-position lockable handle.
   3. Stem with blowout-proof design.
   4. Balancing stop for all applications.
   5. Bodies with mounting pad for applications requiring actuators.

### 2.3 PLASTIC BALL VALVES: 1/2 IN TO 4 IN DIA

A. Manufacturers:
   1. Chemtrol/NIBCO.
   2. Spears.
   3. ASAHI/America.

B. Materials:
   1. Body, stem, ball, handle, end connectors:
      a. CPVC ASTM D1784-23447-B.
   2. Ball Seat: Teflon.
   3. O-rings: Vitonor PTFE encapsulated fluorocarbon.
      a. All wetted components to be compatible with the service chemical.

C. Design Requirements:
   1. Rated at 150 PSI at 75 DEGF.
   2. Double or "true union" design.
   3. Blocks both directions, upstream and downstream.
   4. Union nut capable of compensating for seat wear.
   5. Body with mounting pad for actuators where required.
   6. Capable of being disconnected at downstream end under full line pressure.
   7. Sodium hypochlorite service:
      a. Provide "vented" ball valves for all service with greater than 5 PCT concentrated sodium hypochlorite.

### 2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 51 for actuator requirements.

### 2.5 SOURCE QUALITY CONTROL

A. Shop test AWWA C507 ball valves in accordance with AWWA C507.

B. Furnish record of test.

C. Product Testing: MSS SP-110.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Specification Section 40 05 51.

### 3.2 FIELD QUALITY CONTROL

A. For AWWA C507 ball valves and in accordance with Specification Section 01 75 00, employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.

## END OF SECTION

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# SECTION 40 05 64
BUTTERFLY VALVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Butterfly valves.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   4. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      e. A436, Standard Specification for Austenitic Gray Iron Castings.
      f. A536, Standard Specification for Ductile Iron Castings.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-67, Butterfly Valves.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 51.
   3. For valves 8 IN and larger, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. DeZurik.
   2. Mueller/Lineseal.

3. Pratt a Mueller Water Company.
4. Bray.
5. Pentair/Keystone.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 HIGH PERFORMANCE BUTTERFLY VALVES:

A. In locations where reliability is critical (including filter effluent and backwash supply), for automated valves that modulate for flow control or actuate periodically in intervals less than 2 HRS, high performance butterfly valves with an offset disc design shall be used.

B. Design Requirements:
1. One-piece shaft.
2. Separate shaft seal.
3. Minimum shaft diameter to conform to AWWA C504, Class 150B.

C. Materials of construction:
1. Disc: 316 stainless steel.
2. Shaft and pins: 17-4PH stainless steel or 316 stainless steel.
3. Seals:
   a. Water: PTFE.
   b. Process air and high temperature: Graphite rings.
4. Backing ring: Stainless steel.
5. Bushings/Bearings: TFE/Glass liner with a 316 Stainless steel shell.
6. Seat:
   a. Two part with encapsulated RTFE or PTFE.
   b. Seat Retainer: Stainless Steel.
   c. Or Stainless Steel.
7. End connection: Lugged valves may be used.

## 2.3 GENERAL USE BUTTERFLY VALVES

A. For use in all location, except where high performance butterfly valves are required.

B. Comply only with AWWA C504, as noted in this Specification Section.

C. Materials:
1. Valve bodies:
   a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
   b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
2. Valve shafts:
   a. One-piece stainless steel, Type 304.
   b. Pins: 304 stainless steel.
   c. Bushings/Packing/O-rings: EPDM, RTFE or TFE.
   d. Bearings: Reinforced TFE or equal.
3. Valve discs:
   a. Cast iron with welded nickel edge or 304 Stainless Steel disk.
4. Valve seats:
   a. Water: EPDM or Hycar.
   b. Compressed air: Teflon, PTFE.
   c. Process air: Viton, RTFE, rate for 300 DEGF minimum or higher if required by service.
5. Shaft bearing: Bronze, TFE-coated stainless steel or reinforced TFE.
6. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.

D. Design Requirements:
1. Seat type: Resilient.
2. Body type:

a. Wafer Lug (laying length may vary from AWWA C504).
b. Equip wafer type with fully tapped anchor lugs drilled per ASME B16.5.

3. Direct buried valves:
   a. All valves: Working pressure rated for 150 PSI (Class 150B per AWWA C504).
4. Shaft diameter: One-piece constant diameter.

### 2.4 ACCESSORIES

A. Refer to Drawings and/or valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Section 40 05 51 for actuator requirements.

C. Valve Flange Seal Rings:
   1. If Steel Slip-on flanges are being used on the process piping, flange seals will be required for proper installation of valves.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Section 40 05 51.

**END OF SECTION**

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# SECTION 40 05 66
CHECK VALVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Check valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 51 - Valves - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 IN through 24 IN NPS.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
      b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

### 1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, manufacturers listed under the valve with types are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 CHECK VALVES: 2.5 IN AND SMALLER

A. Class 125 Bronze Swing Check Valves (Compressed Air andWater):
   1. Comply with MSS SP-80.
   2. Acceptable manufacturers:
      a. Nibco T413-Y.
      b. Stockham B-319Y.

3. Materials:
   a. Body, bonnet, disc: Bronze.
4. Design requirements:
   a. 125 PSI steam to 406 DEGF, 200 PSI WOG.
   b. Horizontal swing, renewable disc.

## 2.3 CUSHIONED SWING CHECK VALVES: 2 IN TO 24 IN

A. Class 125.

B. Comply with AWWA C508.

C. Manufacturers:
   1. Air:
      a. Golden Anderson Figure 250D (Class 125).
      b. APCO Series 6000.
   2. Oil:
      a. APCO Series 6000B.
      b. Golden Anderson Figure 25-DXH.

D. Materials:
   1. Body, cover, disc, levers: Cast iron or cast steel.
   2. Seat: Bronze or stainless steel.
   3. Seat ring: Bronze or rubber (Buna-N).
   4. Hinge: Stainless steel.
   5. Cushion cylinder: Metallic corrosion resistant material.

E. Design Requirements:
   1. Seat ring: Replaceable.
   2. Hinge: Extend out both sides with lever and weight.
   3. Cushion: Air type with adjustable speed control.

## 2.4 DOUBLE DOOR CHECK VALVES

A. Class 125.

B. Manufacturers:
   1. APCO Series 9000 (2 to 48 IN).
   2. Nibco W920-W (2 to 24 IN).
   3. Technocheck by Techno Corporation.

C. Materials:
   1. Body: Cast iron wafer style.
   2. Doors:
      a. 2 to 12 IN: Aluminum bronze.
      b. 14 to 54 IN: Ductile iron, bronze faced.
   3. Hinge and stop pins: Stainless steel, 316.
   4. Spring: Stainless steel, T316.
   5. Seat: Bronze.

## 2.5 BALL CHECK VALVES: 1/2 IN TO 4 IN

A. 150 PSI at 73 DEGF.

B. Manufacturers:
   1. R&G Sloane.
   2. Corr Tech.

C. Materials:
   1. Body: CPVC.
   2. Ball: Glass filled or polypropylene.
   3. Seals: Viton.

a. Provide compatible material for chemical systems.

D. Design Requirements:
   1. Connectors: Double union.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Specification Section 40 05 51.

B. Install in accordance with manufacturer's instructions.

**END OF SECTION**

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# SECTION 40 12 00
## COMPRESSED AIR SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Compressed air system including:
      a. Reciprocating air compressor with air receiver and controls.
      b. Air filters.
      c. Air dryers.
      d. Stand alone air receiver.
      e. Flow controller
      f. Oil/Water Separator
   2. The air compressor, coalecers, dryer, oil/water separator will be skid mounted. A stand alone air receiver will also be provided by the same Supplier.

B. Equipment Numbers:
   1. AC-4810
   2. SV-4810
   3. ACO-4810
   4. AD-4810
   5. FIL-4820
   6. AR-4820
   7. FC-4820
   8. SEP-4810

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 40 61 13 - Process Control Systems General Requirements.
   5. Section 40 05 51 – Valves – Basic Requirements
   6. Section 40 05 64 – Butterfly Valves

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. Section VIII, Division 1, Construction of Pressure Vessels.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for submittal process requirements.
   2. See Section 01 61 03.
   3. Fabrication drawings:
      a. Air receiver fabrication drawing showing all tap locations and ASME data plate information.
      b. Skid fabrication drawings showing overall dimensions and anchor points.
      c. Show location of all control equipment.

d. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.

4. Manufacturer's installation instruction.
5. Manufacturer's statement of proper installation and start-up.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Air compressor:
a. Ingersoll-Rand.
b. Gardner Denver.
c. Quincy.
d. Atlas-Copco.
2. Air filters:
a. Ingersoll-Rand.
b. Gardner Denver.
c. Atlas-Copco.
d. Quincy.
e. Hankison.
f. Van Air.
3. Air dryer:
a. Ingersoll-Rand.
b. Gardner Denver.
c. Atlas Copco.
d. Quincy.
e. Hankison.
f. Van Air.

B. Submit request for substitution in accordance with Section 01 25 13.

### 2.2 AIR COMPRESSOR SYSTEM

A. Equipment Skid:
1. All equipment and ancillary components shown on P&IDs within the dashed lines are to be installed on a skid with all connecting piping provided by the supplier.
2. The maximum skid footprint shall be 3.25 FT x 9 FT, with equipment laid out for skid installation with the 9 FT side against a wall.
3. Provide layout with proper service clearances for all equipment on the skid.
4. Skid is to be floor mounted, supplier to provide anchorage points and anchor bolts, for installation by the Contractor.

B. Reciprocating Air Compressors AC-4810:
1. Provide an air compressor unit with the following components:
a. Reciprocating air compressors: Two each.
b. Air receiver: One each, 120 GAL in capacity.
c. Controls: As specified.
2. Compressors and motors shall be mounted on a heavy steel base which is mounted on the horizontal air receiver.
3. Unit shall be factory assembled piped and wired requiring field connection of air discharge piping and electrical power.

C. Reciprocating Air Compressors:
   1. Each compressor shall have the following performance and configuration:
      a. Displacement: 34.5 CFM.
      b. Capacity: 18.2 SCFM at 120 PSIG.
      c. Maximum pressure: 150 PSIG.
      d. Horsepower: 5.
      e. Lubricated cylinder(s).
      f. Two-stage.
   2. Compressor features:
      a. Cast iron crankcase and cylinder(s).
      b. Cylinder(s) bolted to crankcase.
      c. Splash lubrication.
      d. Finned intercooler.
      e. Fan-type balance flywheel.
      f. Stainless steel finger valves.
      g. Centrifugal unloader.
      h. Dry-type inlet filter/silencer with 4 micron replaceable element.
      i. Air-cooled aftercooler.
   3. Motor:
      a. See Section 01 61 03.
      b. Totally enclosed, fan cooled.
      c. V-belt drive with belt guard.
      d. 460 V, 3 PH, 60 HZ.

D. Air Receiver AR-4820:
   1. Provide 600 GAL -vertical- receiver.
   2. Receiver to be ASME National Board coded for 200 PSI working pressure.
   3. Receivers shall have following accessories:
      a. Pressure gage, 0-200 PSI.
      b. Drain valve.
      c. Service valve.
      d. Safety valve.
   4. Receivers are to be supported with steel legs or ring base.

E. Controls:
   1. Furnish adjustable pressure switch start-stop control.
      a. Provide automatic alternation between compressors.
      b. Controls to be in NEMA 4 enclosure.
      c. Stop: 145 PSI.
      d. Start lead unit: 85PSI.
      e. Start lag unit: 80 PSI.
   2. Provide automatic oil level shutdown switch.
   3. Furnish magnetic starters for motors in NEMA 4enclosure.

## 2.3 AIR FILTER

A. Particulate Filters FIL-4820:
   1. Provide particle filter sized for 18.2 SCFM.
   2. Filter shall remove 99.95 PCT of particles down to 1.0 micron.
   3. Filter shall be equipped with a differential pressure indicator.
   4. Provide automatic electric drain valve for condensate.
   5. Provide with replaceable filter element.

B. Coalescing Filter ACO-4810:
   1. Provide coalescing filter sized for 18.2 SCFM.
   2. Filter shall remove 99.99 PCT of particles down to 0.01 microns.
   3. Filter shall be equipped with a differential pressure indicator.

4. Provide automatic electric drain valve for condensate.
5. Provide with replaceable filter element.

## 2.4 AIR DRYERS

A. Refrigerated Air Dryer AD-4810:
   1. Provide refrigerated type air dryer size for 18.2 SCFM.
   2. Dried air shall have a dew point of 40 DEGF.
   3. Dryer capacity shall be based upon inlet air at 100 PSIG, 100 PCT relative humidity, 100 DEGF ambient temperature with a maximum of 5 PSI maximum pressure loss across the unit.
   4. Pressure vessels to be UL approved or ASME coded for 200 PSI operating pressure.
   5. Construct with corrosion resistant materials with heat exchanger being aluminum, stainless steel or epoxy coated copper.
   6. All copper components exposed to ambient air to be epoxy coated.
   7. Provide following unit mounted indicators:
      a. Temperature indicators:
         1) Inlet air.
         2) Outlet air.
         3) Refrigerant suction.
         4) Refrigerant discharge.
      b. Pressure indication:
         1) Air outlet.
      c. Indicator lights:
         1) Power on.
         2) Compressor on.
         3) High temperature.
   8. Cycle refrigerant compressor to maintain outlet temperature.
   9. Provide controls to automatically start and stop refrigerant compressor with safety shut down interlocks for thermal overloads.
   10. Unit enclosure to be NEMA4.
   11. Power supply to be 115 V, 1 PH, 60 Hz.
   12. Provide automatic electric drain valve piped to nearest drain.

## 2.5 ACCESSORIES

A. Automatic Electric Drain Valves SV-4810:
   1. Provide automatic drain valve for condensate:
      a. Valve shall have solenoid actuated valve.
      b. Solenoid shall have integral timer with adjustable setpoint for opening frequency 1 to 24 HRS and length of time open, 1 to 10 seconds.
      c. Power supply to be 110 V, 1 PH.

B. Outlet pressure and Flow Controller FC-4820.
   1. Sized and provided by Supplier.
   2. Install filter upstream of controller
   3. Install upstream of and as close as possible to where controlled compressed air is needed.
   4. Install downstream of air treatment and primary storage unites.

C. Air receiver pressure transmitter:
   1. Smart transmitters utilizing microprocessor-based electronics.
   2. Integral LCD type display.
   3. Signal Output:
      a. 4-20 mA DC proportional to pressure.
      b. Scale range: 0-200 PSIG.
   4. Optional Communication: HART.
   5. Nonvolatile EEPROM memory.
   6. Power supply: 24 VDC Loop Power.

7. Adjustable zero and span.
8. Temperature limits:
   a. -20 to 180 DEGF (without digital display).
   b. -4 to 175 DEGF (with digital display).
9. Overpressure limits: Withstand 150 PCT of stated maximum service pressure without damage.
10. Humidity limits: 0 to 100 PCT relative humidity.
11. Damping: Adjustable between 0 and 60 seconds.
12. Accuracy (includes effects of linearity, repeatability and hysteresis): ±0.10 PCT of calibrated span for 15:1 rangeability.
13. Stability: ±0.2 PCT of upper range limit for 12 months.
14. Temperature effect:
    a. Total effect including span and zero errors: + 0.2 PCT of upper range limit per 100 DEGF for minimum 15:1 rangeability.
15. Minimum 1/2 IN pressure connection.
16. Equip with test jacks or accessible terminals for testing output.
17. Equip with isolation valve and test connections with isolation valves and/or plugs.

### 2.6 FABRICATION

A. Complete all brackets or connections and openings for air receiver and vessels prior to testing in manufacturer's plant.
   1. No field welding or drilling permitted.

B. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes. See Section 01 61 03 for information on how to determine the available fault current, such that, the SCCR rating meets or exceeds the available fault current.

### 2.7 SOURCE QUALITY CONTROL

A. Air Receivers and Vessels:
   1. Test and stamp in accordance with ASME code.

### 2.8 MAINTENANCE MATERIALS

A. Filter Element:
   1. Provide a minimum of six filter replacement elements for each filter type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with Section 01 61 03.

B. Install products in accordance with manufacturer's instructions.

### 3.2 FIELD QUALITY CONTROL

A. See Section 01 75 00.

B. Employ and pay for services of manufacturer's representative to:
   1. Inspect final installation.
   2. Supervise startup and perform final adjustments.
   3. Instruct Owner's representative for a minimum of 8 HRS on operation and maintenance procedures.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

## END OF SECTION

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# SECTION 40 20 55
## DIESEL FUEL BELOW GRADE PIPING SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Prefabricated double containment piping system.
   2. Containment pumps.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings: Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      c. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      d. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      e. D2467, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
      f. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
      g. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
      h. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
      i. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
      j. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
      k. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
      l. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
      m. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
      n. UL971, Standard for Nonmetallic Underground Piping for Flammable Liquids.

### 1.3 DEFINITIONS

A. PDVF: Polyvinyl Fluoride.

### 1.4 SYSTEM DESCRIPTION

A. Below grade diesel fuel piping system shall utilize flexible double containment piping for the supply and return piping. The double containment piping shall be routed inside an access pipe. The below grade piping shall terminate on each end in transition containment sumps that allow

above grade access to the piping for testing as well as capture any leakage from the outer containment pipe. A leakage alarm shall also be provided as part of the piping system.

### 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 - Submittals for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 05 00.
      a. Include details of pipe fabrications (including supporting devices, method of attachment and spacing), pre-fabricated double-containment fitting dimensions, starting and terminating connections, valves and accessories.
      b. Submit joint details, methods and location of supports and all other pertinent technical data for all piping to be furnished.
      c. Details and materials of construction for transition sumps and accessories.
   3. Field quality control documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. OPW

### 2.2 MATERIALS

A. Double Containment Piping:
   1. Double containment piping shall be an integral piping system. The outer piping shall be designed with stand-off ribs to allow migration of any fluid leaking from the inner piping to Transition Containment Sumps. The inner piping shall convey fluid.
   2. Minimum Bend Radius: 18 IN.
   3. Size: 1 IN (to be verified by generator manufacturer).
   4. No fittings or joints allowed for below grade piping.
   5. Terminal points located in containment sumps.
   6. Outer Containment Pipe Material: PDVF.
   7. Inner Conveyance Pipe Material: PDVF.
   8. Outer Containment Pipe Pressure Rating: 10 PSI.
   9. Inner Conveyance Pipe Pressure Rating: 100 PSI.

B. Access Piping:
   1. Access piping shall have a corrugated exterior and semi-smooth interior. The supply and return Double Containment Piping shall be routed through the Access Piping to the Transition Containment Sumps.
   2. Minimum Bend Radius: 18 IN.
   3. Size: 4 IN.
   4. No fittings or joints allowed for below grade piping.
   5. H20 rated.
   6. Pipe Material: PDVF.

C. Transition Containment Sumps
   1. Provide transition sumps on either end of the below grade piping. The sumps shall allow above grade access to the piping and contain any leakage from the piping system.
   2. Configuration as shown on Drawings.
   3. Above grade access door.
   4. Water tight.
   5. UV resistant.
   6. Materials of construction: FRP and/or Polyethylene.

D. Accessories:
   1. Stainless steel swivel joints for Double Containment Piping.
   2. Stainless Steel Double Containment Fittings (to be installed in sumps only, not buried).
   3. Test boots for Double Containment Piping.
   4. Water tight sump entry boots for Double Containment Piping.
   5. Leak Sensor.

### 2.3 FABRICATION

A. Pre-assemble and pre-test all fittings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. The manufacturer shall furnish the services of a competent representative to instruct the Contractor's personnel prior to or during the start of installation.

### 3.2 FIELD QUALITY CONTROL

A. Following installation of the systems, flush clean the primary piping system.
   1. Check the operation of all valves and appurtenances.

B. Pressure test the primary piping system at 50 PSI for a period of 1 HR.

C. Pneumatically test the secondary containment piping system at a minimum duration of 2-1/2 HRS.
   1. Soap the external joints and visually inspected for leaks.
   2. Ensure that over-pressurization beyond 7.5 PSI cannot occur.
   3. Take precautions to protect against the hazards of a possible brittle fracture under compressed gas.
   4. Tests shall be done in strict accordance with the recommendations of the manufacturer.

**END OF SECTION**

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# SECTION 40 41 13
## HEAT TRACING CABLE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Heat tracing cable as required for heat tracing of pipes as indicated on the Drawings.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical - Basic Requirements.
   4. Section 40 42 00 – Pipe, Duct, and Equipment Insulation
   5. Section 43 41 45 – Fiberglass Reinforced Plastic Tanks

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SYSTEM DESCRIPTION

A. Provide heat tracing on the following systems for freeze protection and kept at indicated temperature.
   1. Aluminum Sulfate
   2. Sodium Carbonate
   3. Ozone Cooling Water
   4. Potable Water Tepid

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.
      b. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.
      c. Length of heat tape for each pipe size and run.
      d. Coordinate and verify length and Watts/FT of heat tape required based upon pipe size and insulation thickness.
         1) Include the calculations to support the heat tape output.
      e. See Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Wiring diagrams showing physical locations of thermostats and heat trace power supply.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Test reports: Megger test results.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Shall be stored such that they are not exposed to sunlight or other UV rays.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Thermon.
   2. Chemelex Division; Raychem Corp.
   3. Chromalox.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 HEAT TRACING

A. Design Parameters:
   1. Pipe diameter, length and material: See Drawings and relevant piping Specifications.
   2. Flange, valve, pipe support size: See Drawings and relevant piping Specifications.
   3. Pipe insulation type and thickness: See Drawings and relevant piping Specifications.
   4. Temperatures requirements:
      a. Low ambient temperature for the specific location: 0 DEGF.
      b. Start-up temperature (alarm thermostat set point):
         1) Water/wastewater lines: 40 DEGF.
         2) Aluminum Sulfate: 40 DEGF.
         3) Sodium Carbonate: 40 DEGF
         4) Potable Water Tepid: 40 DEGF
      c. Maintain temperature (power thermostat set point):
         1) Water/wastewater lines: 40 DEGF.
         2) Aluminum Sulfate: 40 DEGF.
         3) Sodium Carbonate: 40 DEGF
         4) Potable Water Tepid: 40 DEGF
      d. High temperature exposure with power off: 185 DEGF.
   5. Wind factor for the specific location: 25 MPH.
   6. Electrical requirements:
      a. Voltage: 120 V.
      b. Circuit breaker: Field coordinate if other than 20A GFEPCI type.
   7. Safety factor: 20 PCT.

B. Self-regulating or power-limiting parallel circuit construction consisting of an inner core of conductive material between parallel copper bus wires, with inverse temperature - conductivity characteristics with metal overbraid.

C. Thermostats adjustable between 35 and 200 DEGF minimum with maximum differential range of 9 DEGF, furnished complete with NEMA 4 enclosures in all areas, stainless steel temperature bulb and capillary.

D. All necessary or required components and accessories, such as power connection boxes, end seals, straps, tape and fitting brackets.

E. In noncorrosive and nonhazardous locations, insulation shall be Polyolefin.

F. In corrosive, hazardous and hydrocarbon locations insulation shall be Fluoropolymer (Teflon).

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Install materials after piping has been tested and approved.

### 3.2 INSTALLATION

A. Insulate and heat trace wet pipe systems as indicated on Drawings.

B. Install materials in accordance with manufacturer's instructions.
   1. Each circuit shall not exceed the manufacturer's recommended maximum length.

C. For Metallic Piping:
   1. Heat tracing shall be installed completely wired.
   2. Cut heat trace to lengths as required and secure to pipe with glass or polyester fiber tape.

D. For Nonmetallic Piping:
   1. Allow for extra heat trace output because nonmetallic pipe has a lower heat transfer.
      a. Heat tracing shall be installed completely wired.
   2. Cut heat trace to lengths as required and secure to pipe with aluminum tape throughout the length of the trace.

E. Protection and Control Requirements:
   1. Protection by a GFEPCI circuit breaker.
      a. Breaker amperage rating shall be coordinated with Contractor when different than the Contract Drawings.
   2. Provide an ambient sensing thermostat for power and line sensing thermostat for alarm.
   3. The alarm thermostat shall be placed on the opposite end of the circuit from the power thermostat or power connection to allow for annunciation of partial failure of a circuit or the loss of power from a tripped GFEPCI circuit breaker.
   4. Provide a monitoring module that monitors the voltage (circuit breaker status) to each circuit.

### 3.3 TESTING

A. Megger the cables at the manufacturers recommended voltage level three times.
   1. Before installation.
   2. After attachment to pipe but before insulation is installed.
   3. After pipe insulation is installed but before energization.

**END OF SECTION**

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# SECTION 40 42 00
## PIPE, DUCT AND EQUIPMENT INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Insulation:
      a. Piping insulation.
      b. Duct insulation.
      c. Equipment and tank insulation.
   2. Adhesives, mastics, sealants, and finishes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements
   4. Section 40 05 07 - Pipe Support Systems.
   5. Section 43 41 43 – Polyethylene Chemical Tanks
   6. Section 43 41 45 – Fiberglass Reinforced Plastic Tanks

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
      b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
      c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      d. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      e. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      f. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      h. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      i. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
      j. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      l. E119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
      m. E136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
      n. E162, Surface Flammability of Materials.
      o. E814, Through-Penetration, 2-Hour Firestop Test.
      p. E2336: Standard Test Methods Fire Resistive Grease Duct Enclosure Systems.
   2. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
   3. National Fire Protection Association (NFPA):
      a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   4. Underwriters Laboratories, Inc. (UL):

a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

5. National Commercial and Industrial Insulation Standards (2013 seventh edition).
   a. Published by Midwest Insulation Contractors Association (MICA).
   b. Endorsed by National Insulation Association (NIA).
   c. MICA plate numbers listed in this specification reference this document.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.
   3. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
   4. Certifications: Products will meet the requirements of the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Elastomeric insulation:
      a. Rubatex.
      b. Armstrong.
   2. Fiberglass insulation:
      a. CertainTeed Corporation.
      b. Johns Manville.
      c. Owens Corning.
      d. Knauf.
   3. PVC jacket:
      a. Ceel-Co.
      b. PIC Plastics.
   4. Equipment insulation:
      a. CertainTeed Corporation.
      b. Johns Manville.
      c. Owens Corning.
   5. Ductwork insulation:
      a. CertainTeed.
      b. Johns Manville.
      c. Owens Corning.
   6. High density perlite:
      a. Johns Manville.
      b. Industrial Insulation Group (LIC).
   7. High density calcium silicate:
      a. Industrial Insulation Group (LIC).
   8. Adhesives, mastics, sealants, and finishes:
      a. Foster Products.
      b. Childers.
      c. Dow Corning.
      d. Johns Manville.

e. Knauf.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PIPING INSULATION - ELASTOMERIC

A. General:
1. Insulation fire and smoke hazard ratings for composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation), as tested by procedure ASTM E84, NFPA 255 and UL 723, not exceeding:
   a. Flame spread: 25.
   b. Smoke developed: 50.
2. Accessories (adhesives, mastics, cements, and tapes: Same component ratings as listed above.
3. Indicate on product labels or their shipping cartons: Flame and smoke ratings do not exceed above requirements.
4. Permanent treatment of jackets or facings to impart flame and smoke safety is required.
   a. Water-soluble treatments are prohibited.
5. Insulated shields at pipe support points.

B. Pipe, Fitting, and Valve Insulation:
1. Flexible elastomeric closed cell pipe insulation.
   a. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT$^2$-DEGF) at mean temperature of 75 DEGF, temperature range -40 to 220 DEGF; permeability not to exceed 0.20 by ASTM E96; water absorption 3 PCT by ASTM D1056 and ozone resistance.
2. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

## 2.3 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:
1. Preformed fiberglass pipe insulation:
   a. Density: 4 LBS/CUFT.
   b. Temperature rated: 650 DEGF.
   c. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT$^2$-DEGF) at mean temperature of 75 DEGF.
   d. Fire hazard rating:
      1) UL 723, ASTM E84, NFPA 255.
      2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
2. Moisture adsorption:
   a. ASTM C553.
   b. Not greater than 5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.
3. Fungi and bacteria resistance:
   a. ASTM C665.
   b. Does not breed or promote growth.
   c. Flame attenuated glass fibers bonded with thermosetting resin.
4. Piping jackets (general applications):
   a. Aluminum: 16 MIL embossed aluminum.
   b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
   c. Piping jacket not required on concealed piping.
5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

## 2.4 PIPE INSULATION INSERTS AT HANGERS

A. High Density Perlite:
   1. Pre-formed.
   2. Fire hazard rating:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread: Zero.
      c. Smoke developed: Zero.
   3. Average density: 13 LBS/CUFT.
   4. Compressive strength: 80 PSI to produce 5 PCT compression.
   5. Maximum surface temperature: 1,200 DEGF.

B. High Density Calcium Silicate:
   1. Pre-formed.
   2. Fire hazard rating:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread: Zero.
      c. Smoke developed: Zero.
   3. Average density: 14 LBS/CUFT.
   4. Compressive strength: 100 PSI to produce 5 PCT compression.
   5. Maximum surface temperature: 1,200 DEGF.

## 2.5 EQUIPMENT INSULATION

A. Insulation for Equipment:
   1. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Provide minimum insulation thickness conforming to Schedules, or as shown on Drawings.

## 2.6 DUCTWORK INSULATION: FIBERGLASS

A. Flexible Insulation:
   1. Material: Commercial-grade fiberglass thermal insulation, formaldehyde free.
   2. Scheduled thickness and installed R-value. Installed R-value when compressed to a maximum of 25 PCT following recommended duct wrap stretch outs.
   3. Factory-applied foil scrim vapor barrier facing.
   4. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT$^2$-DEGF) at a mean temperature of 75 DEGF (installed).
   5. Fungi and bacteria resistance:
      a. ASTM C1338.
      b. Does not breed or promote growth.
   6. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   7. Basis of design: Johns Manville Microlite fiberglass duct wrap insulation.

B. Semi-Rigid Insulation for Indoor Installation:
   1. Scheduled thickness and R-value.
   2. Factory applied vapor barrier facing-white scrim foil.
   3. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT$^2$-DEGF) at a mean temperature of 75 DEGF.
   4. Fungi and bacteria resistance:
      a. ASTM C1338.
      b. Does not breed or promote growth.
   5. Moisture adsorption:
      a. ASTM C553.

b. Not greater than 0.5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.

C. Semi-Rigid Insulation for Outdoor Installation:
1. Scheduled thickness and R-value.
2. Factory-applied foil scrim vapor barrier facing.
3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT$^2$-DegF) at mean temperature of 75 DEGF.
4. Minimum density: 3 LBS/CUFT.
5. Fungi and bacteria resistance:
a. ASTM C1338.
b. Does not breed or promote growth.
6. Basis of Design: Johns Manville #815 SPIN-GLASS fiberglass duct insulation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Piping below ground covered with earth will not be insulated unless specified in Specification 40 41 13.
2. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
3. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
a. Consider ductwork, piping and equipment above ceilings as concealed.
4. Provide release for insulation application after installation and testing is complete.
a. Apply insulation on clean, dry surfaces after inspection.
5. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
6. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
7. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Piping Insulation - Elastomeric:
1. Do not insulate until satisfactory completion of required pressure testing.
2. Apply insulation to clean, dry surfaces.
3. Slip insulation on pipe prior to connection.
a. Whenever the slip-on technique is not possible provide insulation neatly slit and snapped over the pipe.
4. Fabricate and install fitting cover insulation according to manufacturer's recommendations.
5. Seal joints, slits, miter-cuts and other exposed edges of insulation with adhesive, recommended by the insulation manufacturer, to ensure complete vapor barrier.

D. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
a. Butt all joints together firmly.
2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
4. PVC pipe jacket:
a. Apply jacketing with a minimum of 1 IN overlap.

1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
c. Provide pre-molded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
5. Aluminum pipe jacket:
a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
b. Provide smooth and straight joint with a minimum 2 IN overlap.
c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
d. Center spacing of screws 5 IN maximum or as required to provide smooth tight-fitted joints.
e. Place joints on least exposed side of piping to obtain neat appearance.

E. Equipment: Install per manufacturer's instructions.

F. Ductwork Insulation - Fiberglass:
1. Flexible insulation:
a. Butt edges tightly.
1) Secure insulation with Benjamin Foster 85-20 adhesive applied in 6 IN strips on 12 IN centers and/or pins, applied on not more than 18 IN centers so that the insulation conforms to the duct surfaces uniformly and firmly.
b. Seal joints with facing overlap or 4 IN wide strips of like facing material adhered and stapled in place.
c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20.
d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.
2. Semi-rigid insulation:
a. Impaling over pins.
1) Apply insulation with edges tightly butted.
2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
3) Clip pins off close to clip.
4) Space pins as required to hold insulation firmly against duct surface but not less than one pin per 1.5 SQFT.
5) Seal joints and speed clips with 3 IN wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
1) Cover the entire surface of duct with adhesive.
2) Use corner metal angle to protect edge of insulation.
3) Protect edge of insulation.
4) Seal joints as above.
c. For outdoor application finish with Benjamin Foster #4610 weatherproof mastic with white glass fabric membrane.

## 3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

## 3.3 SCHEDULES

A. Refrigeration Lines and condensate drain lines (35-60 DEGF):
1. Elastomeric.
2. 1 IN thickness for lines 1-1/2 IN and smaller.
3. PVC jacket inside building and aluminum jacket outside building.

B. Pipe, Fittings and Valves:
   1. Fiberglass.

| APPLICATION | PIPE SIZE | THICKNESS | JACKET |
|---|---|---|---|
| Roof Drainage | 2-1/2 to 6 IN | 1/2 IN | PVC |
| Hot Water, recirculation, and tempered water (domestic) | 1-1/2 IN and less | 1 IN | PVC |
| | Over 1-1/2 IN | 1-1/2 IN | PVC |
| Cold Water (domestic) | All sizes | 1 IN | PVC |

C. Equipment:

| EQUIPMENT | INSULATION SYSTEM |
|---|---|
| Hot water pumps, flash tanks, compression tanks | Uninsulated |
| Below drain pans serving cooling coils, pre-heat systems, domestic water heaters | 1 IN flexible elastomeric closed cell sheet. |
| Cold water meter | Uninsulated |

D. Ductwork:
   1. Fiberglass.

| DUCT SERVICE | INSULATION AND THICKNESS | MINIMUM R-VALUE $(HR\text{-}FT^2\text{-}DEGF)/BTU$ |
|---|---|---|
| Outside air and supply air downstream of heat recovery units, outside building | 2-1/2 IN semi-rigid for outdoor installation | 12.0 |
| Outside air ducts, inside building | 2-1/2 IN semi-rigid with vapor barrier | 12.0 |
| Supply and return air ducts inside building | 2 IN flexible with vapor barrier | 6.0 |
| Supply and return air ducts outside building and where exposed to atmospheric air | 2-1/2 IN semi-rigid for outdoor installation | 12.0 |
| Return air duct in non-conditioned areas including shafts | 2-1/2 IN flexible with vapor barrier | 12.0 |
| Exhaust air ducts upstream of heat recovery units, inside building | 1-1/2 IN semi-rigid | 6.0 |
| Exhaust air ducts upstream of heat recovery units, outside building | 2-1/2 IN semi-rigid for outdoor installation | 12.0 |
| All other ductwork | Uninsulated | N/A |

**END OF SECTION**

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# SECTION 40 61 13
## PROCESS CONTROL SYSTEMS GENERAL REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Division 26 - Electrical.
   5. Section 27 21 00 - Telemetry Systems.
   6. Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
   7. Section 40 63 43 - Programmable Logic Controller (PLC) Control System.
   8. Section 40 67 00 - Control System Equipment Panels and Racks.
   9. Section 40 71 00 - Flow Instrumentation.
   10. Section 40 72 00 - Level Instrumentation.
   11. Section 40 73 00 - Pressure Instrumentation.
   12. Section 40 74 00 - Temperature Instrumentation.
   13. Section 40 75 00 - Process Liquid Analytical Measurement.
   14. Section 40 79 00 - Miscellaneous Instruments and Appurtenances.
   15. Section 40 97 00 - Control Auxiliaries.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The International Society of Automation (ISA):
      a. 7.0.01, Quality Standard for Instrument Air.
      b. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      d. S5.4, Standard Instrumentation Loop Diagrams.
      e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Qualifications:
   1. System Integrator:
      a. The following firms are pre-qualified as being acceptable system integrators to provide the work described in this Specification Section.
         1) Control Systems Northwest (CSNW):
            a) Address: 3553 Arrowhead Drive, Suite 200; Medford, OR 97504
            b) Phone: (541) 665-5233.
         2) The Automation Group:
            a) Address: 4678 Isabelle St, Eugene, OR 97402

b) Phone: (541) 359-3755.
3) Portland Engineering:
a) Address: 7675 High Banks Rd #1, Central Point, OR 97502.
b) Phone: (541) 664-6200.
4) Taurus Power and Controls:
a) Address: 9999 SW Avery St, Tualatin, OR 97062
b) Phone: (503) 692-9004.
5) No other firms are acceptable.

2. System Integrator:
a. Experience:
1) Have satisfactorily provided a control system for a minimum of five projects of similar magnitude and function.
2) Recognized System Integrator for Rockwell Automation.
b. Certification:
1) UL508A and UL698A Certification
2) Control Systems Integrators Association (CSIA) Certification.
3) Cisco Certified Network Associate (CCNA).
c. Qualification:
1) Regularly engaged in the design and the installation of process control and instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry.
2) Maintains a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, documenting, fabricating, installing, calibrating, programming, configuring, providing training services, and testing the systems specified herein.
3) Capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.

C. Miscellaneous:
1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

## 1.3 DEFINITIONS

A. Calibrate: To standardize a device so that it provides a specified response to known inputs.

B. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

C. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. System Integrator: A Contractor/Subcontractor who combines instrumentation, control devices, hardware, software, and networking products from multiple vendors to provide a fully functioning control system.

## 1.4 SYSTEM DESCRIPTION

A. Control System Requirements:
1. This Specification Section provides the general requirements for the control system.
2. The control system consists of all primary elements, transmitters, switches, controllers, computers, communication devices, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or

isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. Utilization of System Integrator:
   1. Utilize a System Integrator to provide a fully functioning control system.
      a. The System Integrator shall be responsible for the provision of an integrated control system fully functioning in accordance with the requirements of the Contract Documents.
   2. Provide all required coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

## 1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   3. Limit the scope of each submittal to one Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 40 61 13.
   4. Product technical data including:
      a. Equipment catalog cut sheets.
      b. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument type.
      c. Materials of construction.
      d. Minimum and maximum flow ranges.
      e. Pressure loss curves.
      f. Physical limits of components including temperature and pressure limits.
      g. Size and weight.
      h. Electrical power requirements and wiring diagrams.
      i. NEMA rating of housings.
      j. Submittals shall be marked with arrows to show exact features to be provided.
   5. Comprehensive asset inventory of all networked components:
      a. Provide in Excel spreadsheet format.
      b. Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in asset inventory.
      c. Include:
         1) Device ID.
         2) Manufacturer.
         3) Model Number.
         4) Serial Number.
         5) MAC Address.
         6) IP Address.
         7) Device Use description.
         8) Firmware.
   6. Network Diagrams:
      a. Provide in both AUTO CAD and PDF formats.
      b. Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in Network Diagrams.
      c. Logical Network Diagram(s):

1) Depict information flow through network(s), and include:
a) Major network devices, subnets, and VLANs.
b) Include all wireless communication devices.
c) Include the following information for each networked device:
(1) Device ID.
(2) Device description.
(3) Manufacturer/model number.
(4) MAC address.
(5) IP address.

d. Physical Network Diagram(s):
1) Show all network components, ports, protocols, connections and cables.
a) Include all wireless communication devices.

7. Loop diagrams per ISA S5.4 as specified in Section 40 67 00.
8. Process connected instrument installation details containing the following minimum information:
a. Bill of materials providing as a minimum the following information:
1) Tube material and size.
2) Connection size.
3) Fitting size, material, and rating.
4) Valve type and material.
5) Instrument description.
6) Pipe stand size and material.
b. Tube slope requirements.
c. Required elevations and dimensions.
9. Comprehensive set of wiring diagrams as specified in Section 40 67 00.
10. Panel fabrication drawings as specified in Section 40 67 00.
11. PLC equipment drawings.
12. HMI graphics.
13. Nameplate layout drawings.
14. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
15. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
a. Furnish electronic files on owner's designated electronic media.
b. Drawings in AUTO CAD format.
16. Provide a parameter setting summary sheet for each field configurable device.
17. Certifications:
a. Documentation verifying that calibration equipment is certified with NIST traceability.
b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
18. Testing reports: Source quality control reports.

B. Qualifications Submittal:
1. Documentation verifying contractor/subcontractor adherence to specified certifications and qualifications

C. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. All Shop Drawings shall be modified with as-built information/corrections.
3. Instrumentation and Control Equipment Operation and Maintenance Manual Content:

a. Provide a printed copy of the following sheets following the Equipment Record sheets or ISA Data Sheets.
   1) Loop Check-out Sheet.
   2) Instrument (calibration) Certification Sheet.
   3) Final Control Element (i.e. control valve) Certification Sheet.
b. Provide the following detailed information:
   1) Use equipment tag numbers from the Contract Documents to identify equipment and system components.
   2) As-constructed fabrication or layout drawings and wiring diagrams.
c. Additional information as required in the associated equipment or system Specification Section.

4. Warranties: Provide copies of warranties and list of factory authorized service agents.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 50.

B. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

## PART 2 - PRODUCTS

### 2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing types per NEMA 250 for control system components in accordance with the area designations provided on the Drawings or DIV 26 specifications.
   1. Areas designated as wet: NEMA Type 4.
   2. Areas designated as wet and/or corrosive: NEMA Type 4X.
   3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
      a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
      a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
   6. Areas designated to be subject to temporary submersion: NEMA 6P.

### 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless stated otherwise, system operating criteria are as follows:
   1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5 PCT full travel.
   2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
   3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 PCT of full scale over a 6:1 operating range.
   4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 PCT of full travel regardless of force required to position final element.

5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 PCT of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

### 2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10 14 00.

B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Clearwells, Reservoirs, etc.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per the requirements of the Electrical design.

C. Panel-Mounted Instruments:
1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

### 3.2 FIELD QUALITY CONTROL

A. See Specification Section 01 75 00.

B. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.

C. In the event that instrument air is not available during calibration and testing, supply either filtered, dry, instrument quality air from a portable compressor or bottled, dry, instrument quality air.
1. Do not, under any circumstances, apply hydrostatic test to any part of the air supply system or pneumatic control system.

D. Pneumatic Signal Tubing Testing:
1. Before the leak test is begun, blow clean with dry air.
2. Test signal tubing for leaks, except for tubing runs of less than 10 FT where simple soap bubble testing will suffice.
3. If a leak is detected, repair the leak and repeat the leak test.
4. After completion of the leak test, check each signal line for obstructions.
   a. If any are indicated, remove and retest.

E. Instrumentation Calibration:
1. Verify and document that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
   a. Utilize the Instrument Certification Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
2. Factory furnished calibration certifications are acceptable for the following:
   a. Flow meters.
   b. Pressure sensors utilized with annular sleeve.
   c. Temperature sensors.
3. On-site calibration verification is required for all other instruments, including "smart" transmitters that have been factory calibrated.

a. Provide calibration checks at 0 PCT, 25 PCT, 50 PCT, 75 PCT and 100 PCT of span for pressure transmitters and gages.
    1) Check for both increasing and decreasing input signals to detect hysteresis.
b. In addition to factory calibration certification, temperature sensors and gages shall be checked at a single point for conformance to required accuracy.
c. Level transducers/transmitters shall be checked at two points in addition to zero.
d. Analytical sensors shall be calibrated in accordance with manufacturer's recommendations.
e. Check operation of all switches to verify actuation occurs in accordance with manufacturer's specified accuracy.
f. Replace any instrument which cannot be properly adjusted.
g. Stroke pneumatic control valves with clean dry air to verify control action, positioner settings, and solenoid functions.

4. Calibration equipment shall be certified by an independent agency with traceability to NIST.
    a. Certification shall be up-to-date.
    b. Use of equipment with expired certifications shall not be permitted.
5. Calibration equipment shall be at least three times more accurate as the device being calibrated.

F. Loop check-out requirements are as follows:
1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
    a. Use actual signals where available.
    b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
        1) Verify that readings at all loop components are in agreement.
        2) Make corrections as required.
            a) Following any corrections, retest the loop as before.
2. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
3. Check all interlocks to the maximum extent possible.
4. Utilize the Loop Check-Out Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
5. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

## END OF SECTION

# Loop Check-out Sheet

| | | | |
|---|---|---|---|
| Project Name: | | Owner's Project No. (if applicable): | Page of |
| Project Owner: | | Regulatory Agency Project No. (if applicable): | |
| HDR Project No.: | | Date: | |

## LEAK AND TERMINATION/CONTINUITY CHECKS

| DESCRIPTION | FIELD | | | | | CONTROL CAB | |
|---|---|---|---|---|---|---|---|
| | LEAK CHECK(1) | | | TERM/CONT CHECK(2) | | TERM/CONT CHECK(2) | |
| | Device Tag No. | Process Conn. | Signal Tube | Device Tag No. | Termination Ident. | Device Tag No. | Termination Ident. |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

## OPERATOR INTERFACE CHECK-OUT

### MONITORING POINTS OBSERVED

| PARAMETER TYPE | TAG NO. | TAG NO. | TAG NO. | TAG NO. | TAG NO. | TAG NO. |
|---|---|---|---|---|---|---|
| PROCESS VAR | | | | | | |
| EQUIP STATUS | | | | | | |
| ALARM POINT | | | | | | |

### OPERATOR CONTROL FUNCTIONS CHECKED

| FUNCTION TYPE | TAG NO. | LOCATION | TAG NO. | LOCATION | TAG NO. | LOCATION |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

## FINAL CONFIGURED SETTINGS

| TAG NO. | SWITCH & ALARM SP | CONTROLLERS | | | |
|---|---|---|---|---|---|
| | | Gain | Reset, rpm | Deriv. (rate), min | PV Set Point |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____

(Work Performed By)

# Instrument Certification Sheet

| | |
|---|---|
| Project Name: | Owner's Project No. (if applicable): |
| Project Owner: | Regulatory Agency Project No. (if applicable): |
| HDR Project No. | Date: |
| Control Loop No.: | |
| Instrument Tag No. | Transmitter/gauge span: |
| Manufacturer: | Switch set-point: |
| Model No. | Switch dead band: |
| Serial No. | Switch range: |

## TRANSMITTERS AND INDICATORS

| | INCREASING INPUT | | | DECREASING INPUT | | |
|---|---|---|---|---|---|---|
| % OF SPAN | INPUT | OUTPUT | ERROR (% of span) | INPUT | OUTPUT | ERROR (% of span) |
| 0% | | | | | | |
| 25% | | | | | | |
| 50% | | | | | | |
| 75% | | | | | | |
| 100% | | | | | | |
| Other (if applicable) | | | | | | |
| Other (if applicable) | | | | | | |
| | | | | | | |

## SWITCHES

| | INCREASING INPUT | | | DECREASING INPUT | | |
|---|---|---|---|---|---|---|
| ACTUATION POINT | INPUT | OUTPUT | ERROR (% of range) | INPUT | OUTPUT | ERROR (% of range) |
| High (Increasing input) | | | | | | |
| Low (Decreasing input) | | | | | | |

Maximum allowable error (per Contract Documents): _____

Remarks: _____

_____

_____

## CALIBRATION EQUIPMENT UTILIZED

| DEVICE TYPE | MFR/MODEL NO. | ACCURACY | NIST TRACEABILITY? |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Certified by:_____ Date Certified:_____

# Final Control Element Certification Sheet

| | |
|---|---|
| Project Name: | Owner's Project No. (if applicable): |
| Project Owner: | Regulatory Agency Project No. (if applicable): |
| HDR Project No. | Date: |
| Control Loop No.: | |

| | | |
|---|---|---|
| Tag No. | Actuator: | Pneumatic: _____ Electric: _____ |
| Description: | Positioner: | Direct: _____ Reverse: _____ |
| Manufacturer: | Positioner: | Input: _____ Output: _____ |
| | I/P Converter: | Input: _____ Output: _____ |
| Model No. | Valve to | _____ on air failure |
| Serial No. | Valve to | _____ on power failure |

## I/P CONVERTER

| | INCREASING INPUT | | | DECREASING INPUT | | |
|---|---|---|---|---|---|---|
| % OF SPAN | INPUT | OUTPUT | ERROR (% of span) | INPUT | OUTPUT | ERROR (% of span) |
| 0% | | | | | | |
| 25% | | | | | | |
| 50% | | | | | | |
| 75% | | | | | | |
| 100% | | | | | | |

Specified I/P converter accuracy: _____ % of span.

## FINAL CONTROL ELEMENT

| | INCREASING INPUT | | | DECREASING INPUT | | |
|---|---|---|---|---|---|---|
| % OF SPAN | INPUT | TRAVEL | ERROR (% of full travel) | INPUT | TRAVEL | ERROR (% of full travel) |
| 0% | | | | | | |
| 25% | | | | | | |
| 50% | | | | | | |
| 75% | | | | | | |
| 100% | | | | | | |

Remarks: _____

_____

_____

## CALIBRATION EQUIPMENT UTILIZED

| DEVICE TYPE | MFR/MODEL NO. | ACCURACY | NIST TRACEABILITY? |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Certified by: _____ Date Certified: _____

# SECTION 40 61 43

## SURGE PROTECTION DEVICES (SPD) FOR INSTRUMENTATION AND CONTROL EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Category IC1 SPD - Dedicated 120 VAC circuit, series connection, control panel mounted.
   2. Category IC2 SPD - Individual equipment plug-in device (point of use protection).
   3. Category IC3 SPD - Discrete 120 VAC control signal, control panel mounted.
   4. Category IC4 SPD - Analog instrumentation signal, field mounted.
   5. Category IC5 SPD - Analog instrumentation signal, control panel mounted.
   6. Category IC6 SPD - Combination 120 VAC circuit and analog signal, field mounted.
   7. Category IC7 SPD - Discrete low voltage control signal, control panel mounted.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. Underwriters Laboratories, Inc. (UL):
      a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
      b. 1283, Standard for Electromagnetic Interference Filters.
      c. 1363, Standard for Relocatable Power Taps.
      d. 1449, Standard for Surge Protective Devices.

B. Qualifications:
   1. Provide devices for a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
   2. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

### 1.3 DEFINITIONS

A. Clamping Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

B. Let-Through Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90 degree phase angle of the applied system frequency voltage.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet it specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 PCT deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may vary by mode.

E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

F. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
   2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      a. The N-G mode is not included in the per phase calculation.

G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

## 1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. For named products, submit only a catalog cut sheet.
      a. For all other products, submit the data required below.
   2. See Specification Section 40 61 13 for general process control systems requirements.
   3. Product technical data for non-specified models:
      a. Manufacturer's experience.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Create a Product Data Sheet for each different model number of SPD provided.
         1) Data in the Product Data Sheet heading:
            a) SPD Type per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
            c) Date of signature.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## 1.5 WARRANTY

A. The manufacturer shall provide a minimum of a five year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers model numbers listed in the individual product paragraphs below are acceptable.

### 2.2 CATEGORY IC1 SPD

A. Approved Products:
   1. Eaton AGPH 12015.
   2. ASCO 252 Series HSP121BT-1RU.
   3. MTL MA15/D/1/SI.
   4. Phoenix Contact SFP 1-20/120AC (2856702).

B. Standards: UL 1449.

C. Design:
   1. General:
      a. Mounted internally to control panels for point-of-use loads.
      b. MOV based or multi-stage hybrid solid state high performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
      f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.
   2. Operating voltage: 120 VAC.
   3. Operating current: 15 A minimum.
   4. Operating frequency: 45 to 65 Hz.
   5. Modes of protection: All modes, L-N, L-G and N-G.
   6. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
   7. Maximum surge current: 20,000 A per phase, 10,000 A per mode minimum.
   8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 PCT deviation of the clamping voltage.
   9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection.
      a. External protection as recommended by manufacturer.
   10. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 DEG phase angle:

| System Voltage | Test Mode | IEEE C62.41.2 | | UL 1449 (3rd Edition VPRs) |
|---|---|---|---|---|
| | | B Comb. Wave | A Ring Wave | |
| L-N = 120 V | L-N | 400 V | 300 V | 400 V |
| | L-G | 500 V | 400 V | 400 V |
| | N-G | 500 V | 400 V | 500 V |

### 2.3 CATEGORY IC2 SPD

A. Approved Product:
   1. MTL Zone Guardian ZG-43006.
   2. Tripp Lite Isobar 6 Ultra.
   3. Phoenix Contact EM-DUO SPD Series.

B. Standards: UL 1283, UL 1363 and UL 1449.

C. Design:
1. General:
a. Multi-stage hybrid solid state high performance suppression system.
b. Point of use protection, designed for plug-in devices.
c. Enclosure: Metallic or impact resistant plastic.
d. Field connection:
1) The minimum line cord shall be #14 three conductors, 6 FT in length, with a single piece strain relief NEMA 5-15P plug.
2) The minimum plug-in strip shall have six single NEMA 5-15R receptacles.
e. ON/OFF toggle switch.
f. Device monitoring:
1) Long-life, solid state, externally visible indicators that monitor the on-line status of the units suppression filter system or power loss in any of the phases.
2) A fuse or circuit breaker status only monitor system is not acceptable.
2. Operating voltage: 120 VAC.
3. Modes of protection: All modes, L-N, L-G and N-G.
4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
5. Operating frequency: 45 to 65 Hz.
6. Maximum surge current: 20,000 A per phase, 10,000 A per mode minimum.
7. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10 PCT deviation of the clamping voltage.
8. Overcurrent protection: The SPD may contain internal fuses or circuit breaker, but an IEEE B3 combination wave shall not cause the fuse or circuit breaker to open and render the SPD inoperable.
9. Maximum clamping voltages, dynamic test with voltages measured from the zero voltage reference and 90 DEG phase angle:

| System Voltage | Test Mode | IEEE C62.41.2 | | UL 1449 |
|---|---|---|---|---|
| | | B Comb. Wave | A Ring Wave | |
| L-N = 120 V | L-N | 400 V | 300 V | 330 V |
| | L-G | 500 V | 400 V | 400 V |
| | N-G | 500 V | 400 V | 400 V |

10. EMI-RFI noise rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

## 2.4 CATEGORY IC3 SPD

A. Approved Products:
1. ASCO 205120NF010AN3D0..
2. MTL MA-15/D/1/SI.
3. MTL SD-150X.
4. Phoenix Contact TTC Series.
5. Phoenix Contact PLT-SEC-T3-120-FM.

B. Standards: UL 497B or UL 1449.

C. Design:
1. General:
a. Mounted internally to control panels for point-of-use loads.
b. Multi-stage hybrid solid state high performance suppression system.
c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.

f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the units suppression filter system or power loss in any of the phases.

2. Operating voltage: 120 VAC.
3. Operating current: 3 A minimum.
4. Operating frequency: 45 to 65 Hz.
5. Modes of protection: L-N; when ground conductor is present L-G and N-G.
6. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
7. Maximum surge current: 6000 A per phase, 3000 A per mode minimum.
8. Minimum repetitive surge current capacity:
   a. The SPD shall meet one of the following:
      1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
      2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
      3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
      4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
9. Maximum clamping voltages, measured from the zero voltage reference:
   a. The SPD shall meet one of the following:
      1) 400A, 10x700 microsecond waveform: 200 PCT of system voltage.
      2) IEEE B3 combination wave: 250 PCT of system voltage.
      3) IEEE B3 ring wave: 200 PCT of system peak voltage.
      4) IEEE A3 ring wave: 200 PCT of system peak voltage.
      5) Mode N-G clamping voltage may be 175 PCT higher than the L-G levels.

## 2.5 CATEGORY IC4 SPD

A. Approved Products:
   1. ASCO 157D036S10KXW5R0, 157D036S10KXW5S0, 157D036S10KXW6M0, or 157D036S10KXW6P0.
   2. .MTL TP48-NDI.
   3. Phoenix Contact SURGETRAB/PIPETRAB Series.

B. Standards: None.

C. Design:
   1. General:
      a. For protection of field mounted equipment connected to 4-20mA analog signal loops.
      b. Mounted directly to an unused conduit entry on a process transmitter housing.
      c. Multi-stage hybrid solid state high performance suppression system.
      d. Designed for series connection.
      e. Enclosure: 1/2 IN to 3/4 IN stainless steel conduit pipe nipple.
   2. Operating voltage: 24 VDC or as indicated on the Drawings.
   3. Modes of protection: All modes, L-L and L-G.
   4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
   5. Maximum surge current: 10,000 A.
   6. Minimum repetitive surge current capacity:
      a. The SPD shall meet one (1) of the following:
         1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
         2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
         3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
         4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
         5) 10 occurrences of a 10,000 A, 8 x2 0 microsecond waveform.
   7. Maximum clamping voltages, L-L:
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
         3) IEEE B3 combination wave: 250 PCT of system voltage.
   8. Maximum clamping voltages, L-G:
      a. The SPD shall meet one of the following:

1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
3) IEEE B3 combination wave: 300 PCT of system voltage.

## 2.6 CATEGORY IC5 SPD

A. Approved Products:
1. ASCO 105D036S10KAN3D0 or 175D036S10KAPCN0 with PCB1B base.
2. MTL SD32 or SD32X.
3. Phoenix Contact TTC Series.

B. Standards: UL 497B.

C. Design:
1. General:
a. Mounted internally to control panels for protection of equipment connected to analog signal loops.
b. Multi-stage hybrid solid state high performance suppression system.
c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: The unit shall have external terminal screws for line and ground conductors.
2. Operating voltage: 24 VDC or as indicated on the Drawings.
3. Modes of protection: All modes, L-L and L-G.
4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
a. The SPD shall meet one of the following:
1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
7. Maximum clamping voltages, L-L:
a. The SPD shall meet one of the following:
1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
3) IEEE B3 combination wave: 225 PCT of system voltage.
8. Maximum clamping voltages, L-G:
a. The SPD shall meet one of the following:
1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
3) IEEE B3 combination wave: 300 PCT of system voltage.

## 2.7 CATEGORY IC6 SPD

A. Approved Products:
1. ASCO 265120NF015BD4J0.
2. MTL TPAC-4W.
3. Phoenix Contact BXT-N4X 4-Wire.

B. Product:
1. Field mounted for protection of field mounted equipment connected to 120 V power and 4 - 20 mA analog signal loops.
2. Category IC1 and Category IC5 SPDs mounted in a common enclosure.
3. Enclosure: Metallic or nonmetallic NEMA 250 Type 4X.

## 2.8 CATEGORY IC7 SPD

A. Approved Products:
   1. ASCO 105 Series.
   2. MTL SD Series.
   3. Phoenix Contact: TTC Series.

B. Standards: UL 497B.

C. Design:
   1. General:
      a. Mounted internally to control panels for protection of equipment connected to a discrete signal.
      b. Multi-stage hybrid solid state high performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for line and ground conductors.
   2. Operating voltage: 24 VDC or 24 VAC or 120 VAC or as indicated on the Drawings.
   3. Modes of protection: All modes:
      a. AC applications: L-N, L-G, N-G
      b. DC applications: Pos-Neg, Pos-Gnd, Neg-Gnd.
   4. Maximum continuous operating voltage: Less than 130 PCT of system peak voltage.
   5. Maximum surge current: 10,000 A.
   6. Minimum repetitive surge current capacity:
      a. The SPD shall meet one of the following:
         1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
         2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
         3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
         4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
         5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
   7. Maximum clamping voltages, L-L (Pos-Neg):
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 400 PCT of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 400 PCT of system voltage.
         3) IEEE B3 combination wave: 250 PCT of system voltage.
   8. Maximum clamping voltages, L-G:
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 200 PCT of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 200 PCT of system voltage.
         3) IEEE B3 combination wave: 300 PCT of system voltage.

## 2.9 SOURCE QUALITY CONTROL

A. Performance tests to be performed or independently verified by a certified testing laboratory.

B. The SPD are to be tested as a complete SPD system including: Integral unit level and/or component level fusing.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Category IC1 SPD:
   1. Provide on the following applications:
      a. Incoming 120 V power to all control panels.
      b. Line side of 120 V power terminals to equipment (e.g., PLCs, transmitters).

2. Connected in series with the panel's or equipment's branch circuit.
3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

C. Category IC2 SPD:
   1. Provide on the following applications:
      a. All desk top or rack mounted equipment that is cord and plug connected (e.g., computers, printers) except where power is sourced from a UPS.
   2. Locate near equipment to be protected.

D. Category IC3 SPD:
   1. Provide on the following applications:
      a. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
      b. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors and the control conductors are routed above grade or underground.
   2. Connected in series with the equipment.
   3. Provide fuse protection as recommended by manufacturer.
   4. Flange mount or DIN rail mount in control panel.
   5. Connect all SPDs in the panel to the same grounding point.

E. Category IC4 SPD:
   1. Provide on the following applications:
      a. Loop powered transmitter (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
      b. Loop powered transmitter (flow, level, etc.) where both the transmitter and control panel are mounted outdoors and the signal conductors are rounted above grade or underground.
   2. Connect in series with the equipment.
   3. Attach to spare conduit entry of transmitter or inline of conduit at the transmitter.
   4. Bond transmitter to a grounded structure or provide a ground rod.
   5. Ground shield at control panel end.
   6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

F. Category IC5 SPD:
   1. Provide on the following applications:
      a. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
      b. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where both the transmitter and control panel are mounted outdoors and the signal conductors are routed above grade or underground.
   2. Connect in series with the equipment.
   3. Flange mount or DIN rail mount in control panel.
   4. Connect all SPDs in the control panel to the same grounding point.
   5. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

G. Category IC6 SPD:
   1. Provide on the following applications:
      a. Outdoor field mounted transmitter (flow, level, etc.) that requires 120 V power and provides a 4-20 mA signal to a control panel where the conductors are routed above grace or underground.
   2. Connect in series with the equipment.

3. Mounted adjacent to equipment.
4. Bond transmitter to a grounded structure or provide a ground rod.
5. Ground shield at control panel end.
6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

H. Category IC7 SPD:
   1. Provide on the following applications:
      a. Low voltage (e.g., 24 VAC, 24 VDC) discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
      b. Low voltage (e.g., 24 VAC, 24 VDC) discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors and the control conductors are routed above grade or underground.
   2. Connect in series with the equipment.
   3. Flange mount or DIN rail mount in control panel.
   4. Connect all SPDs in the control panel to the same grounding point.

**END OF SECTION**

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# SECTION 40 61 96
## PROCESS CONTROL DESCRIPTIONS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section is intended to describe the functional and operational requirements of the process being monitored and controlled by the process control system, and to define the Contractor's responsibilities related to the work described herein.

B. Section Includes:
   1. Document Maintenance and Content Requirements.
   2. Process Control Description content and structure.
      a. Process Control Description for each system includes:
         1) Reference Documents.
         2) Major Equipment and Field Instruments.
         3) Overview Description.
         4) Detailed Process Control Descriptions.
         5) Response to Instrument or Equipment Failures.
         6) Displays at HMI/OIT.
         7) Report Descriptions.

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 – Process Control Systems General Requirements.

D. General Requirements:
   1. The Process Control Descriptions describe the operational interface and functional requirements of the Process Control System (PCS) and of the control loops and other PCS functions represented in the Contract Documents.
   2. The Process Control Descriptions do not necessarily address every PCS point or alarm point associated with the process or equipment. Provide and incorporate all hard-wired, networked and internal equipment alarms as shown on the P&IDs, the I/O Lists, instrument schedules, or elsewhere within the Contract Documents, as well as other points required to meet the intent of the system control.
   3. The process control descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions but are rather intended to supplement and complement the Drawings and other Specification Sections.
   4. The Process Control Descriptions shall not be considered equal to a bill of materials.
   5. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on Drawings.
   6. Unless otherwise specified, the following general requirements apply to all process control descriptions.
      a. Analog control loops shall operate based on a standard PID controller, with the controller faceplate incorporated on the PCS HMI graphic display. The PID controller faceplate includes (but is not limited to) the following functions:
         1) Bar graphs for setpoint, process variable and percent output, poke point buttons for Auto/Manual Mode selection, and a numeric entry field with popup keypad for Operator entered values.
            a) Auto/Manual Mode selection: In Auto Mode, the output of the controller is based on the PID controller calculation. In Manual Mode, the output of the controller is operator adjustable. Switching between the PID controller's

operational modes shall be configured with setpoint tracking and bump-less transfer.

b) Compound Mode, where applicable: In the Compound Mode, the setpoint is trimmed by a remote setpoint input. This mode is used in applications requiring a cascade control loop such as level/flow.

2) When in the Automatic Mode, PID algorithms shall monitor the margin of error between the setpoint value and the actual process variable. A deviation of +/- 10 PCT between setpoint and process variable generates a Deviation Alarm notifying the operator of the condition. The % of deviation is an adjustable value.

b. All motors (constant and variable speed) must be monitored for the associated Run, Stop, and Fail status. When the PCS initiates a run command output, the PCS logic monitors the running status feedback from the motor (starter or variable speed drive) and produces a "Fail to Run" or "Fail to Stop" alarm (as applicable) if the motor feedback does not correspond with the status of the PCS initiated command output. A PCS internal delay timer with typical preset of 15 SEC (individually adjustable) shall be configured for each logic statement to allow the motor control adequate time to comply with the output command.

1) The PCS output command is de-energized subsequent to the expiration of the alarm delay time period, i.e. a timed-out command.

c. All VFD drives shall be connected to the PCS using both hard-wired control signals and EtherNet/IP communications. The primary controls and monitoring of the drive shall be via the hard-wired control signals. The PCS shall monitor non-mission critical information from the drives via EtherNet/IP communications, which will be displayed on an information pop-up displays on the HMI. Unless otherwise noted, the EtherNet/IP data exchange shall include the following parameters:

1) Parameter 001 – Output Frequency.
2) Parameter 007 – Output Current.
3) Parameter 008 – Output Voltage.
4) Parameter 009 – Output Power.
5) Parameter 015 – Elapsed Run Time.
6) Parameter 935 – Drive Status 1.
7) Parameter 937 – Condition Status 1.

d. Valves or gates with limit switch functions for position feedback: when the PCS initiates an Open/Close command output, the PCS logic monitors the position feedback and produces a "Failure to Open" or Failure to Close" Alarm (as applicable) if the valve/gate feedback does not correspond with the status of the PCS initiated command output. A PCS internal delay timer preset of 60 SEC (operator adjustable to match actual valve actuator speed) is configured for each logic statement allowing the valve/gate actuator time to comply with the output command. The timer preset requires adjustment at startup depending on the type of valve or gate and the full open to close travel time for each.

1) The PCS output command is de-energized subsequent to the expiration of the alarm delay time period, i.e., a timed-out command.

e. Analog inputs shall have a signal Out of Range Alarm generated via a PCS internal timer when the PCS input is 3.8 mADC or 20.5 mADC. The alarm delay timer preset is initially set at 20 SEC. The delay preset value is operator adjustable.

f. All flow inputs shall be totalized (integrated) and logged on the PCS historian. All totalized values are displayed on the PCS HMI graphic display in the appropriate engineering units as required. Provide daily flow totals for all measured flows.

g. All equipment run times shall be totalized, displayed and logged on the PCS historian. Run times shall have a resolution of one minute and be displayed in hours and tenths of hours on the appropriate PCS HMI graphic display.

h. For each piece of process equipment controllable by the PCS, an equipment "ready" or control mode permissive signal is needed to indicate to the PCS control logic PCS

control is allowed. The PCS shall monitor the Local Control Panel mounted L/R mode selector switch and control the equipment that is in the Remote mode.

i. Non-modulating motorized valves or gates shall be controllable via Open-Stop-Close buttons on HMI and OIT faceplates. The valves/gates shall be controlled in the Open and Close directions by separate PCS control signals. The PCS shall stop the Open or Close command to the actuator when the actuator reaches the respective end of travel.
j. I/O points shown on the P&IDs, I/O List or elsewhere within the Contract Documents shall be incorporated into the PCS HMI and OIT graphic displays as indicated by their function.
k. Operator entry of setpoints shall be limited to values within upper and lower operating limits corresponding to the valid operating range of the equipment. An operator-entered setpoint outside the valid range must be rejected by the PCS and the original setpoint shall be maintained until a valid value is entered. When an invalid setpoint is entered into the system, an Invalid Value message shall appear in the setpoint entry faceplate, alerting the operator to the condition. The upper and lower range limits are adjustable.
l. In addition to the requirements specifically stated within each Process Control Description, all control software and hardware shall be provided as required to ensure the safe and reliable operation of all controlled equipment.
m. All "soft" alarms on analog signal shall reside in the PLC logic with de-bounce timers. Provide the capability to modify the soft setpoints through the HMI system with appropriate security.
n. All alarm and trip time delays shall be adjustable from the HMI system by an operator with appropriate security.
o. All process values, ranges, and setpoints described herein shall be considered "Initial values" and may be changed during installation and start-up.
p. All measured analog values shall be logged and available for trending via Operator selection at the HMI.

## 1.2 DEFINITIONS/ABBREVIATIONS

A. Abbreviations are defined as listed below:

| | |
|---|---|
| A/M | Auto/Manual |
| H/O/A | Hand-Off-Auto |
| H/O/R | Hand-Off-Remote |
| HMI | Human-Machine Interface |
| I/O | Input/Output |
| L/R | Local/Remote |
| LCP | Local Control Panel |
| LCS | Local Control Station |
| MCC | Motor Control Center |
| O/C | Open/Close |
| OI | Operator Interface (valve actuator, VFD) |
| OIT | Operator Interface Terminal |
| P&ID | Process and Instrumentation Diagram |
| PCS | Process Control System |
| PID | Proportional-Integral-Derivative |

| | |
|---|---|
| PFD | Process Flow Diagram |
| PLC | Programmable Logic Controller |
| RIO | Remote DCS or PLC Input/Output Equipment |
| RTU | Remote Terminal Unit |
| S/S | Start/Stop |
| UPS | Uninterruptible Power Supply |
| VFD | Variable Frequency Drive |

### 1.3 SUBMITTALS

A. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 ADMINISTRATIVE REQUIREMENTS

A. Control Strategy for Record Documents:
   1. Obtain this Specification Section 40 61 96 in electronic format (Microsoft Word) from Engineer at beginning of Project. Provide updated Process Control Descriptions as follows:
      a. As needed or requested following any PCS workshops, working sessions, and/or related submittal reviews.
      b. As needed or requested during the course of programming, start-up and testing to reflect all refinements and changes that occur due to specific operational needs and the characteristics of specific equipment and systems supplied under this Contract.
      c. Show all revisions in 'track change' mode.
      d. Change Specification Section Title to read "Process Control Descriptions - Contractor Record Document."
      e. Reference all changes by Request for Information (RFI) number or Change Proposal Request (CPR) number.
   2. Submit the revised and updated file as a final Process Control description Record Document in the Operation and Maintenance Manual described in Specification Section 01 33 04.
      a. Provide both paper copy and electronic copy (on USB drive) of the Record Document process control descriptions in the Operation and Maintenance Manual described in Specification Section 01 33 04.

B. Coordination with vendor-furnished control packages
   1. Where vendor packages are supplied as part of the Contract, the vendor packages that are supplied with PLC-based controls shall be programmed by the respective vendors. Provide all programming as required to integrate Vendor-furnished controls into the PCS as described in the Contract Documents.

## PART 2 - PRODUCTS - (NOT USED)

## PART 3 - EXECUTION

### 3.1 PROCESS CONTROL DESCRIPTIONS

A. The following Appendices to this Section contain the process control descriptions that define the PCS procedural and operational requirements of the processes included in the Work:
   1. 40 61 96 - Appendix A – Pretreatment Process Control Description
   2. 40 61 96 - Appendix B – Rapid Mix Process Control Description

3. 40 61 96 - Appendix C – Ballasted Flocculation System Process Control Description
4. 40 61 96 - Appendix D – Filters Process Control Description
5. 40 61 96 - Appendix E – Backwash Waste Basins Process Control Description
6. 40 61 96 - Appendix F – Ozone Generation, Feed, and Injection Systems Process Control Description
7. 40 61 96 - Appendix G – Calcium Thiosulfate System Process Control Description
8. 40 61 96 - Appendix H – Alum System Process Control Description
9. 40 61 96 - Appendix I – Caustic System Process Control Description
10. 40 61 96 - Appendix J – Settling Aid Polymer System Process Control Description
11. 40 61 96 - Appendix K – Filter Aid Polymer System Process Control Description
12. 40 61 96 - Appendix L – Sodium Hypochlorite System Process Control Description
13. 40 61 96 - Appendix M – Sodium Carbonate System Process Control Description
14. 40 61 96 - Appendix N – Intermediate Pump Station Process Control Description
15. 40 61 96 - Appendix O – Crowson Pump Station Process Control Description

**END OF SECTION**

# APPENDIX A
## PRETREATMENT
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Pretreatment

### A.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y601, Pretreatment P&ID

### A.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Filter Systems: STR-1201, STR-1202
   2. Flow Control Valves: FCV-1501, FCV-1502

B. Major Field Instruments:
   1. Plant Raw Water flowmeter: FE/FIT-1001
   2. Raw Water PRV intake pressure transmitter: PIT-1500
   3. Raw Water PRV discharge pressure transmitter: PIT-1513
   4. Raw Water turbidimeter: AIT-1511
   5. Raw Water pH/temp analyzer: AIT-1512

### A.3 OVERVIEW DESCRIPTION

A. Raw water is screened by a filter system consisting of automatic strainers. The strainers automatically backwash as the differential pressure rises. Each strainer is controlled by its own master control panel provided by the equipment manufacturer. The master control panel includes a PLC. Backwash water is discharged to the sanitary sewer via motorized drain valve. See Specification Section 46 61 73 for a description of the local control panel(s).

B. The flow control valves operate based on an operator selected flow setpoint, while also maintaining a set downstream pressure.

C. Turbidity and pH/temperature analyzers are used to monitor analytical information for raw water.

### A.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. All control logic for starting up and shutting down the Filter systems is maintained in the strainers system Local Control Panel (LCP).

B. PLC-based Process Monitoring and Control:
   1. For the Filter systems equipment, the PLC will monitor flush status as well as alarms.
   2. For the Flow Control Valves, the PLC will monitor valve status as well as send flow setpoint values.

### A.5 DISPLAYS AT HMI/OIT

A. Indicators and alarms:
   1. Filter Systems, typical:
      a. Flush status (ON/OFF).
      b. System fault.
   2. Flow Control Valves, typical:
      a. Flow rate (GPM).
      b. Flow controller in AUTO mode.

c. Valve in fully closed position.

3. Raw water flow rate.
4. Strainer outlet pressure.
5. Raw water pH signal.
6. Raw water pH low, low-low, high, and high-high alarms.
7. Raw water temperature signal.
8. Raw water turbidity signal.
9. Raw water high and high-high turbidity alarms.

B. Operator entries and setpoints:

1. Raw water turbidity high and high high alarm thresholds.
2. Raw water pH low, low-low, high, and high-high alarm thresholds.

## A.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:

1. Average plant flow rate.
2. Measured low flow rate.
3. Measured high flow rate.
4. Total volume (MGD) of raw water.
5. Strainer outlet pressure.
6. Flow control valve outlet pressure.
7. Raw water pH signal.
8. Raw water temperature signal.
9. Raw water turbidity signal.

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX A**

## APPENDIX B

NOT USED

## END OF APPENDIX B

# APPENDIX C
## BALLASTED FLOCCULATION SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Ballasted Flocculation System

### C.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y601, Pretreatment
   2. 000Y603, Rapid Mix
   3. 000Y604, Ballasted Sedimentation Train 1
   4. 000Y605, Ballasted Sedimentation Train 2
   5. 000Y606, Microsand Pump System

### C.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Turbidimeter: AE/AIT-1511
   2. pH/Temp Analyzer: AE/AIT-1512, AE/AIT-3003
   3. Sample Pump: PMP-3311
   4. Ballasted Flocculation Train Control Panel: CP-3211, CP-3221
   5. Coagulation Mixers: MX-3212, MX-3222
   6. Streaming Current Analyzer: AE/AIT-3004
   7. Maturation Mixers: MX-3213, MX-3223
   8. Sludge Scraper Drives: MX-3214, MX-3224
   9. Microsand Pumps: PMP-3311, PMP-3321
   10. Level transmitter: LT-4001
   11. Hydrocyclones: HC-3411 HC-3412, HC-3421, HC-3422
   12. Chemical Injection Quills: IQ-3210, IQ-3320

B. Major Field Instruments:
   1. FIT-3311, FIT-3321: Microsand flow meter.
   2. PIT-3311, PIT-3321: Microsand pressure transmitter.
   3. LT-4001: Ballasted Flocculation Effluent Channel level transmitter.

### C.3 OVERVIEW DESCRIPTION

A. Two Ballasted Flocculation Basins are included, each with a coagulation mixer, maturation mixer, rotating scraper mechanism, and sludge recirculation system.
   1. Plant PLC will provide individual run commands for each train to the ballasted sedimentation system PLC.
   2. Ballasted sedimentation PLC will control individual ballasted sedimentation train startup and shutdown, individual component start/stop and speed control and alum and settling aid polymer feed rates.
   3. A turbidity meter installed in the Pretreatment Building monitors the raw water turbidity before chemicals are added.
   4. A combination pH/Temperature transmitter, installed in the Pretreatment Building, monitors the pH and temperature of the raw water before chemicals.
   5. The ozonated water that has been dosed with coagulant and settling aid is directed to the ballasted flocculation for treatment.
   6. The ozonated water sample is pumped to the plant lab by sample pump PMP-3311.
   7. A streaming current detector continuously monitors the ozonated water entering the ballasted flocculation basins.
      a. Streaming current is proportional to the particle charge remaining after coagulation and can be used to monitor and adjust the coagulant dosage.

8. Maturation mixers provide additional mixing of microsand, polymer, and floc in the maturation tank.
9. Settled solids/microsand are transported to the microsand recirculation pump inlet hopper by rotating scraper mechanism.
10. One recirculation pump per train delivers settled solids/microsand mixture to hydrocyclones for solids/microsand separation.
11. High and high high level alarms are installed to notify operator of impending or actual overflow event respectively.
12. Settled water is tapped at the discharge pipe and pumped to the plant lab by sample pump PMP-3231.
13. The supernatant overflows the troughs and then proceeds to the filters.

## C.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Operators can start the drive(s) by using the Hand/Off/Auto selector switches at the local control panel(s). When the HOA selector switch is in Auto, control is by the vendor control panel PLC.
      a. Sample Pump: PMP-3311
         1) Overload stops pump.
      b. Maturation Mixers MX-3213, MX-3223
         1) Overload stops motor.
      c. Sludge Scraper Drives MX-3214, MX-3224
         1) VFD faults will stop drive
      d. Microsand Pumps PMP-3311, PMP-3321
         1) Pump discharge pressure high stops pump via motor starter. Fail condition is reset from local pushbutton.
      e. Sample Pump PMP-3231
         1) Overload stops pump.

B. PLC-based Process Monitoring and Control:
   1. HMI Manual:
      a. When the Auto/Manual selector is in Manual, the operator can enable or disable the drives.
      b. When the Auto/Manual selector is in Manual, the operator can start the drive(s) by selecting Start, and Stop the drive(s) by selecting Stop.
   2. HMI Auto:
      a. When the Auto/Manual selector is in Auto, the PLC will run the drive(s) continuously, whenever the Ballasted Flocculation system is enabled.
   3. Ballasted Flocculation Train Control Panel CP-3211, CP-3221
      a. HMI Manual:
         1) Operator can start/stop each train.
      b. HMI Auto:
         1) Provide individual train run commands in accordance with the Plant Master Start/Stop Control.

## C.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Turbidimeter: AE/AIT-1511
      a. Turbidity.
      b. Turbidity high alarm
      c. Turbidity high high alarm
      d. Trubitidy transmitter fail
   2. pH/Temp Analyzer AE/AIT-1512
      a. pH
      b. Temperature

c. pH low alarm
d. pH high alarm
e. pH transmitter fail
f. Temperature lowalarm
g. Temperature high alarm
h. Temperature transmitter fail

3. Sample Pump PMP-3311
   a. Running
   b. Fail alarm
4. Ballasted Flocculation Train Control Panel CP-3211, CP-3221
   a. Ballasted sedimentation train(s) in service
   b. Train startup sequence step status
   c. Train shutdown sequence step status
5. Coagulation Mixers MX-3212, MX-3222
   a. Hand
   b. Auto
   c. Running
   d. Fail alarm
6. Streaming Current Analyzer AE/AIT-3004
   a. Streaming current (range -10.00 to +10.00)
   b. Streaming current setpoint
   c. Streaming current deviation alarm setpoint
   d. Streaming current deviation alarm
   e. Streaming current transmitter fail
7. Maturation Mixers MX-3213, MX-3223
   a. Running
   b. Maturation tank mixer speed
   c. Mixer fail alarm
8. Sludge Scraper Drives MX-3214, MX-3224
   a. Running
   b. Scraper speed
   c. Fail alarm
9. Microsand Pumps PMP-3311, PMP-3321
   a. Running
   b. Discharge pressure
   c. Microsand pump fail
   d. Microsand pump pressure high
   e. Microsand pump pressure low
10. Level transmitter: LT-4001
    a. Ballasted sedimentation effluent channel high level
    b. Ballasted sedimentation effluent channel high high level
11. Sample Pump PMP-3231
    a. Running
    b. Fail alarm
12. Mixer Enabled/Disabled Status (6).
    a. Drive Auto/Manual Status (6).
    b. Drive Stopped/Running Status (6).
13. Pump Enabled/Disabled Status (2).
    a. Running status.
    b. Fault.
    c. Fail to start.
    d. Operating speed feedback.
    e. Motor current.
    f. Valve closed.

B. Operator entries and setpoints:
   1. Turbidimeter: AE/AIT-1511
      a. Turbidity high alarm setpoint
      b. Turbidity high high alarm setpoint
   2. pH/Temp Analyzer AE/AIT-1512
      a. pH low alarm setpoint
      b. pH high alarm setpoint
      c. Temperature low alarm setpoint
      d. Temperature high alarm setpoint
   3. Sample Pump PMP-3311
      a. None
   4. Ballasted Flocculation Train Control Panel CP-3211, CP-3221
      a. Start/Stop
   5. Streaming Current Analyzer: AE/AIT-3004
      a. Streaming current setpoint.
      b. Streaming current deviation alarm set point (%)
      c. Streaming current deviation alarm time delay
   6. Maturation Mixers MX-3213, MX-3223
      a. Maturation tank mixer speed
   7. Sludge Scraper Drives MX-3214, MX-3224
      a. None
   8. Microsand Pumps PMP-3311, PMP-3321
      a. None
   9. Sample Pump PMP-3231
      a. None

## C.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Turbidimeter: AE/AIT-1511
      a. Data sampling interval – 5 minutes
      b. Instantaneous
      c. 8 hour trend
      d. 24 hour trend
      e. 7 day trend
   2. pH/Temp Analyzer AE/AIT-1512
      a. Data sampling interval – 5 minutes
      b. pH and temperature:
         1) Instantaneous
         2) 8 hour trend
         3) 24 hour trend
         4) 7 day trend
   3. Sample Pump PMP-3311
      a. None
   4. Coagulation Mixers MX-3212, MX-3222
      a. Run time
   5. Streaming Current Analyzer: AE/AIT-3004
      a. Data logging interval – 5 minutes
      b. Instantaneous
      c. 8 hour trend
      d. 24 hour trend
      e. 7 day trend
   6. Maturation Mixers MX-3213, MX-3223
      a. Run time
   7. Sludge Scraper Drives MX-3214, MX-3224
      a. Run time

8. Microsand Pumps PMP-3311, PMP-3321
    a. Run time
    b. Discharge pressure
9. Level transmitter: LT-4001
    a. None.
10. Sample Pump PMP-3231
    a. None

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX C**

# APPENDIX D
## FILTERS
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Filters

### D.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y607, Filter 1 P&ID
   2. 000Y608, Filter 2 P&ID
   3. 000Y609, Filter 3 P&ID
   4. 000Y610, Filter 4 P&ID
   5. 000Y611, Low Pressure Air P&ID
   6. 000Y612, Instrument Air

### D.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Filters: FIL-4111, FIL-4121, FIL-4131, FIL-4141
   2. Filter Inlet Valves: BFV-4011, BFV-4021, BFV-4031, BFV-4041
   3. Filter Air Vent Valves: SV-4111, SV-4121, SV-4131, SV-4141
   4. Air Scour Valves: BFV-4111A, BFV-4121A, BFV-4131A, BFV-4141A
   5. Filter Flow Control Valves: BFV-4211, BFV-4221, BFV-4231, BFV-4241
   6. Filter Effluent Valves: BFV-4212, BFV-4222, BFV-4232, BFV-4242
   7. Filter Waste Valves: BFV-4311, BFV-4321, BFV-4331, BFV-4341
   8. Backwash Supply Valves: BFV-4411, BFV-4421, BFV-4431, BFV-4441
   9. Backwash Waste Valves: BFV-4611, BFV-4621, BFV-4631, BFV-4641
   10. Filter Air Scour Blower 1: BLW-4501
   11. Filter Air Scour Blower 1 VFD: VFD-4501
   12. Blower Air Vent Valve: BFV-4511
   13. Instrument Air Compressor: AC-4810
   14. Instrument Air Receiver: AR-4820
   15. Air System Flow Controller: FC-4820

B. Major Field Instruments:
   1. Filter Level Transmitters: LT-4111, LT-4121, LT-4431, LT-4141
   2. Filter High Level Switches: LSH-4111, LSH-4121, LSH-4131, LSH-4141
   3. Filter Headloss Transmitters: DPIT-4111, DPIT-4121, DPIT-4131, DPIT-4141
   4. Filter Effluent Turbidimeter: AE/AIT-4111, AE/AIT-4121, AE/AIT-4131, AE/AIT-4141
   5. Filter Effluent Flowmeter: FE/FIT-4111, FE/FIT-4121, FE/FIT-4131, FE/FIT-4141
   6. Filter Air Scour Blower 1 High Pressure Switch: PSH-4501
   7. Air Scour Flowmeter: FE/FIT-4511
   8. Air Scour Temperature: TE/TIT-4511
   9. Air Scour Pressure Transmitter: PIT-4511
   10. Instrument Air Pressure Transmitter: PIT-4821

### D.3 OVERVIEW DESCRIPTION

A. The filters remove remaining solids following the sedimentation process (ballasted flocculation). Water from the ballasted flocculation system flows by gravity to the filter influent channel. Butterfly valves on the inlet of each filter control whether a filter is on or offline.

B. Flow through the filter is controlled by a filter effluent valve on the downstream side of the filter. The filter will be operated to maintain constant flow as determined by the PLC to maintain

a level range in the filter inlet channel using proportional control (cascade control). As the pressure differential increases due to solids build-up, the filter effluent valve will open more.

1. If an individual filter effluent turbidimeter (AE/AIT-41x1) records a value above setpoint in two consecutive readings (15 minutes apart), that filter will be automatically taken offline until the Operator resets the alarm.

C. Once the filter reaches a set run time, pressure differential, or turbidity, a backwash alarm will be initiated. A backwash can only be run if there is sufficient volume in the clearwell, and so must be initiated manually by an operator. Once a backwash is initiated, the filter valves will modulate as needed to allow for backwash supply water to pass up through the filter and out through the backwash waste line. During backwashing, air scour will be provided by the low pressure air blower.

1. A backwashed clean filter remains offline in resting mode until the next filter backwash is initiated.

D. The blower is called by the control system to provide an air scour for Filter unit when a backwash of the unit is required. Vent valve is opened prior to starting the Blower. Once the air scour valve associated with the filter being backwashed is open, the vent valve will be closed slowly to route air to the backwashing filter.

E. Pneumatic actuated valves are provided for all control valves for the filters. The compressed air system provides air for proper operation of valves and filters. Two compressors will be mounted on top of a single horizontal air receiver tank. Air from this tank will be dried and filtered before entering the primary air receiver AR-4820. A flow controller FC-4820 will be provided to control flow and pressure to the pneumatic actuated valves. The solenoid drain valve SV-4810 will intermittently drain the small air receiver tank allowing flow to enter the oil/water separator SEP-4810.

## D.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hard-wired controls and indicators at the Filter Control Panel (LCP-303):

1. For each filter:
   a. Turbidity display.
   b. Filter head loss display.
   c. Effluent flow control valve auto/manual station.
   d. Inlet valve O/C/A selector switch.
   e. Filter air vent valve O/C/A selector switch.
   f. Backwash waste valve O/C/A selector switch.
   g. Air scour valve O/C/A selector switch.
   h. Backwash supply valve O/C/A selector switch.
   i. Filter waste valve O/C/A selector switch.
   j. Filter effluent valve O/C/A selector switch.
2. Air scour blower 1 H/O/A selector switch and auto/manual station.
3. Blower vent valve O/C/A selector switch.
4. Backwash Supply Valve auto/manual station.
5. Control Mode Selection:
   a. Each Filter may be started and stopped via manual START/STOP selection made by the Operator at the local HMI. Manual control is when the Filter has been placed in the AUTO mode at the valve and in HAND control mode via the HMI screen. From the local HMI, the operator can change the filtration rate or the operation status (ON/OFF) of the filter selected. Note that the flow to the other Filters in operation will be adjusted to reflect the selected filtration rate or operational status (ON/OFF) of the Filter in HAND. The continued operation of the selected Filter will be in accordance with the local PLC.
6. When the backwash flow control valve opens, a backwash supply valve for one of the filters must open to prevent over pressurization of the backwash supply piping.

B. PLC-based Process Monitoring and Control:

1. General:
   a. The remote control mode must be locally selected for all required control valves, pumps, blowers, etc. associated with the selected filter(s) in order for remote (PLC) control to be enabled for filter effluent flow control, backwashing, or filter-to-waste control.
2. Actuated valves:
   a. When the valve HOA selector switch is in Auto, the valve is controlled in accordance with selections made via any Operator Workstation/OIT.
      1) HMI Manual. When the Auto/Manual selector is in Manual, Operator can manually:
         a) Open the valve.
         b) Close the valve.
         c) Position the valve if modulating type.
      2) HMI Auto:
         a) Each valve will operate as described in automatic sequences below.
3. Filter Controls:
   a. HMI Manual:
      1) Operator can manually initiate an automatic Backwash or Filter-to-Waste sequence.
      2) Operator selects which filters are online and which filters are offline.
         a) When a filter is placed offline, all filter valves shall then close.
         b) If the Operator desires to drain the filter, it must be done by manually opening the appropriate valves.
   b. HMI Auto:
      1) The filters' effluent control valve modulates to maintain a set flow rate through the filter.
      2) Flow setpoint is entered independently for each individual filter.
      3) Each filter's effluent flow rate is measured by inline magnetic flow meter, FE/FIT-41x1.
   c. When Filter Interlocks are enabled, the PLC will monitor filter valve states and won't allow the wrong combination of valve positions for an online filter. A filter shutdown will automatically occur if valves are not in proper position.
      1) The following valve positions are required when a filter is online:
         a) Influent Valve BFV-40x1 – open.
         b) Backwash-to-Waste Valve BGV-46x1 – closed.
         c) Air Scour Valve BFV-41x1 closed.
         d) Backwash Supply Valve BFV-44x1 – closed.
         e) Filter Effluent Control Valve BFV-42x1 - modulated open.
         f) Filter Effluent Valve BFV-42x2 – open.
         g) Filter Waste Valve BFV-43x1 – closed.
4. Filter Backwash and Filter-to-Waste Sequence:
   a. General:
      1) Backwash and filter-to-waste sequences are automatic once initiated. An Auto/Manual mode selection is available at the HMI so that a backwash cycle may either be manually initiated by the Operator or will automatically be initiated by whichever of the following conditions occurs first:
         a) High filter head loss as measured by pressure differential transmitter (DPIT-41x1). The high differential setpoint resides within PLC control logic.
         b) Turbidity as measured in the filter effluent by AE/AIT-41x1. The high turbidity setpoint resides within PLC control logic.
         c) Elapsed time that a filter has been in service. The time setpoint resides within PLC control logic.
            (1) Filter run time shall be calculated from when the filter influent valve (BFV-40x1) is open, the filter effluent isolation valve (BFV-42x1B)

is open, and the flow as measured by (FE/FIT-41x1) is above minimum flow to when the filter influent valve and filter effluent isolation valve close.

2) During any step of the backwash sequence, an operator can pause or extend the duration of any single step.
3) If a filter has been offline for a longer than normal period of time, the Operator is prompted to manually initiate a backwash prior to bringing it back online. The rest and filter-to-waste sequences will follow per standard operating procedure.
4) If a filter calls for backwash while another is already in the backwash sequence, the PLC will notify the operator that this filter is waiting for a backwash.
5) Operator will be notified if the Backwash Waste Basin(s) do not have sufficient volume to accept an entire backwash or if the Clearwell level is low and needs to recover prior to initiating backwash.
6) If any of the alarm conditions listed below occur during a backwash or filter-to-waste sequence, all backwash and filter-to-waste sequences will be paused until the operator resets the alarm(s). Valves BFV-46x1, BFV-41x1A and BFV-44x1 will all close, trapping water in the filter until the alarm(s) have been cleared and reset. A new backwash sequence will need to be manually initiated starting from the beginning of the sequence.
    a) High level alarm from either of the two Backwash Waste Basins. See Appendix E, Backwash Waste Basin.
    b) Low level alarm from the Clearwell. Appendix N, Intermediate Pump Station.
    c) Valve fails to open or close as commanded.
    d) Any step in the automatic sequence fails to function as commanded.
7) Only one filter can be backwashed at a time.
8) A backwashed clean filter remains offline in resting mode until the next filter backwash is initiated.
9) When the backwash procedure is initiated, the backwashing filter is taken offline and the rested filter is placed online simultaneously.
10) The rested filter goes into Filter-to-Waste mode until turbidity or time setpoints are indicated in SCADA, then switches to filter effluent mode.
11) The source water for the backwash procedure is treated, finished water from the Clearwell. Backwash supply flow measured by flow meter FE/FIT-5411 is monitored by the PLC.

b. Automatic Backwash Sequence:
    1) The following instrument readings are ignored during backwash:
        a) Filter head loss.
        b) Filter effluent turbidity.
    2) The backwashing filter is isolated (influent isolation valve BFV-40x1 is closed) and drained down as follows:
        a) Filter effluent isolation valve BFV-42x2 remains open and filter effluent flow control valve BFV-42x1 continues to modulate until the water level drops to a setpoint initial level (measured by LE/LIT-41x1).
        b) Filter effluent isolation valve BFV-42x12 is closed and filter-to-waste isolation valve BFV-43X1 is opened simultaneously, and filter effluent flow control valve BFV-42x1 continues to modulate until the water level drops to a setpoint final level (measured by LE/LIT-41x1).
        c) Then filter-to-waste isolation valve BFV-43X1 is closed and backwash waste valve BFV-46x1 is opened.
    3) The air only air scour sequence is initiated for a set number of minutes by starting the air blower and opening the backwash air isolation valve BFV-41x1. Air scour blower with VFD will maintain a target air flow rate via feedback from corresponding air flow meter.

4) Simultaneous air/water backwash with air scour at 5 scfm/SF and low rate water is initiated and run for setpoint minutes by opening the backwash supply isolation valve BFV-41x1 and Backwash Supply Flow Control Valve BFV-5411 which will maintain a target low rate backwash via feedback from corresponding flow meter(s).
5) Air scour is stopped by closing the backwash air isolation valve BFV-41x1 and stopping the air blower. Water flow is ramped up by the Backwash Supply Flow Control Valve BFV-5411 to high rate water over setpoint minutes (to bleed air out while increasing flow rate).
6) After set point minutes the high rate ramp down begins.
   a) High rate backwash water flow is ramped down by the Backwash Supply Flow Control Valve BFV-5411 over setpoint minutes, to allow for proper re-stratification of filter media. The Backwash Supply Flow Control Valve BFV-5411 supplying the backwash will maintain a minimum setpoint flow and run for the time as determined when the totalized backwash water volume equals the volume of water in the filter box from the top of troughs to the top of underdrains, to fully exchange the filter box volume and trigger a Backwash Waste Valve closure (BFV-46x1).
7) After the Backwash Waste Valve closure (BFV-46x1) closes, the BWS valve (BFV-44x1) will remain open until the filter box level is brought up to match in service filters. Then the BWS valve will close, the Backwash Supply Flow Control Valve BFV-5411 will close and the filter will begin rest mode.
8) In rest mode, all valves and gates are closed such that water remains in the filters at an elevation equal to the online filters. At such time as another filter is called to go into backwash, then the resting filter will automatically begin filter-to-waste mode.
   a) Filter-to-Waste: the first step of filter-to-waste mode is to purge any air that may have accumulated in the filter effluent channel.
      (1) Valve SV-41x1 is opened for setpoint minutes and then closed.
      (2) Next, influent valve BFV-40x1 and filter-to-waste valve BFV-43x1 will open and filter effluent control valve BFV-42x1 will modulate to pass a set flow rate (as determined by flow control algorithms as previously described); flow rate feedback is provided by FE/FIT-41x1.
      (3) Filter-to-waste mode will continue until AE/AIT-4200 records setpoint turbidity. If a setpoint time duration is reached before setpoint turbidity is reached, an alarm condition shall be indicated, but filter-to-waste shall continue until setpoint turbidity is reached. When the filter-to-waste sequence is complete, filter effluent control valve BFV-42x1 remains unchanged while filter effluent isolation valve BFV-42x2 opens simultaneously with the closure of filter-to-waste isolation valve BFV-43x1.

c. Air Scour Blower:
   1) HMI Manual:
      a) When the Auto/Manual selector is in Manual, the Operator may start and stop the blower and set and adjust blower speed via selections made at any Operator Workstation/OIT.
   2) HMI Auto:
      a) Upon a command to start the blower, the blower vent valve is commanded to open first. The blower's vent valve must be proven open prior to starting the Blower.
      b) The blower is called to start when the filter backwash sequence requires air scour. The blower speed is automatically controlled to maintain an operator adjustable flow setpoint.

c) Once the air scour valve associated with the filter being backwashed is open, the vent valve will be closed slowly to route air to the backwashing filter.
d) When a blower stop command is communicated, the vent valve shall be signaled to open slowly to ramp down air flow to the backwashing filter.
e) When the vent valve is completely open as proven by the open limit switch, the associated air scour valve shall be signaled to close.
f) When confirmation is received that the associated air scour valve is closed, the Blower shall stop.
g) Following blower stop, the vent valve remains opens to be ready for the next blower start.
h) In the event the blower discharge reaches a high-high temperature setting, the PLC initiates a blower stop.

## D.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
1. Settled Water Channel:
   a. Level signal.
2. For each Filter:
   a. Filter Online/Offline.
   b. Filter run time.
   c. Filter in Rest Mode.
   d. Filter in Backwash.
      1) Status indication of each step of sequence.
      2) Current timer and timer duration for timed sequences.
   e. Filter flow rate signals:
      1) Backwash flow rate.
      2) Effluent flow rate.
         a) High flow rate alarm.
      3) Filter-to-waste flow rate.
         a) High flow rate alarm.
      4) Air scour flow rate.
   f. Filter level signal.
   g. Filter level alarms: low, low-low, high, and high-high level alarms.
   h. Turbidity signal.
   i. Turbidity high and high-high alarms.
   j. Headloss signal.
   k. Headloss high alarm.
      1) Disabled during backwash sequence.
   l. Alarm for any valve not in Auto control mode when an automatic sequence is initiated.
   m. Automatic backwash failure (sequence interrupted).
   n. Filter-to-waste failure (automatic sequence interrupted).
   o. Online filter shutdown due to improper valve position.
   p. Filter Inlet Valves:
      1) HOA switch in Auto.
      2) Open position.
      3) Closed position.
      4) Valve failed to open alarm.
      5) Valve failed to close alarm.
   q. Filter Air Vent Valves:
      1) HOA switch in Auto.
   r. Filter Effluent Control Valves:
      1) Manual Loading Station in Auto.
      2) Valve Position feedback signal.

s. Filter Effluent Valves:
   1) HOA switch in Auto.
   2) Open position.
   3) Closed position.
   4) Valve failed to open alarm.
   5) Valve failed to close alarm.

t. Filter Waste Valves:
   1) HOA switch in Auto.
   2) Open position.
   3) Closed position.
   4) Valve failed to open alarm.
   5) Valve failed to close alarm.

u. Backwash Supply Valves:
   1) HOA switch in Auto.
   2) Open position.
   3) Closed position.
   4) Valve failed to open alarm.
   5) Valve failed to close alarm.

v. Backwash Waste Valves:
   1) HOA switch in Auto.
   2) Open position.
   3) Closed position.
   4) Valve failed to open alarm.
   5) Valve failed to close alarm.

3. Filter Air Scour Blower:
   a. HOA in Auto.
   b. Auto/Manual Station in Auto.
   c. Running.
   d. Failure.
   e. Speed feedback.
   f. VFD parameters as described above in the general requirements paragraph.
4. Air Scour temperature signal.
5. Air scour high temperature alarm.
6. Air scour pressure signal.
7. Air scour pressure high alarm.
8. Filter Air Vent Valve:
   a. HOA switch in Auto.
   b. Open position.
   c. Closed position.
   d. Valve failed to open alarm.
   e. Valve failed to close alarm.
9. Instrument Air:
   a. Compressor fault.
   b. Pressure signal.
   c. Pressure low alarm.

B. Operator entries and setpoints:
   1. PLC/HMI settings are listed in table below:

| DESCRIPTION | INITIAL SET POINT | ALLOWABLE ADJUSTMENT RANGE |
|---|---|---|
| Filter flow rate setpoint | 465 GPM | 325 – 1,625 GPM |
| BW Waste Valve (BFV-46x1) fail to open timer | 60 Sec | 15 – 60 Sec |

| DESCRIPTION | INITIAL SET POINT | ALLOWABLE ADJUSTMENT RANGE |
|---|---|---|
| BW Waste Valve (BFV-46x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| Influent Valve (BFV-40x1) fail to open timer | 60 Sec | 15 – 60 Sec |
| Influent Valve (BFV-40x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| BW Air Valve (BFV-41x1) fail to open timer | 60 Sec | 15 – 60 Sec |
| BW Air Valve (BFV-41x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| BW Supply Valve (BFV-44x1) fail to open timer | 60 Sec | 15 – 60 Sec |
| BW Supply Valve (BFV-44x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| Filter Flow Control Valve (BFV-42x1) fail to open timer | 60 Sec | 15 – 60 Sec |
| Filter Flow Control Valve (BFV-42x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| FTW Valve (BFV-43x1) fail to open timer | 60 Sec | 15 – 60 Sec |
| FTW Valve (BFV-43x1) fail to close timer | 60 Sec | 15 – 60 Sec |
| FTW Vent Valve (SV-41x1) open timer | 2 Min | 1-5 Min |
| Filter high head loss alarm (pre-backwash initiation SP) | 75 INWC | 72 – 96 INWC |
| Filter high-high head loss alarm – initiates Auto backwash | 78 INWC for 20 Secs | 72 – 96 INWC for 10 – 60 Secs |
| High effluent turbidity – initiates Auto backwash | 0.20 NTU for 20 Secs | 0.15 – 0.30 NTU for 10 – 60 Secs |
| High-high effluent turbidity-automatically places filter offline | 0.25 NTU for 15 Mins | 0.20-0.50 NTU for 1-30 Mins |
| Time between filter backwashes | 72 Hrs | 48 – 72 Hrs |
| FTW Mode timer | 15 Mins | 0 – 30 Mins |
| Turbidity at which filter transitions from FTW to FE mode | 0.10 NTU for 10 Secs | 0.10 – 0.30 NTU for 10 – 60 Secs |
| Backwash: initial filter drain down level prior to air scour (closes FE valve and opens FTW valve) | 7 FT | 2-11 FT |
| Backwash: final filter drain down level prior to air scour (closes FTW valve and opens BWW valve) | 3 FT | 2-7 FT |
| Backwash: Filter drain down level prior to air scour | 3 FT | 2 – 11 FT |
| Backwash: air scour time | 2 Mins | 0 – 10 Mins |
| Backwash: simultaneous air scour and low water rate backwash timer | 7 Mins | 0 – 15 Mins |
| Backwash: air scour air flow rate | TBD CFM | TBD-TBD CFM |
| Backwash: low water flow rate | TBD GPM | TBD – TBD GPM |
| Backwash: high water flow rate | 4,875 GPM | 4,875 – 7,150 GPM |
| Backwash: high water backwash ramp up timer | 2 Mins | 1 – 5 Mins |
| Backwash: ramp down time from high to minimum backwash flow rate (for proper media re-stratification) | 2 Min | 1 – 5 Min |
| Backwash: minimum water flow rate | 1,625 GPM | 950 – 7,500 GPM |

| DESCRIPTION | INITIAL SET POINT | ALLOWABLE ADJUSTMENT RANGE |
|---|---|---|
| Filter box volume | 29,200 Gallons | 1,600 – 32,000 Gallons |
| Filter high level alarm | 20.5 FT | 18 – 22 FT |
| Filter high-high level alarm | 21.5 FT | 18 – 22 FT |
| Filter low level alarm | 7 FT | 6 – 8 FT |
| Filter low-low level alarm | 6 FT | 6 – 8 FT |
| Filter high flow alarm | 5.10 GPM/FT2 | 4.928 – 5.10 GPM/FT2 |
| "Longer than normal" time to be off-line | 14 days | 7-30 days |

## D.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Total volume of water filtered.
   2. Average filtration rate (gpm/sf).
   3. Unit filter run volume.
   4. Average individual filter effluent turbidity

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX D**

# APPENDIX E
## BACKWASH WASTE BASINS
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Backwash Waste Basins

### E.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y613, Backwash Waste Basins

### E.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Decanters: DEC-4701, DEC-4702
   2. Decanter mud valves: MV-4701, MV-4702
   3. Decanter butterfly valves: BFV-4701, BFV-4702

B. Major Field Instruments:
   1. Decanter level transmitters: LE/LIT-4701, LE/LIT-4702
   2. Drain flowmeter: FE/FIT-4703

### E.3 OVERVIEW DESCRIPTION

A. The backwash waste basins are used as an equalization and settling tank for backwash waste and filter to waste flows.

B. The floating decanter will passively overflow water from the basin water surface. The decanter will not completely empty the basin, at which point the electric actuated mud valves will be used to drain the basin completely.

### E.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. The valves may be locally controlled from the associated valve actuator:
      a. Local/Off/Remote selector switch.
      b. Open, Stop, and Close pushbuttons.

B. PLC-based Process Monitoring and Control:
   1. Operators will manually adjust the inlet valves to the Backwash Waste Basin to select which basin they would like to have in service.
   2. LE/LIT-4701 will monitor the level in backwash waste basin 1 and have an adjustable set point that will call PV-4701 to open.
      a. This elevation will initially be set above the maximum water surface elevation in the tank when no flow is going through DEC-4701, approximately 5 FT.
   3. LE/LIT-4702 will monitor the level in backwash waste basin 2 and have an adjustable set point that will call PV-4702 to open.
      a. This elevation will initially be set above the maximum water surface elevation in the tank when no flow is going through DEC-4702, approximately 5 FT.
   4. LE/LIT-4701 will have an adjustable set point to identify when the basin has been drained by DEC-4701 and will then call MV-4701 to open and drain the settled solids out of the basin.
   5. LE/LIT-4702 will have an adjustable set point to identify when the basin has been drained by DEC-4702 and will then call MV-4702 to open and drain the settled solids out of the basin.

### E.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:

1. For each basin:
    a. In Service / Out of Service
2. For each valve:
    a. Local/Remote status.
    b. Open.
    c. Closed.
3. Flowmeter:
    a. Flow rate.
    b. Totalized flow.

B. Operator entries and setpoints:
    1. Basin In Service / Out of Service selection.

## E.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
    1. Daily totalized flow.

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX E**

# APPENDIX F
## OZONE GENERATION, FEED, AND INJECTION SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Ozone Generation, Feed, and Injection System

### F.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
1. 000Y614, LOX Storage and Vaporizers
2. 000Y615, Ozone Generation System
3. 000Y616, Ozone Cooling Water System
4. 000Y617, Ozone Off Gas Treatment System

### F.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
1. Master Ozone Control Panel (MOCP): MOCP-2000
2. Switching Manifold Control Panel: CP-2100
3. LOX Tank: T-2101
4. Vaporizer Isolation Motorized Ball Valves: BV-2111, BV-2121
5. GOX Motorized Ball Valves: BV-2201, BV-2411, BV-2421
6. GOX Filters: LT-2201, LT-2202
7. GOX Pressure Reducing Valves: PRV-2202, PRV-2203
8. Nitrogen Boost System (if necessary): NBS-2301
9. Nitrogen Control Panel (if necessary): CP-2301
10. Nitrogen Air Compressor (if necessary): AC-2301
11. Ozone Generator Control Panel: CP-2410, CP-2420
12. Ozone Generator: GEN-2410, GEN-2420
13. Ozone Motorized Ball Valves: BV-2413, BV-2423, BV-2418, BV-2417, BV-2428, BV-2427
14. Ozone Backflow Preventer: BFP-2416, BFP-2426
15. Cold Water Return Ball Valve: BV-2510, BV-2511
16. Chiller Control Panel: CP-2510, CP-2511
17. Chiller: CHL-2510, CHL-2511
18. Ozone Gas Motorized Butterfly Valves: BFV-2611, BFV-2621
19. Ozone Destruct Control Panel: CP-2610, CP-2620
20. Ozone Destruct: OZD-2610, OZD-2620

B. Major Field Instruments:
1. LOX Pressure: PI/PIT-2101
2. LOX Level: LI/LIT-2101
3. LOX Level Switch: LS-2101
4. GOX Temperature Switch Low: TSL-2111, TSL-2121
5. GOX Temperature Transmitter: TE/TIT-2201
6. GOX Pressure Transmitter: PIT-2201, PIT-2203
7. GOX Filter Differential Pressure Transmitter: DPIT-2202
8. GOX Dewpoint Analyzer: AE/AIT-2203
9. Cold Water Supply Pressure Transmitter: PIT-2410, PIT-2411
10. Ambient Ozone Analyzer: AE/AIT-2401, AE/AIT-2402
11. Master Ozone Control Panel E-Stop: HS-2401
12. Ozone Analyzer: AE/AIT-2400, AE/AIT-2600, AE/AIT-2601
13. Ozone Gas Pressure Transmitter: PIT-2600

## F.3 OVERVIEW DESCRIPTION

A. Generates and doses ozone based on flow, see Specification 46 31 54 for further description.

## F.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks.
   1. Alarms and interlocks shall be provided to ensure proper operation of the ozone generation equipment and its sequenced shutdown based on potentially unsafe or improper conditions that may exist.
   2. The following section lists the minimum amount of alarm conditions and interlocks that will be monitored by the Local Control Panels and the Ozone System Master Control Panel.
      a. Local Ozone Control System
         1) High cooling water temperature alarm
         2) Low cooling water flow alarm
         3) High inlet gas pressure alarm
         4) Low inlet gas flow alarm
         5) Backflow protection device triggered alarm
         6) Power supply status alarm
         7) Power supply communication error alarm
         8) External Modbus communication error alarm
      b. Ozone System Master Control Panel
         1) General warning alarm
         2) Emergency stop status
         3) High dew point in inlet oxygen gas line to generator
         4) High and Low Dissolved Ozone Residual for each Ozone Treatment Train
         5) Low ambient oxygen system shut-down alarm
         6) High ambient oxygen system shut-down alarm
         7) High ambient ozone system shut-down alarm
         8) Ambient ozone monitor alarm
      c. Compressed Air System
         1) Air compressor general fault
      d. Cooling Water System
         1) Cooling systems major fault
         2) High water temperature
         3) Low water pressure
         4) No / low cooling water flow
         5) Pump fail to start
         6) Major equipment component failure such as no/low cooling water flow, pump failure or other condition that could damage the gas feed, ozone equipment or result in treatment non-compliance shall initiate ozone generator unit shutdown.
      e. Ozone Destruct System
         1) Inlet temperature monitor signal fault alarm
         2) Outlet temperature monitor signal fault alarm
         3) Fan VFD fault alarm
         4) Fan run status
         5) Fan VFD communication error alarm
         6) Heater run status
         7) Heater high-temperature limit alarm
         8) Main circuit breaker tripped alarm
         9) Flow or pressure monitor signal fault alarm

B. PLC-based Process Monitoring and Control:
   1. MOCP Manual:
      a. If Local and Manual modes of control are selected, control is from the OIT mounted on the MOCP.

b. The operator can control components of the Ozone Generation System (valves, pumps, etc.) on an individual basis from the OIT.
c. This mode of operation is used for troubleshooting purposes.

2. MOCP Automatic:
   a. If Local and Automatic modes of control are selected, the operator can only start/stop the Ozone Generation System and enter setpoints from the OIT mounted on the MOCP.
      1) Operator enters the desired Applied Ozone dosage rate on the OIT mounted on MOCP.
      2) Then the MOCP's PLC starts and stops the Ozone Generation System in a pre-defined sequence, continuously controls and monitors the availability of all dependent subsystems to ensure that the Ozone Generation System as a whole can continue operation, and monitors and displays all alarms for both advisory purposes and shutdown.
3. SCADA Automatic:
   a. If Remote and Automatic modes of control are selected, the operator can start/stop the entire Ozone Generator System from SCADA. In the mode, the MOCP PLC shall accept the following from the Plant SCADA HMI:
      1) Master start/stop command for Ozone Generation
      2) System.
      3) All operator-entered setpoints.
      4) Then the MOCP PLC controls the entire Ozone Generation System as described for MOCP Automatic mode.
4. SCADA Manual:
   a. Manual mode is not permitted via SCADA system.
5. MOCP Automatic or SCADA Automatic modes of control shall be the preferred operation.
6. All signals and data required by the Ozone System MOCP from systems outside of the MOCP control shall be provided. This shall include, at a minimum:
   a. Operational permissive from MASTER SCADA SYSTEM
   b. LOX switching manifold status (CP-2100).
   c. Vaporizer isolating ball valves statuses (BV-2111 and BV-2121).
   d. Raw water flowrate from FCV-1501 and FCV-1502 (FI-1501 and FI-1502).

## F.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. All indications and alarms on the MOCP shall be duplicated on the MASTER SCADA SYSTEM.

B. Operator entries and setpoints:
   1. All entries and setpoints on the MOCP shall be duplicated on the MASTER SCADA SYSTEM.

## F.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. LOX Tank Storage Daily Volume.
   2. LOX Tank Daily Usage.
   3. LOX Tank Pressure summary low, average, high pressure.
   4. Vaporizer run time for each unit.
   5. LOX Filter differential pressure daily.
   6. Dewpoint daily report.
   7. Nitrogen Boost System run time (if required).
   8. Master Ozone Control Panel Error report.
   9. Ambient Ozone detection.
   10. Ozone Generator run time.
   11. Ozone Generator daily production.

12. Ozone production concentration.
13. Ozone Generator other parameters recommended by Supplier.
14. Chiller run time.
15. Ozone Gas pressure report.
16. Ozone Gas concentration at inlet and outlet.

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX F**

# APPENDIX G
## CALCIUM THIOSULFATE SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Calcium Thiosulfate System

### G.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y603, Rapid Mix
   2. 000Y618, Calcium Thiosulfate 1
   3. 000Y619, Calcium Thiosulfate 2
   4. 000Y627, Clearwell

### G.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. CTH feed pump to raw water: P-7611, P-7612
   2. CTH feed pump to backwash: P-7621, P-7622
   3. CTH storage tank: T-7601
   4. Chemical injection quills: IQ-3001, IQ-5411

B. Major Field Instruments:
   1. Drum scale: WE/WIT-7601

### G.3 OVERVIEW DESCRIPTION

A. Calcium thiosulfate is used to consume any remaining ozone prior to ballasted flocculation and consume free chlorine in finished water used for backwashing filters.

### G.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Local feeder control is provided via the Pump Control Panel and Start/Stop pushbuttons located on the face of the Pump Control Panel.
   2. When the pump is in Local, the pump is controlled (start, stop and speed adjustment) using the Start/Stop pushbuttons and speed control dial furnished with the pump control panel.
   3. When the pump is in Off, the pump does not run.
   4. When the pump is in Remote, control is by the PLC in accordance with selections made by the Operator at any Operator Workstation or OIT.
   5. When a pump tubing leak detector is activated, an alarm will be generated at the HMI and the feeder will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.

B. PLC-based Process Monitoring and Control:
   1. General
      a. The remote-control mode must be locally selected at the feed pump control panel for remote (PLC) control to be enabled.
   2. Pump HMI Manual:
      a. In the HMI Manual mode, the Operator can manually:
         1) Start the pump.
         2) Stop the pump.
         3) Adjust pump feed rate.
   3. Pump HMI Automatic:
      a. Dose Control Mode for P-7611/7612:

1) In this mode of operation, the pump will automatically run whenever FE/FIT-1001 indicates positive flow.
2) Feed rate is automatically adjusted based on the dissolved ozone remaining post contact piping, measured by AE/AIT 3002.
3) Adjustable dosage, chemical percentage, chemical specific gravity, and pump capacity shall be provided at the HMI.
4) Calculated feed rate (ml/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.

b. Once positive flow is confirmed to the treatment plant, the feed rate for pumps P-7611/7612 should be automatically controlled using the following equation:

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{\frac{mg}{L}} \times \frac{mg}{L} DO_3 \times Flow_{MGD}}{1{,}440 \times Chem_{PCT} \times Chem_{SG}}$$

c. Pump rate percent is calculated using the following equation:

$$Pump\ Rate\ \% = \frac{Pump\ Feed\ Rate\ \frac{mL}{min}}{Pump\ Capacity\ \frac{mL}{min}}$$

d. Dose Control Mode for P-7621/7622:
1) In this mode of operation, the pump will automatically run whenever FE/FIT 5411 indicates positive flow.
2) Feed rate is automatically adjusted based on the free chlorine concentration in the finished water measured by AE/AIT 5201.
3) Adjustable dosage should be provided at the HMI. Chemical percentage and specific gravity parameters will be the same as P-7611/7612.
4) Calculated feed rate (ml/min and gal/hr) and percent of pump capacity shall be displayed by the HMI.

e. Once positive flow is confirmed to the backwash piping, the feed rate for pumps P-7621/7622 should be automatically controlled using the following equation.

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{mg/L} \times \frac{mg}{L} Free\ CL_2 \times Flow_{MGD}}{1{,}440 \times Chem_{PCT} \times Chem_{SG}}$$

f. Pump rate percent is calculated using the following equation:

$$Pump\ Rate\ \% = \frac{Pump\ Feed\ Rate\ \frac{mL}{min}}{Pump\ Capacity\ \frac{mL}{min}}$$

C. Software Interlocks
1. Pump: If the Tank weight/level low-low alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the Tank low-low level alarm is active.

## G.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
1. Drum scale:
a. Current weight.
b. Daily change in weight.
c. Low and low-low level.

2. For each pump:
    a. Run status.
    b. In remote.
    c. Pump speed feedback signal.
    d. Pump flow rate, calculated.
    e. Fault.
    f. Meter tube failure.
3. Emergency shower activated alarm.

B. Operator entries and setpoints:
1. For each pump:
    a. Lead/Off/Standby select.
    b. Manual/Auto mode selection.
    c. Manual start/stop select.
    d. Manual speed entry.
2. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Tank low level alarm | No | Yes | Yes | No | 65 LB | N/A |
| Tank low-low level alarm | Yes | Yes | Yes | No | 35 LB | N/A |
| Tank Full Weight | No | No | Yes | No | 588 LB | N/A |
| Pump Capacity | No | No | No | No | TBD mL/min | N/A |
| Chemical Solution PCT. | No | No | No | No | 20 % | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.235 | N/A |
| Dosage ($DO_3$) | No | No | No | No | 0.79 mg/L | 0 - 2 mg/L |
| Dosage ($Cl_2$) | No | No | No | No | 1.0 mg/L | 0 – 2 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |

## G.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
1. Average CTH DO3 pump rate %.
2. Average CTH DO3 dosage (mg/L).
3. Average CTH Cl2 pump rate %.
4. Average CTH Cl2 dosage (mg/L).
5. Last tank level reading (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX G**

# APPENDIX H
## ALUM SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Alum System

### H.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y603, Rapid Mix
   2. 000Y620, Alum System

### H.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Alum Storage Tank: T-7101, T-7102
   2. Alum Feed Pumps: P-7111, P-7121
   3. Alum Fill Station Control Panel: LCP-7101
   4. Chemical Injection Quill: IQ-1001

B. Major Field Instruments:
   1. Alum Storage Tank Level Transmitter: LT-7101, LT-7102
   2. Alum Secondary Containment Level Switch: LSH-7141

### H.3 OVERVIEW DESCRIPTION

A. Alum is the coagulant used for the settling process and is added to the raw water prior to the coagulation tank.

B. Dosage of alum is based on bench testing of raw water sample and optimizing settled water turbidity.

### H.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Alum Feed Pumps:
      a. Local control is provided via the pump control panel integral to each feed pump, and Start/Stop pushbuttons and speed rate dial/buttons located on the face of the pump control panel.
      b. When the pump is in Local, the pump is controlled (start, stop and feed rate) using the Start/Stop and feed adjuster (dial/buttons) furnished with the control panel.
      c. When the pump is in Off, the pump does not run.
      d. When the pump is in remote, control is by the PLC in accordance with the selections made by the Operator at any Operator Workstation or OIT.
   2. Fill Station Control Panel:
      a. The tank level signal is displayed at the fill station control panel.
         1) The signal is retransmitted to the Plant Control System for monitoring.
         2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

B. PLC-based Process Monitoring and Control:
   1. General:
      a. The remote control mode must be locally selected at the pump control panel for remote (PLC) control to be enabled.
   2. Feed Pumps:
      a. When the Remote mode is selected at the pump control panel, the pump is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.

1) HMI Manual:
   a) In the HMI Manual Mode, the Operator can manually:
      (1) Start the pump.
      (2) Stop the pump.
      (3) Adjust the pump feed rate.
2) HMI Automatic:
   a) Pump Dose Control Mode:
      (1) In this mode of operation, the pump will automatically run whenever FE/FIT 1001 indicates positive flow.
      (2) Feed rate of pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.
      (3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

      (4) Pump rate percent is calculated using the following equation:

$$Pump\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

   b) Chemical Volume:
      (1) Chemical volume in T-7101 in gallons is based on LT-7101 measurement. An adjustable volume per unit height (GAL/IN) setpoint shall be provide at the HMI. The volume is calculated by the following equation:

$$Volume_{T-7101} GAL = LT_{7101}\ IN\ \times T - 7101 \frac{GAL}{IN}$$

3. Software Interlocks:
   a. Pump: If the Alum Tank low-low level alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the tank low-low level alarm is activated.
4. Hardwired Interlocks:
   a. When the pump tube leak detector is activated, an alarm will be generated at the HMI and the pump will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.

## H.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Storage tank:
      a. Tank level signal.
      b. Tank volume.
      c. Tank high and high-high level alarms.
      d. Tank low and low-low level alarms.
   2. For each pump:
      a. Run status.
      b. In remote.
      c. Pump speed feedback signal.
      d. Pump flow rate, calculated.

e. Fault.
f. Meter tube failure.

3. Emergency shower activated alarm.
4. Containment sump high level alarm.

B. Operator entries and setpoints:
1. For each pump:
a. Lead/Off/Standby select.
b. Manual/Auto mode selection.
c. Manual start/stop select.
d. Manual speed entry.
2. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Chemical Volume | No | No | Yes | No | 48 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 12 IN | N/A |
| Tank low-low level alarm | Yes | Yes | No | No | 6 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 120 IN | N/A |
| Tank high-high alarm | No | Yes | No | No | 128 IN | N/A |
| Tank Capacity | No | No | No | No | 6,100 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/MIN | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.330 | N/A |
| Chemical Dosage | No | No | No | No | 20.0 mg/L | 0 – 50 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |

## H.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
1. Average Alum pump rate %.
2. Average Alum dose, (mg/L).
3. Last tank level reading, (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX H**

# APPENDIX I
## CAUSTIC SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Caustic System

### I.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y603, Rapid Mix
   2. 000Y621, Caustic System

### I.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Caustic Storage Tank: T-7501
   2. Caustic Feed Pumps: P-7511, P-7512, P-7513
   3. Caustic Fill Station Control Panel: LCP-7501
   4. Chemical Injection Quill: IQ-3002

B. Major Field Instruments:
   1. Caustic Storage Tank Level Transmitter: LT-7501

### I.3 OVERVIEW DESCRIPTION

A. Caustic soda, aka sodium hydroxide, is used to aid in ballasted flocculation performance prior to filters and adjusting pH of finished water for corrosion control.

B. Dosage of caustic for ozonated water is based on lab testing.

C. Dosage of caustic for intermediate pump station is based on pH sensor reading, AIT-5001.

### I.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Caustic Feed Pumps:
      a. Local control is provided via the pump control panel integral to each feed pump, and Start/Stop pushbuttons and speed rate dial/buttons located on the face of the pump control panel.
      b. When the pump is in Local, the pump is controlled (start, stop and feed rate) using the Start/Stop and feed adjuster (dial/buttons) furnished with the control panel.
      c. When the pump is in Off, the pump does not run.
      d. When the pump is in remote, control is by the PLC in accordance with the selections made by the Operator at any Operator Workstation or OIT.
   2. Fill Station Control Panel:
      a. The tank level signal is displayed at the fill station control panel.
         1) The signal is retransmitted to the Plant Control System for monitoring.
         2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

B. PLC-based Process Monitoring and Control:
   1. General:
      a. The remote control mode must be locally selected at the pump control panel for remote (PLC) control to be enabled.
   2. Feed Pumps:
      a. When the Remote mode is selected at the pump control panel, the pump is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.

1) HMI Manual:
   a) In the HMI Manual Mode, the Operator can manually:
      (1) Start the pump.
      (2) Stop the pump.
      (3) Adjust the pump feed rate.
2) HMI Automatic:
   a) OW Dose Control Mode
      (1) In this mode of operation, the pump will automatically run whenever FE/FIT 1001 indicates positive flow.
      (2) Feed rate of pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.
      (3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump_{OW}\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage\ OW_{\frac{mg}{L}} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

      (4) Pump rate percent is calculated using the following equation:

$$Pump_{OW}\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

   b) IPS Dose Control Mode:
      (1) In this mode of operation, the pump will automatically run whenever FE/FIT 5001 indicates positive flow.
      (2) Feed rate of pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.
      (3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump_{IPS}\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage\ IPS_{mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

      (4) Pump rate percent is calculated using the following equation:

$$Pump_{IPS}\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

   c) Chemical Volume:
      (1) Chemical volume in T-7501 in gallons is based on LT-7501 measurement. An adjustable volume per unit height (GAL/IN) setpoint shall be provide at the HMI. The volume is calculated by the following equation:

$$Volume_{T-7501} GAL = LT_{7501}\ IN\ \times T - 7501 \frac{GAL}{IN}$$

3. Software Interlocks:
   a. Pump:
      1) If the Caustic Tank low-low level alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the tank low-low level alarm is activated.
4. Hardwired Interlocks:
   a. When the pump tube leak detector is activated, an alarm will be generated at the HMI and the pump will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.

## 1.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Storage tank:
      a. Tank level signal.
      b. Tank volume.
      c. Tank high and high-high level alarms.
      d. Tank low and low-low level alarms.
   2. For each pump:
      a. Run status.
      b. In remote.
      c. Pump speed feedback signal.
      d. Pump flow rate, calculated.
      e. Fault.
      f. Meter tube failure.
   3. Emergency shower activated alarm.

B. Operator entries and setpoints:
   1. For each pump:
      a. Lead/Off/Standby select.
      b. Manual/Auto mode selection.
      c. Manual start/stop select.
      d. Manual speed entry.
   2. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Chemical Volume | No | No | Yes | No | 16.1 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 12 IN | N/A |
| Tank low-low level alarm | Yes | Yes | Yes | No | 6 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 55 IN | N/A |
| Tank high-high alarm | No | Yes | Yes | No | 60 IN | N/A |
| Tank Capacity | No | No | No | No | 1,000 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/MIN | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.278 | N/A |
| Chemical Dosage OW | No | No | No | No | 7.0 mg/L | 0 – 20 mg/L |
| Chemical Dosage IPS | No | No | No | No | 7.0 mg/L | 0 – 20 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |

## 1.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:

1. Average Caustic OW pump rate %.
2. Average Caustic OW dose, (mg/L).
3. Average Caustic IPS pump rate %.
4. Average Caustic IPS dose, (mg/L).
5. Last tank level reading, (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX I**

# APPENDIX J
## SETTLING AID POLYMER SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Settling Aid Polymer System

### J.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y604, Ballasted Sedimentation Train 1
   2. 000Y605, Ballasted Sedimentation Train 2
   3. 000Y622, Settling Aid Polymer System

### J.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Settling Aid Polymer Storage Tank: T-7201
   2. Settling Aid Polymer Tank Mixer: MX-7201
   3. Settling Aid Polymer Tank Mixer Control Panel: LCP-7201
   4. Settling Aid Polymer Blending Unit: PBU-7211
   5. Settling Aid Polymer Fill Station Control Panel: LCP-7202
   6. Chemical Injection Quills: IQ-3210, IQ-3220

B. Major Field Instruments:
   1. Polymer Storage Tank Level Transmitter: LT-7201
   2. Polymer Secondary Containment Sump Level Switch: LSH-7200

### J.3 OVERVIEW DESCRIPTION

A. Polymer typically comes in an emulsion and will separate out with time. A mixer (MX-7201) is utilized to keep the polymer emulsion consistent. Over-shearing of the polymer can reduce the effectiveness during the flocculation process which is why the mixer is only operated for short periods at a time.

B. Polymers are long chained molecules that are encapsulated in emulsion droplets for transport and storage. A polymer-mixing unit is utilized to unwind the molecules with the proper dilution ratio and provide the necessary mixing energy to disperse them evenly in the dilution water.

C. Typical primary concentrations of the dilution is 0.25-0.50% polymer to water. This can be set locally on the mixing unit's control panel and the based on the flow rate of the primary dilution water, the polymer pump rate is adjusted automatically by the local controller. Otherwise, a remote signal can adjust the polymer feed pump's rate and the dilution water will be constant.

D. Primary dilution water control is adjusted by an operator with a needle or gate valve on mixing unit. Secondary dilution water is added to the primary dilution water to increase the velocity of the mixture and decrease the viscosity even more since 0.25% polymer is still extremely viscous.

E. If primary dilution water is lost, the whole unit trips to prevent the excess feed of polymer. Excess feed of polymer will cause plugging issues in the polymer-mixing unit and may prevent the restart of mixing when water flow is restarted.

### J.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Polymer Mixer:
      a. Local control of the mixer is via the mixer local control panel.
      b. When the control is in Local, the mixer is running.

c. When the control is in Remote, the mixer is controlled via the plant PLC.

2. Polymer Blending Unit:
   a. If the Primary Dilution water flow rate drops below a set flow rate for a set period of time, the mixing unit's control panel will close the solenoid valve, stop the polymer pump and activate the Loss of Dilution Water alarm.
   b. When the pump tube leak detector is activated, an alarm will be generated at the HMI and the pump will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.
3. Polymer Feed Pumps:
   a. Local control can be either from the mixing unit control panel if the pump is set to Remote or from the integral control panel directly on the pump.
   b. When the pump is in Local, the pump is controlled (start, stop and feed rate) using the Start/Stop and feed adjuster (dial/buttons) furnished with the pump control panel.
   c. When the pump is in Off, the pump does not run.
   d. When the pump is in remote, control is by the mixing unit control panel PLC in accordance with the selections made by the Operator on the control panel.
4. Fill Station Control Panel:
   a. The tank level signal is displayed at the fill station control panel.
      1) The signal is retransmitted to the Plant Control System for monitoring.
      2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

B. PLC-based Process Monitoring and Control:
1. General:
   a. The remote-control mode must be locally selected at the mixing unit control panel for remote (PLC) control to be enabled.
2. Polymer Mixer:
   a. When the Remote mode is selected on the mixer control panel, the mixer is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.
      1) HMI Manual:
         a) In the HMI Manual Mode, the Operator can manually:
            (1) Start the mixer
            (2) Stop the mixer
      2) HMI Automatic:
         a) Timed Mixing
            (1) Adjusted mixing-time and time-between-mixings set points shall be provided at the HMI.
3. Feed Pumps:
   a. When the Remote mode is selected at the pump control panel and the mixing unit's control panel is set to remote, the mixing unit / polymer pump is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.
      1) HMI Manual:
         a) In the HMI Manual Mode, the Operator can manually:
            (1) Start the mixing unit and pump.
            (2) Stop the mixing unit and pump.
            (3) Adjust the pump feed rate.
               (a) Concentration of the polymer solution changes since the dilution water is controlled manually.
      2) HMI Automatic:
         a) Dose Control Mode:
            (1) In this mode of operation, the pump will automatically run whenever FE/FIT-1001 indicates positive flow.

(2) Feed rate of polymer pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.

(3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{\ mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

(4) Pump rate percent is calculated using the following equation:

$$Pump_{OW}\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

b) Chemical Volume:

(1) Chemical volume in T-7201 in gallons is based on LT/LIT-7201 measurement. An adjustable volume per unit height (GAL/IN) setpoint shall be provide at the HMI. The volume is calculated by the following equation:

$$Volume_{T-7201} GAL = LT_{7201}\ IN\ \times T - 7201 \frac{GAL}{IN}$$

4. Software Interlocks:
   a. Polymer Blending Unit:
      1) If the Settling Aid Polymer Tank low-low level alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the tank low-low level alarm is activated.

## J.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Storage tank:
      a. Tank level signal.
      b. Tank volume.
      c. Tank high and high-high level alarms.
      d. Tank low and low-low level alarms.
   2. Tank mixer;
      a. Local/Remote status.
      b. Auto/Manual status.
      c. Running status.
      d. Fault.
      e. Fail to start alarm.
      f. Fail to stop alarm.
      g. Repeat cycle time count down timers
   3. Blending unit:
      a. Local/Remote status.
      b. Auto/Manual status.
      c. Running status.
      d. Fault.
      e. Loss of dilution water alarm.

f. Speed command.
g. Fail to start alarm.
h. Fail to stop alarm.

4. Containment sump high level alarm.

B. Operator entries and setpoints:

1. Tank mixer:
   a. Manual/Auto mode selection.
   b. Manual start/stop select.
   c. Mixing repeat cycle time entries.
2. Blending unit:
   a. Manual/Auto mode selection.
   b. Manual start/stop select.
   c. Manual speed entry.
3. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Mixer Run Time (MX) | No | No | No | No | 15 MIN | N/A |
| Time Between Mixings (MX) | No | No | No | No | 6 HR | N/A |
| Chemical Volume | No | No | Yes | No | 7.8 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 28 IN | N/A |
| Tank low-low level alarm | Yes | Yes | No | No | 24 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 48 IN | N/A |
| Tank high-high alarm | No | Yes | No | No | 54 IN | N/A |
| Tank Capacity | No | No | No | No | 372 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/MIN | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.15 | N/A |
| Chemical Dosage | No | No | No | No | 1.2 mg/L | 0 – 5 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |
| Low dilution water flow | Yes | Yes | Yes | Yes | N/A | N/A |

## J.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:

1. Average Settling Aid Polymer pump rate %.
2. Average Settling Aid Polymer dose, (mg/L).
3. Last Settling Aid Polymer tank level reading, (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX J**

# APPENDIX K
## FILTER AID POLYMER SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Filter Aid Polymer System

### K.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y607, Filter 1
   2. 000Y623, Filter Aid Polymer System

### K.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Filter Aid Polymer Storage Tank: T-7301
   2. Filter Aid Polymer Tank Mixer: MX-7301
   3. Filter Aid Polymer Tank Mixer Control Panel: LCP-7301
   4. Filter Aid Polymer Blending Unit: PBU-7311
   5. Filter Aid Polymer Fill Station Control Panel: LCP-7302
   6. Chemical Injection Quill: IQ-4111

B. Major Field Instruments:
   1. Filter Aid Polymer Storage Tank Level Transmitter: LT-7301

### K.3 OVERVIEW DESCRIPTION

A. Polymer typically comes in an emulsion and will separate out with time. A mixer (MX-7301) is utilized to keep the polymer emulsion consistent. Over-shearing of the polymer can reduce the effectiveness during the flocculation process which is why the mixer is only operated for short periods at a time.

B. Polymers are long chained molecules that are encapsulated in emulsion droplets for transport and storage. A polymer-mixing unit is utilized to unwind the molecules with the proper dilution ratio and provide the necessary mixing energy to disperse them evenly in the dilution water.

C. Typical primary concentrations of the dilution is 0.25-0.50% polymer to water. This can be set locally on the mixing unit's control panel and the based on the flow rate of the primary dilution water, the polymer pump rate is adjusted automatically by the local controller. Otherwise, a remote signal can adjust the polymer feed pump's rate and the dilution water will be constant.

D. Primary dilution water control is adjusted by an operator with a needle or gate valve on mixing unit. Secondary dilution water is added to the primary dilution water to increase the velocity of the mixture and decrease the viscosity even more since 0.25% polymer is still extremely viscous.

E. If primary dilution water is lost, the whole unit trips to prevent the excess feed of polymer. Excess feed of polymer will cause plugging issues in the polymer-mixing unit and may prevent the restart of mixing when water flow is restarted.

### K.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Polymer Mixer:
      a. Local control of the mixer is via the mixer local control panel.
      b. When the control is in Local, the mixer is running.

c. When the control is in Remote, the mixer is controlled via the plant PLC.

2. Polymer Blending Unit:
   a. If the Primary Dilution water flow rate drops below a set flow rate for a set period of time, the blending unit's control panel will close the solenoid valve, stop the polymer pump and activate the Loss of Dilution Water alarm.
   b. When the pump tube leak detector is activated, an alarm will be generated at the HMI and the pump will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.
3. Polymer Feed Pumps:
   a. Local control can be either from the blending unit control panel if the pump is set to Remote or from the integral control panel directly on the pump.
   b. When the pump is in Local, the pump is controlled (start, stop and feed rate) using the Start/Stop and feed adjuster (dial/buttons) furnished with the pump control panel.
   c. When the pump is in Off, the pump does not run.
   d. When the pump is in remote, control is by the blending unit control panel PLC in accordance with the selections made by the Operator on the control panel.
4. Fill Station Control Panel:
   a. The tank level signal is displayed at the fill station control panel.
      1) The signal is retransmitted to the Plant Control System for monitoring.
      2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

B. PLC-based Process Monitoring and Control:
1. General:
   a. The remote-control mode must be locally selected at the blending unit control panel for remote (PLC) control to be enabled.
2. Polymer Mixer:
   a. When the Remote mode is selected on the mixer control panel, the mixer is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.
      1) HMI Manual:
         a) In the HMI Manual Mode, the Operator can manually:
            (1) Start the mixer
            (2) Stop the mixer
      2) HMI Automatic:
         a) Timed Mixing:
            (1) Adjusted mixing-time and time-between-mixings set points shall be provided at the HMI.
3. Feed Pumps:
   a. When the Remote mode is selected at the pump control panel and the blending unit's control panel is set to remote, the blending unit / polymer pump is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.
      1) HMI Manual:
         a) In the HMI Manual Mode, the Operator can manually:
            (1) Start the blending unit and pump.
            (2) Stop the blending unit and pump.
            (3) Adjust the pump feed rate.
               (a) Concentration of the polymer solution changes since the dilution water is controlled manually.
      2) HMI Automatic:
         a) Dose Control Mode:
            (1) In this mode of operation, the pump will automatically run whenever FE/FIT-1001 indicates positive flow.

(2) Feed rate of polymer pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.

(3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{\ mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

(4) Pump rate percent is calculated using the following equation:

$$Pump_{OW}\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

b) Chemical Volume:

(1) Chemical volume in T-7301 in gallons is based on LT/LIT-7301 measurement. An adjustable volume per unit height (GAL/IN) setpoint shall be provide at the HMI. The volume is calculated by the following equation:

$$Volume_{T-7301} GAL = LT_{7301}\ IN\ \times T - 7301 \frac{GAL}{IN}$$

4. Software Interlocks:
   a. Polymer Blending Unit:
      1) If the Filter Aid Polymer Tank low-low level alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the tank low-low level alarm is activated.

## K.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Storage tank:
      a. Tank level signal.
      b. Tank volume.
      c. Tank high and high-high level alarms.
      d. Tank low and low-low level alarms.
   2. Tank mixer:
      a. Local/Remote status.
      b. Auto/Manual status.
      c. Running status.
      d. Fault.
      e. Fail to start alarm.
      f. Fail to stop alarm.
      g. Repeat cycle time count down timers
   3. Blending unit:
      a. Local/Remote status.
      b. Auto/Manual status.
      c. Running status.
      d. Fault.
      e. Loss of dilution water alarm.
      f. Speed command.

g. Fail to start alarm.
h. Fail to stop alarm.

4. Containment sump high level alarm.

B. Operator entries and setpoints:

1. Tank mixer:
   a. Manual/Auto mode selection.
   b. Manual start/stop select.
   c. Mixing repeat cycle time entries.
2. Blending unit:
   a. Manual/Auto mode selection.
   b. Manual start/stop select.
   c. Manual speed entry.
3. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Mixer Run Time (MX) | No | No | No | No | 15 MIN | N/A |
| Time Between Mixings (MX) | No | No | No | No | 6 HR | N/A |
| Chemical Volume | No | No | Yes | No | 3.5 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 8 IN | N/A |
| Tank low-low level alarm | Yes | Yes | No | No | 6 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 28 IN | N/A |
| Tank high-high alarm | No | Yes | No | No | 32 IN | N/A |
| Tank Capacity | No | No | No | No | 101 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/MIN | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.15 | N/A |
| Chemical Dosage | No | No | No | No | 0.5 mg/L | 0 – 5 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |
| Low dilution water flow | Yes | Yes | Yes | Yes | N/A | N/A |

## K.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:

1. Average Filter Aid Polymer pump rate %.
2. Average Filter Aid Polymer dose, (mg/L).
3. Last Filter Aid Polymer tank level reading, (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX K**

# APPENDIX L
## SODIUM HYPOCHLORITE SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Sodium Hypochlorite System

### L.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y624, Sodium Hypochlorite System
   2. 000Y626, Intermediate Pump Station
   3. 000Y627, Clearwell

### L.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Sodium Hypochlorite Storage Tank: T-7401
   2. Sodium Hypochlorite Feed Pumps: P-7411, P-7412, P-7413
   3. Sodium Hypochlorite Fill Station Control Panel: LCP-7401
   4. Chemical Injection Quills: IQ-5002, IQ-6001

B. Major Field Instruments:
   1. Sodium Hypochlorite Storage Tank Level Transmitter: LT-7401
   2. Sodium Hypochlorite Secondary Containment Level Switch: LSH-7431

### L.3 OVERVIEW DESCRIPTION

A. Sodium hypochlorite (bleach) is the primary disinfectant used for the finished water prior to distribution.

B. The strength of the chemical will degrade with time and automation of the feed system is important to maintain the proper level of free chlorine in the finished water.

C. Dosage of sodium hypochlorite is based on AE/AIT-5002 measurement of free chlorine.

D. If the free chlorine level is below set standards for distribution after the clear well, measured by AE/AIT-5201, the secondary injection at Crowson Pump Station can be used to increase the concentration prior to distribution.
   1. AE/AIT-5201 is also used to calculate CT ("Concentration X Time") for primary disinfection for the EPA SWTR regulation.

### L.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Local feeder control is provided via the Pump Control Panel and Start/Stop pushbuttons located on the face of the Pump Control Panel.
   2. When the pump is in Local, the pump is controlled (start, stop and speed adjustment) using the Start/Stop pushbuttons and speed control dial furnished with the pump control panel.
   3. When the pump is in Off, the pump does not run.
   4. When the pump is in Remote, control is by the PLC in accordance with selections made by the Operator at any Operator Workstation or OIT.
   5. When a pump tubing leak detector is activated, an alarm will be generated at the HMI and the feeder will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.
   6. Fill Station Control Panel:
      a. The tank level signal is displayed at the fill station control panel.
         1) The signal is retransmitted to the Plant Control System for monitoring.

2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

B. PLC-based Process Monitoring and Control:
1. General:
   a. The remote-control mode must be locally selected at the feed pump control panel for remote (PLC) control to be enabled.
2. Pump HMI Manual:
   a. In the HMI Manual mode, the Operator can manually:
      1) Start the pump.
      2) Stop the pump.
      3) Adjust pump feed rate.
3. Pump HMI Automatic:
   a. Dose Control Mode for pump feeding IPS (P-7411 or P-7412 as a spare):
      1) In this mode of operation, the pump will automatically run whenever FE/FEIT 5001 indicates positive flow.
      2) Feed rate is based on the set point entered at the HMI/OIT enter by the operator.
      3) Adjustable dosage, chemical percentage, chemical specific gravity, and pump capacity shall be provided at the HMI.
      4) Calculated feed rate (ml/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.
   b. Once positive flow is confirmed to the treatment plant, the feed rate for pump feeding the IPS should be automatically controlled using the following equation:

$$Pump\ Feed\ Rate_{IPS}\ \frac{mL}{min} = \frac{3{,}786 \times Dosage\ IPS_{\frac{mg}{L}} \times Flow_{MGD}}{1{,}440 \times Chem_{PCT} \times Chem_{SG}}$$

   c. Pump rate percent is calculated using the following equation:

$$Pump\ Rate_{IPS}\ \% = \frac{Pump\ Feed\ Rate\ \frac{mL}{min}}{Pump\ Capacity\ \frac{mL}{min}}$$

   d. Dose Control Mode for pumps feed CPS (P-7413 or P-7412 as a spare):
      1) In this mode of operation, the pump will automatically run whenever FE/FIT 5001 indicates positive flow and there is a minimum of 13 FEET of water in the clear well (LE/LI-5201).
      2) Feed rate is adjusted automatically based on the free chlorine concentration in the finished water measured by AE/AIT 5201.
      3) Adjustable dosage should be provided at the HMI. Chemical percentage and specific gravity parameters will be the same as the CPS pumps.
      4) Calculated feed rate (ml/min and gal/hr) and percent of pump capacity shall be displayed by the HMI.
   e. Once positive flow is confirmed to the plant and at least 13 FEET of water are in the clear well, the feed rate for CPS pumps should be automatically controlled using the following equation:

$$Pump\ Feed\ Rate_{CPS}\ \frac{mL}{min} = \frac{3{,}786 \times Dosage\ CPS_{mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{PCT} \times Chem_{SG}}$$

   f. Pump rate percent is calculated using the following equation:

$$Pump\ Rate_{CPS}\ \% = \frac{Pump\ Feed\ Rate\ \frac{mL}{min}}{Pump\ Capacity\ \frac{mL}{min}}$$

C. Software Interlocks:
   1. Pump: If the Sodium Hypochlorite tank level low-low alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the Tank low-low level alarm is active.

## L.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Storage tank:
      a. Tank level signal.
      b. Tank volume.
      c. Tank high and high-high level alarms.
      d. Tank low and low-low level alarms.
   2. For each pump:
      a. Run status.
      b. In remote.
      c. Pump speed feedback signal.
      d. Pump flow rate, calculated.
      e. Fault.
      f. Meter tube failure.
   3. Emergency shower activated alarm.
   4. Containment sump high level alarm.

B. Operator entries and setpoints:
   1. For each pump:
      a. Lead/Off/Standby select.
      b. Manual/Auto mode selection.
      c. Manual start/stop select.
      d. Manual speed entry.
   2. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Chemical Volume | No | No | Yes | No | 48 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 12 IN | N/A |
| Tank low-low level alarm | Yes | Yes | No | No | 6 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 120 IN | N/A |
| Tank high-high alarm | No | Yes | No | No | 128 IN | N/A |
| Tank Capacity | No | No | No | No | 6,100 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/min | N/A |
| Chemical Solution PCT. | No | No | No | No | 12.5 PCT | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.21 | N/A |
| Dosage (IPS) | No | No | No | No | 1.5 mg/L | 0 - 2 mg/L |
| Dosage (CPS) | No | No | No | No | 0.1 mg/L | 0 – 2 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |

## L.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Intermediate Pump Station:
      a. Average SHC pump rate %.
      b. Average SHC dosage (mg/L).
   2. Crowson Pump Station:
      a. Average SHC pump rate %.
      b. Average SHC dosage (mg/L).
   3. Last tank level reading (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX L**

# APPENDIX M
## SODIUM CARBONATE (LIQUID) SYSTEM
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Sodium Carbonate (Liquid) System

### M.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y602, Ozone Sidestream Injection System
   2. 000Y625, Sodium Carbonate (Liquid) System

### M.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Sodium Carbonate Storage Tank: T-7701
   2. Sodium Carbonate Feed Pumps: P-7711, P-7121
   3. Chemical Injection Quill: IQ-2400

B. Major Field Instruments:
   1. None.

### M.3 OVERVIEW DESCRIPTION

A. Sodium carbonate, aka soda ash, is used for alkalinity adjustment of the raw water stream.

B. Dosage of sodium carbonate is based on lab testing.

### M.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:

B. Sodium Carbonate Feed Pumps:
   a. Local control is provided via the pump control panel integral to each feed pump, and Start/Stop pushbuttons and speed rate dial/buttons located on the face of the pump control panel.
   b. When the pump is in Local, the pump is controlled (start, stop and feed rate) using the Start/Stop and feed adjuster (dial/buttons) furnished with the control panel.
   c. When the pump is in Off, the pump does not run.
   d. When the pump is in remote, control is by the PLC in accordance with the selections made by the Operator at any Operator Workstation or OIT.
   e. When the pump tube leak detector is activated, an alarm will be generated at the HMI and the pump will shut down regardless of mode of operation. A pump shall not be capable of starting if the alarm is active.

   2. Fill Station Control Panel:
      a. The tank level signal is displayed at the fill station control panel.
         1) The signal is retransmitted to the Plant Control System for monitoring.
         2) The fill station display will generate high and low tank level alarms for local display and for monitoring by the Plant Control System.

C. PLC-based Process Monitoring and Control:
   1. General:
      a. The remote-control mode must be locally selected at the pump control panel for remote (PLC) control to be enabled.
   2. Feed Pumps:
      a. When the Remote mode is selected at the pump control panel, the pump is controlled in accordance with the selections made by the Operator at any Operator Workstation/OIT.

1) HMI Manual:
   a) In the HMI Manual Mode, the Operator can manually:
      (1) Start the pump.
      (2) Stop the pump.
      (3) Adjust the pump feed rate.
2) HMI Automatic:
   a) Dose Control Mode
      (1) In this mode of operation, the pump will automatically run whenever FE/FIT 1001 indicates positive flow.
      (2) Feed rate of pump is automatically adjusted based on the associated flow signal and a chemical dosage set point (mg/L). Adjustable dosage, chemical specific gravity and pump capacity set points shall be provided at the HMI. The calculated feed rate (mL/min and gal/hr) and percent of pump capacity shall be displayed at the HMI.
      (3) Once the pump is confirmed running, the feed rate shall be automatically controlled using the following equation.

$$Pump\ Feed\ Rate\ \frac{mL}{min} = \frac{3{,}786 \times Dosage_{mg/L} \times Flow_{MGD}}{1{,}440 \times Chem_{SG}}$$

      (4) Pump rate percent is calculated using the following equation:

$$Pump\ Rate\ \% = \frac{Pump\ Feed\ Rate \frac{mL}{min}}{Pump\ Capcity\ \frac{mL}{min}}$$

   b) Chemical Volume:
      (1) Chemical volume in T-7701 in gallons is based on LT/LIT-7701 measurement. An adjustable volume per unit height (GAL/IN) setpoint shall be provide at the HMI. The volume is calculated by the following equation:

$$Volume_{T-7701} GAL = LT_{7701}\ IN\ \times T - 7701 \frac{GAL}{IN}$$

3. Software Interlocks:
   a. Pump:
      1) If the Sodium Carbonate Tank low-low level alarm is active, the Operator shall not be able to start a pump. All operating pumps shall shut down if the tank low-low level alarm is activated.

## M.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. For each pump:
      a. Run status.
      b. In remote.
      c. Pump speed feedback signal.
      d. Pump flow rate, calculated.
      e. Fault.
      f. Meter tube failure.
   2. Emergency shower activated alarm.
   3. Containment sump high level alarm.

B. Operator entries and setpoints:
   1. For each pump:

a. Lead/Off/Standby select.
b. Manual/Auto mode selection.
c. Manual start/stop select.
d. Manual speed entry.

2. PLC/HMI settings are listed in the table below:

| Description | Interlock | Warning | Local Indication | Status To PLC | Initial Set Point | Range |
|---|---|---|---|---|---|---|
| Chemical Volume | No | No | Yes | No | 48.0 GAL/IN | N/A |
| Tank low level alarm | No | Yes | Yes | No | 12 IN | N/A |
| Tank low-low level alarm | Yes | Yes | Yes | No | 6 IN | N/A |
| Tank high alarm | No | Yes | Yes | No | 120 IN | N/A |
| Tank high-high alarm | No | Yes | Yes | No | 128 IN | N/A |
| Tank Capacity | No | No | No | No | 6,100 GAL | N/A |
| Pump Capacity | No | No | No | No | TBD mL/MIN | N/A |
| Chemical Spec. Grav. | No | No | No | No | 1.192 | N/A |
| Chemical Dosage | No | No | No | No | 10 mg/L | 0 – 20 mg/L |
| Tube leak | Yes | Yes | Yes | Yes | N/A | N/A |

## M.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Average Sodium Carbonate pump rate %.
   2. Average Sodium Carbonate dose, (mg/L).
   3. Last tank level reading, (%).

B. Other reports as determined at the Report Configuration Workshop(s).

**END OF APPENDIX M**

# APPENDIX N
## INTERMEDIATE PUMP STATION AND CLEARWELL PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Intermediate Pump Station, Clearwell

### N.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y626, Intermediate Pump Station
   2. 000Y627, Clearwell

### N.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Intermediate Pumps: P-5011, P-5012, P-5013.
   2. Intermediate Pump VFD's: VFD-5011, VFD-5012, VFD-5013
   3. Clearwell Tank 1: T-5201

B. Major Field Instruments:
   1. Wet Well Level Transmitter: LE/LIT-5001
   2. Wet Well Low Level Switch: LSLL-5001
   3. Combined Effluent Turbidimeter: AE/AIT-5001
   4. Combined Effluent Chlorine Analyzer: AE/AIT-5002
   5. Combined Effluent pH Analyzer: AE/AIT-5003
   6. Potable Water Chlorine Analyzer: AE/AIT-5201
   7. Effluent Flowmeter: FE/FIT-5001
   8. Clearwell Tank 1 Level Transmitter: LE/LIT-5201
   9. Clearwell Tank 1 High Level Switch: LSH-5201
   10. Clearwell Tank 1 Hatch Limit Switch: ZSC-5201

### N.3 OVERVIEW DESCRIPTION

A. These pumps will be utilized to transfer water following filtration to the clearwell.

B. The clearwell is used to provide finished water storage and achieve disinfection.

### N.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Pumps may be manually controlled from the VFD. The operator may manually call the pumps to start and manually enter in the required operating speed.
      a. A local control station with a lockout stop pushbutton will inhibit the pump.
      b. A high motor temperature switch will inhibit the pump.
      c. The pump will shut down if operating and the high pressure switch is tripped.
      d. Pump VFD fault: A detected VFD fault deactivates the controls at the VFD and stops the pump.
      e. The pumps will be disabled upon a low low wetwell level condition as determined from the float switch LSLL-5001.

B. PLC-based Process Monitoring and Control:
   1. Pumps may be manually controlled via selections made at the VFD. When placed in the REMOTE control mode at the VFD, pumps are controlled by PLC control logic as follows:
      a. The three VFD driven Intermediate Pumps are controlled via operator input at the HMI. Pump control is in accordance with selections made at the HAND-OFF-AUTO

selector, AUTO-MANUAL speed controllers and LEAD-LAG1-LAG2 or STANDBY selector function.

b. A low level switch will be used to protect the pumps from operating on a low level condition.

2. When operating in an AUTOMATIC control mode, pump control is in accordance with level in the Wet Well and in accordance with an AUTO-MANUAL speed controller. AUTOMATIC operation is as follows:

a. PLC logic commands the LEAD pump to start when the tank level rises above a set level set point. Pump speed will ramp to a minimum set speed at start-up and gradually increase speed up to 100 PCT in accordance with the measured tank level as listed in schedule below. If the LEAD pump fails to operate (after a time delay, initially set at 10 SEC), then the LAG1 pump will be commanded to operate as the LEAD pump.

b. If the tank level rises above a higher set point (see schedule below) while the LEAD pump has been running at maximum speed for a set period of time, the LAG1 pump will be commanded to operate. The LEAD pump will slow down to minimum speed while the LAG1 pump starts. Once the LAG1 pump reaches minimum speed, both pumps will operate together at the same speed. Both pumps gradually increase speed up to 100 PCT in accordance with the measured tank level as listed in schedule below. If either one of the two operating pumps fails to operate (after a time delay, initially set at 10 SEC), then the LAG2 pump will be commanded to operate as the LAG1 pump.

c. If the tank level rises above a yet higher set point (see schedule below) while both the LEAD and LAG1 pumps have been running at maximum speed for a set period of time, the LAG2 pump will be commanded to operate. The LEAD and LAG1 pumps will slow down to minimum speed while the LAG2 pump starts. Once the LAG2 pump reaches minimum speed, all pumps will operate together at the same speed. All running pumps gradually increase speed up to 100 PCT in accordance with the measured tank level as listed in schedule below. If any of the three operating pumps fails to operate (after a time delay, initially set at 10 SEC), then the STANDBY pump will be commanded to operate as the LAG2 pump.

d. PLC logic utilizes a 1-minute time delay (adjustable) prior to commanding an additional booster pump to start following the start of the previous pump.

e. If the tank level drops below a set point with the LEAD, LAG1 and LAG2 pumps running at a minimum set speed for a set period of time (initially set at 15 SEC), the PLC commands the LAG2 pump to stop.

f. If the tank level drops below a set point with the LEAD and LAG1 pumps running at a minimum set speed for a set period of time (initially set at 15 SEC), the PLC commands the LAG1 pump to stop.

g. If the tank level drops below a set point with only the LEAD pump operating at a minimum speed for a set period of time (initially set at 15 SEC), the PLC commands the LEAD pump to stop.

h. Pump speed is to be controlled by an AUTO-MANUAL speed controller function and level control logic resident with PLC programming.

1) In MANUAL mode, the speed controller function provides a speed control signal to the pump per the operator's manual speed selection at the HMI.

2) In AUTO mode, the speed controller function modulates pump speed so as to minimize the number of pump starts and stops. It does this by modulating from a set minimum speed to maximum speed in accordance with the pump control schedule below. Pump speed will increase as tank level rises in order to preclude the need for another pump if possible. Pump speed will decrease as tank level drops in order to keep the pump running as long as possible and thus prevent numerous pump starts and stops.

3) Pump speed will ramp up at a controlled rate during pump start-up.

4) During a controlled pump shutdown, the pump speed will ramp down to minimum speed prior to pump turn-off.

3. Wet Well Level Control Schedule:

| Pump | Pump Control Action | Tank Level, FT** |
|---|---|---|
| LEAD Pump | 100 PCT Speed | TBD |
| | On at Minimum Speed*** | TBD |
| | Off | TBD |
| LAG1 Pump | 100 PCT Speed | TBD |
| | On at Minimum Speed*** | TBD |
| | Off | TBD |
| LAG2 Pump | 100 PCT Speed | TBD |
| | On at Minimum Speed*** | TBD |
| | Off | TBD |

** Tank elevations are in terms of FT above wet well bottom.

## N.5 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Intermediate Pumps, typical:
      a. Running status.
      b. Fault.
      c. Fail to start.
      d. Operating speed feedback.
      e. Motor current.
      f. High temperature alarm.
   2. Intermediate Pump Station wetwell level.
   3. Intermediate Pump Station low level alarm.
   4. Combined effluent flow rate.
   5. Combined effluent turbidity.
   6. Combined effluent pH signal.
   7. Combined effluent chlorine residual signal.
   8. Clearwell level signal.
   9. Clearwell high level alarm.
   10. Clearwell hatch open alarm.

B. Operator entries and setpoints:
   1. For each pump:
      a. Lead/Lag1/Lag2/Off mode select.
      b. Manual/Auto mode selection.
      c. Manual start/stop select.
      d. Manual speed entry.
   2. Combined effluent turbidity high and high high alarm thresholds.
   3. Combined effluent pH low, low-low, high, and high-high alarm thresholds.
   4. Combined effluent chlorine residual low, low-low, high, and high-high alarm thresholds.

## N.6 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Total volume (MGD) of water pumped to the clearwell.
   2. Combined effluent turbidity.
   3. Combined effluent pH signal.
   4. Combined effluent chlorine residual signal.

B. Other reports as determined at the Report Configuration Workshop(s).

## END OF APPENDIX N

# APPENDIX O
## CROWSON PUMP STATION
## PROCESS CONTROL DESCRIPTION

Project: City of Ashland, OR – Ashland Creek Water Treatment Plant
Process Areas: Crowson Pump Station

### O.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:
   1. 000Y628, Crowson Pump Station

### O.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:
   1. Crowson Pumps: P-6001, P-6002, P-6003
   2. Crowson Pump VFD's: VFD-6001, VFD-6002, VFD-6003

B. Major Field Instrumentation:
   1. Crowson Pumps Discharge Pressure Switches: PSH-6001, PSH-6002, PSH-6003
   2. Plant Effluent Chlorine Analyzer: AE/AIT-5201.

### O.3 OVERVIEW DESCRIPTION

A. These pumps will be utilized to pump water from the clearwell to the Crowson Reservoir and provide pressure to the plant water system

### O.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Hardwired Controls and Interlocks:
   1. Pumps may be manually controlled via selections made at the VFD
   2. Emergency stop: Activation of the emergency stop shall stop the pump.
   3. Pump high discharge pressure: A high discharge pressure switch is hardwired to each pump VFD to trip the pump on high discharge pressure.
   4. Pump high motor temperature is hardwired to each pump VFD to trip the pump.
   5. Pump VFD fault: A detected VFD fault deactivates the controls at the VFD and stops the pump.

B. PLC-based Process Monitoring and Control:
   1. General
      a. Pumps may be manually controlled via selections made at the VFD. When placed in the REMOTE control mode at the VFD, pumps are controlled by PLC control logic as follows:
      b. The three VFD driven pumps are controlled via operator input at the HMI. Pump control is in accordance with selections made at the HAND-OFF-AUTO selector, AUTO-MANUAL speed controllers and LEAD-LAG1-LAG2 or STANDBY selector function.
   2. Normal (PCS-AUTO) Operation:
      a. When operating in an AUTOMATIC control mode, pump control is in accordance with flow rate set by the Operator and in accordance with an AUTO-MANUAL speed controller. AUTOMATIC operation is as follows:
      b. PLC logic commands the LEAD pump to start. Pump speed will ramp to a minimum set speed at start-up and gradually increase speed up to 100 PCT in accordance with the measured flow level as measured by the Crowson pump station flow meter. If the LEAD pump fails to operate (after a time delay, initially set at 10 SEC), then the LAG1 pump will be commanded to operate as the LEAD pump.
      c. If the LEAD pump cannot meet the Operator flow setpoint while the LEAD pump has been running at maximum speed for a set period of time, the LAG1 pump will be commanded to operate. The LEAD pump will slow down to minimum speed while

the LAG1 pump starts. Once the LAG1 pump reaches minimum speed, both pumps will operate together at the same speed. Both pumps gradually increase speed up to 100 PCT to meet the desired flow rate. If either one of the two operating pumps fails to operate (after a time delay, initially set at 10 SEC), then the LAG2 pump will be commanded to operate as the LAG1 pump.

d. If both the LEAD And LAG1 pump cannot meet the Operator flow setpoint while both the LEAD and LAG1 pumps have been running at maximum speed for a set period of time, the LAG2 pump will be commanded to operate. The LEAD and LAG1 pumps will slow down to minimum speed while the LAG2 pump starts. Once the LAG2 pump reaches minimum speed, all pumps will operate together at the same speed. All running pumps gradually increase speed up to 100 PCT to meet the desired flow rate. If any of the three operating pumps fails to operate (after a time delay, initially set at 10 SEC), then the STANDBY pump will be commanded to operate as the LAG2 pump.

e. PLC logic utilizes a 1-minute time delay (adjustable) prior to commanding an additional pump to start following the start of the previous pump.

f. If Operator reduces the flow setpoint with the LEAD, LAG1 and LAG2 pumps running at a minimum set speed for a set period of time (initially set at 15 SEC), the PLC commands the LAG2 pump to stop.

g. If the flow from the pump station exceeds the Operator setpoint with the LEAD and LAG1 pumps running at a minimum set speed for a set period of time (initially set at 15 SEC), the PLC commands the LAG1 pump to stop.

h. If the flow from the pump station exceeds the Operator setpoint with only the LEAD pump operating at a minimum speed for a set period of time (initially set at 15 SEC), the PLC commands the LEAD pump to stop.

i. Pump speed is to be controlled by an AUTO-MANUAL speed controller function and level control logic resident with PLC programming.
   1) In MANUAL mode, the speed controller function provides a speed control signal to the pump per the operator's manual speed selection at the HMI.
   2) In AUTO mode, the speed controller function modulates pump speed so as to minimize the number of pump starts and stops. It does this by modulating from a set minimum speed to maximum speed in accordance with the pump control schedule below. Pump speed will increase as the flow setpoint increases in order to preclude the need for another pump if possible. Pump speed will decrease as the flow setpoint decreases in order to keep the pump running as long as possible and thus prevent numerous pump starts and stops.
   3) Pump speed will ramp up at a controlled rate during pump start-up.
   4) During a controlled pump shutdown, the pump speed will ramp down to minimum speed prior to pump turn-off.
      (a) The software interlocks associated with the Crowson Pump Station are described below.

j. The pumps are interlocked with the Clearwell level and will only operate if the water level is above an Operator setpoint.

3. All PLC outputs related to pump operation (both speed control and run/stop commands) remain in the last state in the event of either of the following two conditions:
   a. Loss of communication between the local PLC and the Water Treatment Plant Control System.
   b. Loss of the Clearwell level signal.

## 0.5 ALARMS AND CONTROLS

A. Alarms: Alarms for failure of equipment and abnormal conditions are activated at the PLC. The alarms include:
   1. Crowson Pump VFD fault.
   2. Crowson Pump discharge pressure HIGH alarm.
   3. Crowson Pump high motor temperature alarm.

B. Controls: Control functions for the equipment activated at the PLC include:
   1. PCS-AUTOMATIC; PCS-MANUAL selection.
   2. Pump RUN/STOP.
   3. Pump speed setpoint (as selected in GPM flow rate).
   4. Pump selection (operating/standby).
   5. Pump start time delay setpoint (0-5 minutes).

C. All PLC outputs related to pump operation (both speed control and run/stop commands) remain in the last state in the event of either of the following two conditions:
   1. Loss of communication between the local PLC and the Water Treatment Plant Control System.
   2. Loss of the Clearwell level signal.

## O.6 DISPLAYS AT HMI/OIT

A. Indications and alarms:
   1. Crowson Pumps, typical:
      a. Running status.
      b. Fault.
      c. Fail to start.
      d. Operating speed feedback.
      e. Motor current.
      f. High temperature alarm.
      g. High pressure alarm.

B. Operator entries and setpoints:
   1. For each pump:
      a. Lead/Lag1/Lag2/Off mode select.
      b. Manual/Auto mode selection.
      c. Manual start/stop select.
      d. Manual speed entry.
      e. Pump start time delay setpoint (0-5 minutes).

## O.7 REPORT DESCRIPTIONS

A. Provide daily report containing the following:
   1. Total volume (MGD) of water pumped to Crowson.
   2. Plant effluent chlorine residual signal.

B. Provide monthly report containing the following:
   1. Total volume (MGD) of water pumped to Crowson.
   2. Total run time of each pump.

**END OF APPENDIX O**

# SECTION 40 62 16
## COMPUTER NETWORK AND HUMAN MACHINE INTERFACE (HMI) HARDWARE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Computer network and HMI hardware requirements, which include, but are not necessarily limited to:
      a. LCD Flat Panel Type Monitors.
      b. HMI Thin Client Computers.
      c. HMI Network Servers.
      d. Server Racks.
      e. Panel Mounted Personal Computers (PC).
      f. Panel Mounted OIT Operator Interface Terminals (OIT).
      g. Uninterruptible Power Supplies (UPS)
      h. Ethernet Switches.
      i. Firewalls.
      j. Software.
      k. Accessories and Maintenance Materials.

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.
   4. Section 40 97 00 - Control Auxiliaries.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
         1) 802.3u: IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.
         2) 802.3x: IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation.

### 1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. LCD: Liquid Crystal Display.

C. OIT: Operator Interface Terminal.

D. OPC: "OLE for Process Control", a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

E. PC: Personal Computer.

F. RAID: Redundant Array of Independent Disks, a method of storing the same data in different places on multiple hard disks.

G. RAM: Random Access Memory.

H. SCSI: Short for Small Computer System Interface, a parallel interface standard used for attaching peripheral devices to computers.

I. SDRAM: Synchronous Dynamic RAM.

J. SNMP: Simple Network Management Protocol, a set of protocols for managing complex networks.

K. TFT: Thin-Film Transistor, a technology for building LCD screens.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 LCD FLAT PANEL TYPE MONITORS

A. Desktop LCD Monitors:
   1. Manufacturers:
      a. Dell.
      b. HP.
      c. Lenovo.
      d. Asus.
      e. Samsung.
   2. Provide LCD Flat Panel Type Monitors as shown on the Drawings and the Schedule herein.
   3. Design Requirements:
      a. Screen Size: 24-inch diagonal.
      b. Type of display:
         1) LED-backlit LCD monitor.
         2) Panel Type: In-Plane Switching (IPS).
         3) Anti-glare screen coating.
      c. Aspect ratio: 16:9.
      d. Native Resolution: 2560 X 1440.
      e. Image brightness: Minimum 350 cd/m2.
      f. Contrast Ratio: 1000:01:00.
      g. Color Support: 16.7 million colors.
      h. Response time:
         1) Typical: 8 milliseconds.
         2) Gray-to-gray: 6 milliseconds.
      i. Ports and slots:

1) AC power.
2) HDMI/MHL.
3) DisplayPort in.
4) Mini DisplayPort in.
5) DisplayPort out.
6) Audio line out.
7) USB upstream.
8) USB downstream.

j. Height, pivot, swivel and tilt display position adjustments.
k. Power Input: 120 VAC.
l. Energy Star qualified.

4. Schedule:

| EQUIPMENT NO | LOCATION | SIZE |
|---|---|---|
| SCADA TERMINAL #1 – MONITOR #1 | CONTROL ROOM | 24 IN |
| SCADA TERMINAL #1 – MONITOR #2 | CONTROL ROOM | 24 IN |
| SCADA TERMINAL #3 – MONITOR #1 | OFFICE | 24 IN |
| SCADA TERMINAL #3 – MONITOR #2 | OFFICE | 24 IN |

B. Wall-Mounted LCD Monitors:
1. Manufacturers:
   a. NEC.
   b. LG.
   c. Planar.
2. Provide commercial-grade, large format, LCD flat panel displays as shown on the Drawings and the Schedule herein.
3. Design Requirements:
   a. Suitable for continuous, 24 hour/day operation.
   b. Screen size: 65-inch diagonal.
   c. Type of display:
      1) LED edge-lit backlighting.
      2) Anti-glare screen coating.
   d. Aspect ratio: 16:9.
   e. Native resolution: 1920 x 1080 at 60Hz.
   f. Image brightness: Minimum 350 cd/m2.
   g. Image contrast ratio: 4000:1.
   h. Color support: 16.7 million colors.
   i. Response time (gray-to-gray): 8 milliseconds.
   j. Video input:
      1) DisplayPort.
      2) HDMI x 2.
      3) VGA.
   k. Speakers:
      1) Two speakers with 20 watt total output power.
   l. Tuners Configuration: No tuner.
   m. Operational Power Consumption: 230 watts maximum.
   n. Energy Star qualified.
   o. Warranty: 3-year manufacturer warranty.

4. Remote control.
5. Wall mounting bracket:
   a. Extra-large tilt mount, VESA compatible.
6. Schedule:

| EQUIPMENT NO | LOCATION | SIZE (IN) |
|---|---|---|
| Wall Monitor #1 | Control Room | 65 |
| Wall Monitor #2 | Control Room | 65 |

## 2.3 HMI THIN-CLIENT COMPUTERS

A. Desktop Thin-Client:
   1. Manufacturers:
      a. Dell – Pro Slim Plus Desktop
      b. Or approved equal.
   2. Design:
      a. The following are minimum component and performance specifications. Each unit shall incorporate the latest industry standard technology at time of purchase.
         1) Processor: Intel Core Ultra 7 256.
         2) System Memory: 16 GB, DDR5
         3) Mass storage: 256GB SSD, TLC
         4) Integrated graphics.
         5) Ports:
            a) Front:
               (1) One USB 2.0 (480 Mbps) port
               (2) One USB 2.0 (480 Mbps) port
               (3) One USB 3.2 Gen 2 (10 Gbps) port
               (4) One USB 3.2 Gen 2x2 (20 Gbps) Type-C® port
               (5) One headset jack
            b) Rear:
               (1) Two USB 2.0 (480 Mbps) ports
               (2) Three USB 3.2 Gen 1 (5 Gbps) ports
               (3) One USB 3.2 Gen 2 (10 Gbps) port
               (4) Three DisplayPort 1.4a ports
               (5) One RJ45 (1GbE) Ethernet port
      b. Keyboards:
         1) Incorporate Standard QWERTY design with numeric keypad and assigned function keys.
         2) Sculptured keys.
         3) Tactile feedback.
      c. Mouse: High performance mouse with laser sensor and tilt wheel (wireless).
      d. Operating system: Microsoft Windows 11 Professional.
      e. No Microsoft Office, virus protection, or "trial" software shall be installed.
      f. Dell 5 year ProSupport with next business day on-site service.
      g. One Uninterruptible Power Supply (UPS) shall be provided with each desktop thin-client terminal:
         1) APC – Back-UPS Pro, or approved equal.
         2) Provides backup power in the event of a temporary power outage or multiple power supply failures.
         3) Power rating: 750 VA, minimum.
         4) Voltage: 120 VAC, 60 Hz.
         5) Configuration: Tower.
         6) Topology: True online double-conversion.
         7) Internal UPS bypass circuit automatically actuates upon UPS overload or UPS failure in less than 4 ms.

8) UPS shall use advanced, three-stage battery charging cycles to extend battery service life and optimized battery charge time.
9) Provides 60 day notification of end of useful life of the batteries.
10) Batteries: sealed, lead-acid. Maintenance-free.

3. Schedule:

| EQUIPMENT NO. | LOCATION |
|---|---|
| SCADA TERMINAL #1 | Control Room |
| SCADA TERMINAL #2 | Control Room |
| SCADA TERMINAL #3 | Office |

## 2.4 HMI NETWORK SERVERS

A. HMI Fault-Tolerant Servers:
1. Manufacturers:
   a. Stratus, ftServer 6910.
   b. No like, equivalent or "or-equal" item or substitution is permitted.
2. Design and fabrication:
   a. Processors:
      1) Processors: Two Intel Xeon Gold 2.2 GHz.
      2) Intel Hyper-threaded Cores: 18 per processor
      3) Intel UPI speed: 10.4 GT/x
      4) Maximum memory bandwidth: 213.3 GB/s
   b. Memory: 256 GB DDR4.
   c. I/O Subsystem: 4 PCIe 3 x 8.
   d. Storage Subsystem: 12 Gb SAS
   e. ftScalable Storage Subsystem: up to 144.
   f. Embedded I/O ports:
      1) Quantity of 10/100/1000 Ethernet: 4.
      2) Quantity of 10 Gb Ethernet: 4.
      3) Quantity of 10/100 Management ports: 1
      4) Serial ports: 2 (9-pin).
      5) USB Ports:
         a) Redundant: 4 USB 2.0.
         b) Non-redundant: 4 USB 3.0.
   g. Manageability:
      1) Baseboard management controller.
      2) Virtual Technician Module.
      3) Graphics adapter: 1 VGA port.
   h. PCI Adapters:
      1) 1 Gb dual-port Ethernet: 4.
      2) 10 Gb dual-port Ethernet server adapter: 2.
      3) 16 Gb Fibre Channel for external storage: 2.
   i. Hot-swappable CPU, I/O modules and disks.
   j. Operating System:
      1) Windows Server with Hyper-V virtualization.
   k. Input power: 115 VAC.
3. Schedule:

| EQUIPMENT NO. | LOCATION |
|---|---|
| SCADA Server | I.T. Closet |

## 2.5 SERVER RACKS:

A. Seismic-Certified 42U Rack Enclosure Cabinet:
   1. Acceptable Manufactures:
      a. Tripp Lite.
      b. Or approved equal.
   2. Provide Server Racks as shown on the Drawings and the Schedule herein.
   3. Design and fabrication:
      a. Standard depth rack enclosure cabinet with doors and side panels.
      b. Modular front and rear doors.
      c. Baying brackets.
      d. Textured powder coat finish.
      e. Grounding system.
      f. Open bottom.
      g. Certification: RoHS, Seismic Zone 4.
      h. Dimensions and weights:
         1) Rack depth: 27.55 IN.
         2) Maximum device depth: 37 IN.
         3) Minimum device depth: 4 IN.
         4) Rack height: 42U.
         5) Unit dimensions: 78.5 IN high, 23.63 IN wide, 43 IN deep.
         6) Unit weight: 353 LBS.
      i. Weight capacity: 3000 LBS.
      j. Number of vertical mounting rails: 4.
      k. Built-in cable management.
      l. Roof mounted cable management tray and tray expansion.
   4. Schedule:

| EQUIPMENT NO. | LOCATION |
|---|---|
| SVF-3000 | I.T. Closet |

## 2.6 PANEL MOUNTED PERSONAL COMPUTER (PC)

A. Panel Mounted PC:
   1. Manufacturers:
      a. Rockwell Automation, Allen-Bradley:
         1) ASEM 6300P Low Profile Panel PC.
      b. No like, equivalent or "or-equal" item or substitution is permitted.
   2. Design:
      a. Processor: Intel Core i5, 4-cores, 4-threads, 6MB cache, 2.0 GHz to 3.6 GHz Turbo.
      b. System memory: 8GB RAM
      c. Mass storage: 128 GB SSD
      d. Integrated graphics:
      e. Ports:
      f. Chassis: panel mounted
      g. Input power: 24VDC.
      h. Low profile aluminum bezel.
      i. Fanless construction
      j. ThinManager compatible
      k. Input power: 24VDC.
      l. LED backlight TFT LCD.
         1) Screen size: 21.5 IN.
         2) Resolution: 1920x1080.
      m. Protection grade: IP65/IP66.

n. Touch screen: P-CAP multitouch aluminum glass true flat.

3. Schedule:

| EQUIPMENT NO. | LOCATION |
|---|---|
| SCADA TERMINAL #4 | Chemical Room Control Panel (CP-302) |

## 2.7 PANEL MOUNTED OPERATOR INTERFACE TERMINALS (OIT)

A. Panel-Mounted OIT.

1. Manufacturers:
   a. Allen-Bradley Panel View Plus7 Graphic Terminals
   b. No like, equivalent or "or-equal" item or substitution is permitted.
2. Design and Fabrication:
   a. Display: Color graphics.
   b. Combination keypad and touchscreen.
   c. 24 VDC power supply.
   d. Real time battery-backed clock, time stamp data.
   e. Communicate via Ethernet to associated Programmable Logic Controller.
      1) Provide password protection to prevent unauthorized entries for a minimum of two levels:
      2) Authorization to operate.
      3) Authorization to adjust setpoints.
   f. Operating temperature: 32 DEGF to 131 DEGF.
   g. Humidity: 10 to 90 PCT RH non-condensing.
   h. NEMA 4X rating.
   i. UL Listed.
   j. Configuration software:
      1) Provide latest version of configuration software licensed to Owner.
3. Schedule:

| EQUIPMENT NO. | LOCATION | SIZE |
|---|---|---|
| CONTROL PANEL CP-601 | CROWSON PUMP STATION | 15 IN |

## 2.8 UNINTERRUPTIBLE POWER SUPPLIES

A. Rack Mounted UPS's:

1. Manufacturers:
   a. APC Smart-UPS.
   b. Or approved equal
2. Design and fabrication:
   a. Double conversion online type.
   b. Rating: 1500VA.
   c. Rack 3U type format.
   d. Waveform: Pure sine wave.
   e. Power factor correction.
   f. Minimum 10 minutes power ride through of 100 PCT of connected load without incoming power.
      1) Provide extended battery or batteries as necessary to achieve the specified battery run time.
   g. Voltage: 120 VAC, 1 phase.
   h. Frequency range: 45-65 Hz.
   i. Input protection:
      1) Fuse or circuit breaker.
   j. Output voltage regulation:

1) ±1 PCT online.
2) ±2 PCT on battery mode.

k. Battery: Lithium-ion
l. Three stage battery charging for prolonged battery life.
m. Battery over discharge protection.
n. Input power cord.
o. Output receptacles.
p. Efficiency:
1) Normal mode, minimum: 89 PCT.
2) Efficiency mode, minimum: 95 PCT.
3) Battery mode, minimum: 83 PCT.
q. Operating temperature: 32 to 104 DEGF.
r. Relative humidity: 5-95 PCT non-condensing.
s. Integral bypass to automatically bypass UPS on selected fault conditions.
t. Front panel indication of UPS status and alarm conditions.
1) UPS Fault.
2) UPS on battery.
3) UPS is online and operating normally.
4) Battery low.
5) UPS in bypass.
u. Utilize alarm dry, Form C relay contacts to enable remote annunciation of the following conditions.
1) UPS Fault.
2) UPS on battery.
3) Low battery.
4) UPS in bypass.
v. Agency Approvals:
1) Safety: UL 1778.

3. Emissions: FCC Part 15 (Class A).

## 2.9 ETHERNET SWITCHES

A. Rack Mounted Ethernet Switches:
1. Manufacturers:
a. Cisco – Catalyst 9300 Series.
b. Or approved equal.
2. Provided switches as shown on the Drawings.

## 2.10 FIREWALLS

A. Enterprise-Grade for Small to Midsize Business:
1. Manufacturers:
a. WatchGuard – Firebox M270.
b. Or approved equal.
2. Provided Switches as shown on the Drawings.

## 2.11 SOFTWARE

A. Provide all software and associated programming/configuration required to meet performance requirements of the Contract Documents.
1. At substantial completion of the Project:
a. Turn current licenses for all software over to the Owner in the Owner's name and install the latest version, upgrade or service pack for all software.
b. Provide the respective software supplier's Comprehensive Support Contract for all software covering a full one-year warranty period following substantial completion

which shall provide no cost software upgrades, service packs and tech support from the software supplier.

B. HMI Software:
   1. Subject to compliance with the Contract Documents, the following HMI software packages are acceptable:
      a. Rockwell Automation, Allen-Bradley:
         1) FactoryTalk Service Platform.
         2) FactoryTalk View SE Server.
         3) FactoryTalk Alarm and Event Server.
         4) FactoryTalk Historian Server.
         5) Logix Designer.
         6) WIN911.
      b. No like, equivalent or "or-equal" item or substitution is permitted.
   2. Runtime HMI software:
      a. Provide server/client individually licensed software with capability for all HMIs to be active simultaneously.
   3. Development software:
      a. Install development software on engineering workstation.
   4. Data Historian software:
      a. Provide data historian software compatible with HMI software package.
   5. I/O capacity requirements:
      a. As required to meet performance requirements of the Contract Documents.
      b. Capable of handling an additional 20 PCT more points (future expansion) without impacting the license.
   6. Alarm Notification Software:
      a. Industrial Software Solutions, WIN-911 Alarm Notification Platform.

C. Ethernet Network Management Software:
   1. Software to include an OPC Server, capable of integrating real-time SNMP data into OPC client enabled HMI software databases.
   2. Software shall allow control of polling rate for SNMP requests, as well as limit access to write SNMP data on each SNMP point.
   3. Software shall have pre-developed databases for several manufacturer's Ethernet network devices, as well as generic MIB (Management Information Base) databases.
   4. Software shall have integrated OPC client data viewer software, so that SNMP data may be viewed without having to create HMI points.

D. Provide each workstation and server with the latest edition of the following software:
   1. Operating system: Microsoft Windows.
   2. Microsoft Office Suite.

E. All software must be latest edition and licensed to the Owner.

### 2.12 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

B. Furnish Owner with the following extra materials:
   1. One spare Ethernet switch of each type utilized.

## PART 3 - EXECUTION

### 3.1 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01 75 00.

## 3.2 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Specification Section 40 61 13.

**END OF SECTION**

# SECTION 40 63 43
## PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Programmable logic controller (PLC) control system(s), including hardware, software, programming, documentation, and training.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   6. Section 40 61 13 - Process Control Systems General Requirements.
   7. Section 40 61 96 – Process Control Descriptions.
   8. Section 40 62 16 - Computer Network and Human Machine Interface (HMI) Hardware.
   9. Section 40 67 00 - Control System Equipment Panels and Racks.
   10. Section 40 96 52 - Configuration Requirements - Human Machine Interface (HMI) and Reports.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.90.2, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
   2. International Electrotechnical Commission (IEC):
      a. 61131-3, Programmable Controllers – Part 3: Programming Languages.

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and startup of at least three similar installations within the last five years.
   2. Programmer(s) shall have had experience in programming PLCs for at least three projects of similar size and complexity.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.
   3. Product technical data including:
      a. Annotated copies of complete PLC software programs.
         1) Provide one PDF-format file with fully annotated PLC code that can be read without the native configuration and programming environment on electronic media (DVD or USB drive).
         2) Provide one native-format file including all supporting files so that the complete project can be opened in the native configuration and programming environment on electronic media (DVD or USB drive).
         3) Provide written descriptions completely defining all function blocks used in program.
         4) Provide list of all addresses referenced in logic diagram with description of data associated with each address (Tag database).

5) Review will be for general program organization, level of documentation, and overall programming standards (basic pump and valve control, for example). The review will not attempt to confirm the logic works correctly for every loop.

b. Results of factory testing or simulation procedures.

c. Drawings containing the following information to be submitted as part of Specification Section 40 67 00 (control panels) submittals:

1) Arrangement drawings for PLC system components.

2) Panel and enclosure plans, sections and details.

3) Access opening locations and required clearances for each panel and enclosure.

4) Enclosure internal wiring and terminal blocks.

d. DIP Switch and Jumper Settings, if applicable.

e. I/O Rack and I/O Module Layout.

f. Wiring and Interconnection diagrams.

1) Power Supplies.

2) I/O Points.

3) Communications.

g. Catalog cut sheets containing information on PLC components to be submitted as part of these Specification Section submittals.

4. Certifications:

a. Qualifications of installation supervisor.

b. Qualifications of programmer(s).

5. Software Licenses:

a. Documentation proving all software package licenses are assigned to owner.

B. Operation and Maintenance Data:

1. See Specification Section 01 33 04 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. Program Documentation.

a. Program Overview.

b. Program Listing.

c. I/O Listing.

d. Memory Map.

e. I/O Cross Reference.

3. Submit maintenance procedures available to Owner.

a. Include the location and phone numbers of service centers (including 24 HR "hot lines").

b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

C. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Index of all training offered by PLC system equipment manufacturers including operations and maintenance.

3. List of all recommended spares for maintenance purposes with each item separately priced.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rockwell Automation: Allen-Bradley.

2. No like, equivalent or "or-equal" item or substitution is permitted.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

C. Products nearing their "End of Life" shall not be used. "Used" hardware shall also not be used.

## 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Section 40 63 43 – Attachment A (PLC Component Table).

B. See Section 40 63 43 – Attachment B (PLC Input/Output Table).

C. See Specification Section 40 61 13.

D. The PLC system shall accomplish the control requirements of the Loop Descriptions, Drawings, and Specifications.

E. PLC programming shall be documented and factory tested.

F. The PLC system shall operate in ambient conditions of 32 to 140 DEGF temperatures and 5 to 95 PCT relative humidity without the need for purging or air conditioning.

G. Environmental Controls:
   1. Furnish circulation fans in solid state control system enclosures.
   2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
   3. Air conditioning applications shall include means of preventing moisture condensation.

H. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of any one component does not affect equipment on all trains.
   1. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.
   2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common system), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one I/O module does not affect all of the parallel operating equipment units.

## 2.3 HARDWARE

A. Processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

B. I/O modules shall be capable of being replaced while under power.

C. All I/O modules shall report to the CPU should a terminal block fail or be removed.

D. Analog output modules shall have a resolution of at least 12 bits.

E. Provide electric isolation between logic and field device.

F. Field wiring shall not be disturbed when removing or replacing an I/O module.

G. Power Supply Units:
   1. Electrical service to PLC system is 105 to 125 V, 60 Hz, ±10 PCT, 1 PH power.

H. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

I. Incorporate the following minimum safety measures:
   1. Watchdog function to monitor:
      a. Internal processor clock failure.
      b. Processor memory failure.
      c. Loss of communication between processor and I/O modules.

d. Processor ceases to execute logic program.

2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
3. Safe wiring:
   a. Equipment failure mode shall be selected so that the loss of power or control signal to the equipment will result in the equipment either shutting down or operating safely.
   b. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
   c. Low voltage control signal wires:
      1) Place in conduit segregated for that purpose only.
      2) Twisted shielded wire pair.
      3) Not located in the same conduit or bundle with power wiring.
4. Initial safety conditions:
   a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
   b. Utilize program each time PLC is re-initiated and the control program activated.
5. PLC fault relay:
   a. Opening of PLC fault contact:
      1) Occurs upon unsafe or undesirable system operation, including:
         a) Loss of memory.
         b) Processor fault.
         c) Power supply fault.
         d) Communications failure.
         e) Scan time overrun.
         f) Module failure.
      2) Results from de-energization of PLC fault relay or output.
      3) Causes Master Safety Relay to de-energize.
6. Monitoring of internal faults and display:
   a. Internal PLC system status and faults shall be monitored and displayed.
      1) Monitored items shall include:
         a) Memory ok/loss of memory.
         b) Processor ok/processor fault.
         c) Scan time overrun.
7. Control of programs: Protect access to PLC program loading with password protection or with locked, key operated selector switches.
   a. Provide passwords and/or keys to owner at Substantial Completion.
8. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
9. Operator intervention:
   a. Logic system failure shall not preclude proper operator intervention.
   b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

## 2.4 SOFTWARE

A. All software will be furnished and licensed to owner.
   1. Once project is accepted as complete, transfer all licenses and media to owner.
   2. All software must be latest edition and licensed to the Owner.

B. Programming.
   1. Languages supported: All application programming in IEC 61131-3 compliant language.
   2. Program PLC utilizing ladder diagram, function block, or structured text format.
   3. Protect program via removable key switch or password to prevent unauthorized changes. Provide password and/or programming keys to owner.

4. Capable of on-line and off-line programming.

C. PLC program Structure.
   1. Clear, concise, well-annotated logic.
   2. Implement a modular design to allow specific functions to be replicated to ensure consistency.
   3. Program shall align with the control strategies. Include comments reflecting alignment with control strategies.
   4. Include named variables that reflect the actual use of the variable.
   5. Annotate program listing to include the following (using the features of the appropriate PLC programming software):
      a. Clearly identified variables, I/O points, contacts, and analog values.
      b. Written description of each functional area.
      c. Written description of each rung's function.
      d. Reference to control loop number for each rung where applicable.
      e. Reference to instrumentation tag number of I/O devices for each rung where applicable.

## 2.5 COMPONENTS

A. PLC System Central Processor Unit (CPU):
   1. CPU shall provide communications with other control systems and man-machine interfaces as specified.
   2. CPU shall include capability to modify logic via an Ethernet port without taking processor off-line.
   3. Memory:
      a. Battery-backed RAM.
      b. Non-volatile program storage via flash EEPROM:
         1) Automatically download to RAM in the event RAM is corrupted.
   4. Memory battery backup shall be capable of 180 days memory retention with fresh battery.
      a. Provide visual indication of battery status and alarm low battery voltage.
      b. Memory battery backup shall be capable of 28 days memory retention after the "Battery Low" indicating LED is on.
   5. Plug-in card designed to allow quick field replacement of faulty devices.
      a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
   6. 20 PCT minimum spare useable memory capacity after all required programming is in place and operating.
   7. Capable of executing all control functions required by the Specifications and Drawings.
   8. Built-in three-mode (proportional-integral-derivative) control capabilities.
      a. As directly selectable algorithms requiring no user knowledge of programming languages.
   9. Lighted status indicators for "RUN" and "FAILURE".
   10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
      a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:
   1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
   2. Provide I/O system with:
      a. I/O solid state boards with status lights indicating I/O status.
      b. Electric isolation between logic and field device.
      c. Capability of withstanding low energy common mode transient to 1000 V without failure.
      d. Incorporate noise suppression design.
      e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.

f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
g. Install 20 PCT spare I/O points for each type.

3. Input/output connection requirements:
   a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
   b. Prewire I/O modules to terminal blocks.
   c. Provide terminal blocks with continuous marking strip.
   d. Size terminals to accommodate all active data base points and spares.
   e. Provide terminals for individual termination of each signal shield.
   f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
   a. Interface to ON/OFF devices.
   b. I/O status indicator on module front.
   c. Voltage rating to match circuit voltage.
   d. Output module current rating:
      1) Match maximum circuit current draw.
      2) Minimum 1.0 continuous A/point for 120 VAC applications.
   e. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
   a. Provide one fuse per common or per isolated output.
   b. Provide blown fuse indication.
   c. External fusing shall be provided if output module does not possess internal fusing.
   d. Fuses provided external to output model shall:
      1) Be in accordance with module manufacturer's specifications.
      2) Be installed at terminal block.
6. Incorporate noise suppression and inductive load suppression design into input, output, and logic modules.
7. Provide surge suppressors directly across the coils of all inductive devices which are energized by PLC outputs.
   a. Install the surge suppressor at location of the inductive device.
8. Analog I/O modules:
   a. Input modules to accept signals indicated on Drawings or Specifications.
   b. Minimum 12 bit resolution.
   c. I/O chassis supplied power for powering connected field devices.
   d. Differential inputs and outputs.
   e. User configurable for desired fault-response state.
   f. Provide output signals as indicated on Drawings and Specifications.
   g. Individual D/A converter for each output module.
   h. Individual A/D converter for each input module.

C. Power Supply Units:
1. Provide regulated power units:
   a. Designed to operate with PLC system and shall provide power to:
      1) All components of PLC system.
      2) All two-wire field instruments.
      3) Other devices as indicated on Drawings or Specifications.
   b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
   c. Each power supply shall be sized such that it will carry no more than 75 PCT of capacity under normal loads.
2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1 PCT, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.

4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
    a. Immune to transients and surges resultant from noisy environment.
    b. Shall provide constant voltage level DC distribution to all devices.
7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 10 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
    a. UPS powered loads:
        1) All rack mounted PLC components.
        2) Local operator consoles.
        3) All power supplies furnished with the PLC and associated loads.
    b. Input:
        1) 120 VAC +10 PCT.
        2) 60 Hz.
        3) Line fuse protection.
    c. Output:
        1) 120 VAC 5 PCT.
        2) 60 Hz.
        3) Short circuit protected.
        4) Instantaneous transfer time.
    d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
    e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:
1. In accordance with Specification Section 40 67 00 - Control System Equipment Panels and Racks.
2. Component placement:
    a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.
    b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
    c. Do not place I/O racks directly above the CPU or power supply.
    d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
    e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
    f. Place circulating fans close to major heat generating devices.
    g. Segregate input/output modules into groups of identical type.
3. Wiring and grounding to be in accordance with Specification Section 40 67 00.
4. Termination requirements:
    a. In accordance with Specification Section 40 67 00.
    b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
    c. Prewire I/O modules to terminal blocks.
    d. Size terminals to accommodate all active database points and spares.
    e. Provide terminals for individual termination of each signal shield.
    f. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:

1. Provide all hardware and programming required to provide communication between the PLC and the human-machine interface.
2. Coordinate with HMI programmer to allow modification of all setpoint through the HMI utilizing appropriate security considerations.
3. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
4. Full documentation capability.
5. Online and offline programming.
6. Offline simulation prior to download.
7. Program over network capability.
8. Two-step commands requiring PLC programmer verification prior to modification of any programming.

### 2.6 ACCESSORIES

A. Provide all accessories required to install and test a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

B. Provide all programming cables required to configure the PLC logic.

### 2.7 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
   1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
   2. Conduct testing with simulated I/O to verify each control loop operation.
   3. Allow for Owner and Engineer representatives to witness program testing.
      a. Provide minimum of 15 days notice prior to testing.
   4. Do not ship prior to successful completion of this testing program.

### 2.8 MAINTENANCE MATERIALS

A. Furnish Owner with the spare parts as listed in Appendix B prior to start of commissioning activities.

B. Include a complete bill of materials indicating detailed part model number.

C. Include a complete set of all special tools required to install, maintain and test the PLCs.

## PART 3 - EXECUTION

### 3.1 FUNCTIONALITY

A. Complete System.
   1. Provide all programming, configuration, coordination, integration, and testing required for furnishing a fully functioning system.

### 3.2 FACTORY TESTING

A. After assembly, wiring, configuration, and programming, and prior to shipment of the control system to the project site, verify system functionality by applying test signals to all input points and observing system response at output points.

B. Submit a factory test report indicating how the system was tested and which items were tested.

C. After Owner has had sufficient time to review the factory test report, provide an opportunity for Owner and Owner's technical representative to witness a factory acceptance test.

D. Retain the system in test configuration until approval of the factory acceptance test.

## 3.3 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

## 3.4 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Engineer.
      b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

## 3.5 COMMISSIONING AND ACCEPTANCE

A. Commission system in accordance with Specification Section 01 75 00, System Startup.

B. Demonstrate system in accordance with Specification Section 26 08 13, Acceptance Testing.

## 3.6 TRAINING

A. Employee of the manufacturer or certified representative to provide one week of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

B. As a minimum, training shall cover:
   1. Hardware overview.
   2. Software overview.
   3. Documentation.
   4. Maintenance.
   5. Trouble shooting.
   6. Operation, e.g., changing set points, passwords, etc.

## 3.7 DOCUMENTATION

A. Update O&M manuals to reflect as-built conditions.

## 3.8 SUPPORT

A. Provide on-call technical support for a period of one year after substantial completion. Include a minimum of two site visits to work with owner on any final modifications to the logic.

**END OF SECTION**

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PLC Component Table
Attachment A

**PLC COMPONENTS AND QUANTITIES**

| DESCRIPTION | ALLEN-BRADLEY MODEL NO. | CP-101 | CP-301 | CP-302 | CP-303 | CP-401 | CP-501 | CP-601 | SPARES |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| **ALLEN-BRADLEY COMPACTLOGIX PLATFORM** | | | | | | | | | |
| COMPACTLOGIX 5380 CONTROLLER | 5069-L320ER | 1 | – | – | – | 1 | 1 | 1 | 1 |
| COMPACT I/O ETHERNET I/P ADAPTER | 5069-AENTR | 1 | – | – | – | 1 | 1 | 1 | 1 |
| 8-PT ANALOG INPUT | 5069-IF8 | 2 | – | – | – | 1 | 1 | 1 | 2 |
| 4-PT ANALOG OUTPUT | 5069-OF4 | 1 | – | – | – | – | – | – | 1 |
| 16-PT DISCRETE INPUT; 24VDC | 5069-IB16 | 3 | – | – | – | 2 | 1 | 2 | 2 |
| 16-PT DISCRETE OUTPUT; 24VDC | 5069-OB8 | 1 | – | – | – | 1 | – | – | 1 |
| | | | | | | | | | |
| **ALLEN-BRADLEY CONTROLLOGIX PLATFORM** | | | | | | | | | |
| BACKPLANE (7-SLOT) | 1756-A7 | – | 2 | – | – | – | – | – | 1 |
| BACKPLANE (13-SLOT) | 1756-A13 | – | 1 | 2 | 2 | – | – | – | 1 |
| POWER SUPPLY MODULE | 1756-PA75 | – | 3 | 2 | 2 | – | – | – | 2 |
| CPU MODULE | 1756-L905TS | – | 2 | – | – | – | – | – | 1 |
| MICRO SD CARD | 1784-MSD8 | – | 2 | – | – | – | – | – | 1 |
| ETHERNET/IP BRIDGE/SWITCH | 1756-EN4TR | – | 5 | 2 | 2 | – | – | – | 2 |
| REDUNDANCY MODULE | 1756-RM3 | – | 2 | – | – | – | – | – | 1 |
| 8-PT ANALOG INPUT | 1756-IF16 | – | 2 | 4 | 5 | – | – | – | 2 |
| 8-PT ANALOG OUTPUT | 1756-OF8 | – | 1 | 3 | 2 | – | – | – | 1 |
| 16-PT DISCRETE INPUT; 24VDC | 1756-IB16 | – | 3 | 7 | 9 | – | – | – | 3 |
| 16-PT RELAY OUTPUT | 1756-OW16I | – | 2 | 2 | 3 | – | – | – | 2 |
| BLANK COVER | 1756-N2 | * | * | * | * | | – | – | – |
| | | | | | | | | | |

* AS REQUIRED TO COVER ALL EMPTY SLOTS IN THE RACK.

**PLC PANEL LOCATIONS:**

CP-101: PRETREATMENT BUILDING

CP-301: ELECTRICAL ROOM

CP-302: CHEMICAL ROOM

CP-303: FILTER AREA

CP-401: BACKWASH WASTE BASINS

CP-501: CLEARWELL

CP-601: CROWSON PUMP STATION

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PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| FIT-1001 | RAW WATER FLOWMETER | FLOW SIGNAL | AI | 1 | CP-101 | 000Y601 | |
| | | | | | | | |
| CP-1201(2) | FILTER SYSTEM 1(2) | FLUSH ON | DI | 2 | CP-101 | 000Y601 | |
| CP-1201(2) | RAW WATER STRAINER SYSTEM | FAULT | DI | 2 | CP-101 | 000Y601 | |
| | | | | | | | |
| PIT-1500 | FILTER SYSTEM OUTLET PRESSURE XMTR | PRESSURE | AI | 1 | CP-101 | 000Y601 | |
| AIT-1511 | RAW WATER TURBIDIMETER | TURBIDITY SIGNAL | AI | 1 | CP-101 | 000Y601 | |
| AIT-1512 | RAW WATER PH ANALYZER | TEMPERATURE SIGNAL | AI | 1 | CP-101 | 000Y601 | |
| AIT-1512 | RAW WATER PH ANALYZER | PH SIGNAL | AI | 1 | CP-101 | 000Y601 | |
| | | | | | | | |
| FIC-1501(2) | RAW WATER PRV CONTROLLERS | FLOW | AI | 2 | CP-101 | 000Y601 | |
| FIC-1501(2) | RAW WATER PRV CONTROLLERS | FLOW SETPOINT | AO | 2 | CP-101 | 000Y601 | |
| FIC-1501(2) | RAW WATER PRV CONTROLLERS | FIC AUTO | DI | 2 | CP-101 | 000Y601 | |
| FCV-1501(2) | RAW WATER PRVs | VALVE CLOSED | DI | 2 | CP-101 | 000Y601 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | BFV OPEN | IP | 2 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | BFV CLOSED | IP | 2 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | PRESSURE | IP | 2 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | FLOW | IP | 2 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | FCV IN REMOTE | IP | 2 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM VENTURI | FCV POSITION | IP | 2 | CP-101 | 000Y602 | |
| | | | | | | | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | MOISTURE HIGH | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | MV-2001 OPEN | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | MV-2001 CLOSED | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | MV-2004 OPEN | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | MV-2004 CLOSED | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM GAS SUPPLY | PRESSURE | IP | 1 | CP-101 | 000Y602 | |
| | | | | | | | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM | UPSTREAM PRESSURE | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM | AMBIENT O2 CONC. | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONE SIDESTREAM INJECTION SYSTEM | AMBIENT O2 FAIL | IP | 1 | CP-101 | 000Y602 | |
| MOCP-2000 | OZONATED WATER | OZONE | IP | 1 | CP-302 | 000Y603 | |
| MOCP-2000 | OZONATED WATER | ANALYZER FAULT | IP | 1 | CP-302 | 000Y603 | |
| | | | | | | | |
| AIT-3003 | RAW WATER PH ANALALYZER | TEMPERATURE SIGNAL | AI | 1 | CP-302 | 000Y603 | |
| AIT-3003 | RAW WATER PH ANALALYZER | PH SIGNAL | AI | 1 | CP-302 | 000Y603 | |
| AIT-3004 | RAW WATER STREAMING CURRENT ANALYZER | STREAMING CURRENT | AI | 1 | CP-302 | 000Y603 | |
| AIT-3005 | RAW WATER DISSOLVED OZONE ANALYZER | DISSOLVED OZONE | AI | 1 | CP-302 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1 | MIXER FAULT | IP | 3 | CP-301 | 000Y604 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1 | HS AUTO | IP | 3 | CP-301 | 000Y604 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1 | RUN STATUS | IP | 3 | CP-301 | 000Y604 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 2 | MIXER FAULT | IP | 3 | CP-301 | 000Y603 | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| CP-3200 | BALLASTED FLOCCULATION TRAIN 2 | HS AUTO | IP | 3 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 2 | RUN STATUS | IP | 3 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | RUNNING | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | OFF | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | SAND PUMP FAULT | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | SAND PUMP FAULT | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | SAND PUMP FAULT | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | PRESSURE | IP | 2 | CP-301 | 000Y603 | |
| CP-3200 | BALLASTED FLOCCULATION TRAIN 1(2) | FLOW | IP | 2 | CP-301 | 000Y603 | |
| LT-4001 | FILTER INLET CHANNEL LEVEL | LEVEL | AI | 1 | CP-303 | 000Y607 | |
| AIT-4200 | BACKWASH WASTE TURBIDITY | TURBIDITY SIGNAL | AI | 1 | CP-303 | 000Y610 | |
| | | | | | | | |
| LSH-4111(4) | FILTER HIGH LEVEL SWITCH | HIGH LEVEL | DI | 4 | CP-303 | 000Y607-10 | |
| LIT-4111(4) | FILTER LEVEL TRANSMITTER | LEVEL SIGNAL | AI | 4 | CP-303 | 000Y607-10 | |
| PDIT-4111(4) | FILTER HEADLOSS TRANSMITTER | HEADLOSS SIGNAL | AI | 4 | CP-303 | 000Y607-10 | |
| AIT-4111(4) | FILTER EFFLUENT TURBIDIMETER | TURBIDITY SIGNAL | AI | 4 | CP-303 | 000Y607-10 | |
| FIT-4111(4) | FILTER EFFLUENT FLOWMETER | FLOW SIGNAL | AI | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4011(4) | FILTER INLET VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4011(4) | FILTER INLET VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4011(4) | FILTER INLET VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4011(4) | FILTER INLET VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4111(4) | FILTER AIR SCOUR VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4111(4) | FILTER AIR SCOUR VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4111(4) | FILTER AIR SCOUR VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4111(4) | FILTER AIR SCOUR VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4212(4) | FILTER EFFLUENT VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4212(4) | FILTER EFFLUENT VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4212(4) | FILTER EFFLUENT VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4212(4) | FILTER EFFLUENT VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4411(4) | FILTER BACKWASH SUPPLY VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4411(4) | FILTER BACKWASH SUPPLY VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4411(4) | FILTER BACKWASH SUPPLY VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4411(4) | FILTER BACKWASH SUPPLY VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4611(4) | FILTER BACKWASH WASTE VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4611(4) | FILTER BACKWASH WASTE VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4611(4) | FILTER BACKWASH WASTE VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4611(4) | FILTER BACKWASH WASTE VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| BFV-4311(4) | FILTER WASTE VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4311(4) | FILTER WASTE VALVES | OPEN POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4311(4) | FILTER WASTE VALVES | CLOSE POSITION | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4311(4) | FILTER WASTE VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| BFV-4211(4) | FILTER EFFLUENT CONTROL VALVES | ZK AUTO | DI | 4 | CP-303 | 000Y607-10 | |
| BFV-4211(4) | FILTER EFFLUENT CONTROL VALVES | POSITION FDBK | AI | 4 | CP-303 | 000Y607-10 | |
| BFV-4211(4) | FILTER EFFLUENT CONTROL VALVES | POSITION COMMAND | AO | 4 | CP-303 | 000Y607-10 | |
| | | | | | | | |
| SV-4111(4) | FILTER AIR VENT VALVES | OPEN COMMAND | DO | 4 | CP-303 | 000Y607-10 | |
| SV-4111(4) | FILTER AIR VENT VALVES | REMOTE | DI | 4 | CP-303 | 000Y607-10 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | FK AUTO | DI | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | HS REMOTE | DI | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | FAULT | DI | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | RUN COMMAND | DO | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | SPEED COMMAND | AO | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | VFD FAULT CODE | IP | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | SPEED FDBK | IP | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | MOTOR CURRENT | IP | 2 | CP-303 | 000Y611 | |
| BLW-4501(2) | FILTER AIR SCOUR BLOWERS | RUN STATUS | IP | 2 | CP-303 | 000Y611 | |
| | | | | | | | |
| BFV-4511 | FILTER AIR SCOUR BLOWER VENT VALVE | REMOTE | DI | 1 | CP-303 | 000Y611 | |
| BFV-4511 | FILTER AIR SCOUR BLOWER VENT VALVE | OPEN POSITION | DI | 1 | CP-303 | 000Y611 | |
| BFV-4511 | FILTER AIR SCOUR BLOWER VENT VALVE | CLOSE POSITION | DI | 1 | CP-303 | 000Y611 | |
| BFV-4511 | FILTER AIR SCOUR BLOWER VENT VALVE | OPEN COMMAND | DO | 1 | CP-303 | 000Y611 | |
| | | | | | | | |
| FIT-4511 | FILTER AIR SCOUR AIR FLOWMETER | FLOW SIGNAL | AI | 1 | CP-303 | 000Y611 | |
| TIT-4511 | FILTER AIR SCOUR TEMPERATURE TRANSMITTER | TEMPERATURE SIGNAL | AI | 1 | CP-303 | 000Y611 | |
| PIT-4511 | FILTER AIR SCOUR PRESSURE TRANSMITTER | PRESSURE SIGNAL | AI | 1 | CP-303 | 000Y611 | |
| LCP-4810 | INTRUMENT AIR PANEL | FAULT | DI | 1 | CP-303 | 000Y612 | |
| PIT-4821 | INSTRUMENT AIR RECEIVER | PRESSURE SIGNAL | AI | 1 | CP-303 | 000Y612 | |
| BFV-4701(2) | BACKWASH WASTE BASIN DRAIN VALVES | REMOTE | DI | 2 | CP-401 | 000Y613 | |
| BFV-4701(2) | BACKWASH WASTE BASIN DRAIN VALVES | OPEN POSITION | DI | 2 | CP-401 | 000Y613 | |
| BFV-4701(2) | BACKWASH WASTE BASIN DRAIN VALVES | CLOSE POSITION | DI | 2 | CP-401 | 000Y613 | |
| BFV-4701(2) | BACKWASH WASTE BASIN DRAIN VALVES | OPEN COMMAND | DO | 2 | CP-401 | 000Y613 | |
| BFV-4701(2) | BACKWASH WASTE BASIN DRAIN VALVES | CLOSE COMMAND | DO | 2 | CP-401 | 000Y613 | |
| | | | | | | | |
| MV-4701(2) | BACKWASH WASTE BASIN MUD VALVES | REMOTE | DI | 2 | CP-401 | 000Y613 | |
| MV-4701(2) | BACKWASH WASTE BASIN MUD VALVES | OPEN POSITION | DI | 2 | CP-401 | 000Y613 | |
| MV-4701(2) | BACKWASH WASTE BASIN MUD VALVES | CLOSE POSITION | DI | 2 | CP-401 | 000Y613 | |
| MV-4701(2) | BACKWASH WASTE BASIN MUD VALVES | OPEN COMMAND | DO | 2 | CP-401 | 000Y613 | |
| MV-4701(2) | BACKWASH WASTE BASIN MUD VALVES | CLOSE COMMAND | DO | 2 | CP-401 | 000Y613 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| LIT-4701(2) | BACKWASH WASTE BASIN | LEVEL SIGNAL | AI | 2 | CP-401 | 000Y613 | |
| FIT-4703 | BACKWASH WASTE BASIN | FLOW SIGNAL | AI | 1 | CP-401 | 000Y613 | |
| CP-2100 | SWITCHING MANIFOLD | LOX TANK LEVEL | IP | 1 | CP-101 | 000Y614 | |
| CP-2100 | SWITCHING MANIFOLD | LOX TANK PRESSURE | IP | 1 | CP-101 | 000Y614 | |
| CP-2100 | SWITCHING MANIFOLD | LOX TANK LOW LEVEL | IP | 1 | CP-101 | 000Y614 | |
| CP-2100 | SWITCHING MANIFOLD | VAP. VALVE OPEN | IP | 2 | CP-101 | 000Y614 | |
| CP-2100 | SWITCHING MANIFOLD | VAP. VALVE CLOSED | IP | 2 | CP-101 | 000Y614 | |
| CP-2100 | SWITCHING MANIFOLD | VAP. LOW TEMP | IP | 2 | CP-101 | 000Y614 | |
| | | | | | | | |
| MOCP-2000 | PRESSURE REGULATOR STATION | TEMPERATURE | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | SUPPLY VALVE OPEN | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | SUPPLY VALVE CLOSED | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | O2 INLET PRESSURE | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | O2 OUTLET PRESSURE | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | FILTER PDSH | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | PRESSURE REGULATOR STATION | DEWPOINT | IP | 1 | CP-101 | 000Y614 | |
| | | | | | | | |
| MOCP-2000 | NITROGEN BOOST COMPRESSOR SYSTEM | 1.0 FILTER HIGH DP | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | NITROGEN BOOST COMPRESSOR SYSTEM | 0.01 FILTER HIGH DP | IP | 2 | CP-101 | 000Y614 | |
| MOCP-2000 | NITROGEN BOOST COMPRESSOR SYSTEM | PRESSURE | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | NITROGEN BOOST COMPRESSOR SYSTEM | COMP. RUNNING | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | NITROGEN BOOST COMPRESSOR SYSTEM | COMMON ALARM | IP | 1 | CP-101 | 000Y614 | |
| MOCP-2000 | AMBIENT | O2 CONCENTRATION | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | AMBIENT | O2 ANALYZER FAULT | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | AMBIENT | O3 CONCENTRATION | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | AMBIENT | O3 ANALYZER FAULT | IP | 1 | CP-101 | 000Y615 | |
| | | | | | | | |
| MOCP-2000 | OZONE GENERATOR 1(2) | RUNNING | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | OFF | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | MINOR ALARM | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | MAJOR ALAMR | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | LEAD SELECTGOR | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | VALVE OPEN | IP | 8 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | VALVE CLOSED | IP | 8 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | BACKFLOW ALARM | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | O2 FLOW | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | H.C. O3 SAMPLE | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | H.C. O3 SAMPLE FAULT | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | E-STOP ALARM | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | CW INLET TEMP | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | CW OUTLET TEMP | IP | 2 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | CW FLOW | IP | 2 | CP-101 | 000Y615 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| MOCP-2000 | OZONE GENERATOR SYSTEM | START | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | STOP | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | DOSE SETPOINT | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | FIRE ALARM STATUS | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | OZONE GENERATOR 1(2) | VENT. SYS STATUS | IP | 1 | CP-101 | 000Y615 | |
| MOCP-2000 | CHILLER 1(2) | LEAD SELECTOR | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | RUNNING | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | OFF | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | MINOR ALARM | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | MAJOR ALARM | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | E-STOP ALARM | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW INLET VALVE OPEN | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW INLET VALVE CLOSED | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW HIGH PSI | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW LOW PSI | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW LOW FLOW | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | CW LOW TEMP | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | EVAP. FREEZE | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | EVAP. HIGH PSI | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | EVAP. RUNNING | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | EVAP. ALARM | IP | 2 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | COND. FAN RUNNING | IP | 4 | CP-101 | 000Y616 | |
| MOCP-2000 | CHILLER 1(2) | COND. FAN ALARM | IP | 4 | CP-101 | 000Y616 | |
| MOCP-2000 | OZONE DESTRUCT | ALL DESTRUCT OFFLINE | IP | 1 | CP-101 | 000Y617 | |
| | | | | | | | |
| MOCP-2000 | OFF-GAS OZONE | O3 CONCENTRATION | IP | 1 | CP-101 | 000Y617 | |
| MOCP-2000 | OFF-GAS OZONE | O3 ANALYZER FAULT | IP | 1 | CP-101 | 000Y617 | |
| MOCP-2000 | OFF-GAS OZONE | TEMPERATURE | IP | 1 | CP-101 | 000Y617 | |
| MOCP-2000 | OFF-GAS OZONE | PRESSURE | IP | 1 | CP-101 | 000Y617 | |
| | | | | | | | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | RUNNING | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | OFF | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | MINOR ALARM | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | MAJOR ALARM | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | E-STOP ALARM | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | INLET VLV OPEN | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | INLET VLV CLOSED | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | HEATER INLET TEMP. | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | HEATER OUTLET TEMP. | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | HEATER HIGH TEMP | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | COND. FAN RUNNING | IP | 2 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | COND. FAN ALARM | IP | 2 | CP-101 | 000Y617 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| MOCP-2000 | OZONE DESTRUCT EXHAUST ZONE | O3 CONCENTRATION | IP | 1 | CP-101 | 000Y617 | |
| MOCP-2000 | OZONE DESTRUCT 1(2) | O3 ANALYZER FAULT | IP | 1 | CP-101 | 000Y617 | |
| WIT-7601 | CALCIUM THIOSULFATE DRUM SCALE | WEIGHT SIGNAL | AI | 1 | CP-101 | 000Y618 | |
| SWS-7602 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-101 | 000Y618 | |
| SWS-7603 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-101 | 000Y618 | |
| | | | | | | | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | REMOTE | DI | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | RUN STATUS | DI | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | FAULT | DI | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | TUBE FAILURE | DI | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | RUN COMMAND | DO | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | SPEED FDBK | AI | 2 | CP-101 | 000Y618 | |
| P-7611(2) | CALCIUM THIOSULFATE FEED SKID 1 | SPEED COMMAND | AO | 2 | CP-101 | 000Y618 | |
| SWS-7604 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-101 | 000Y619 | |
| | | | | | | | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | REMOTE | DI | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | RUN STATUS | DI | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | FAULT | DI | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | TUBE FAILURE | DI | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | RUN COMMAND | DO | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | SPEED FDBK | AI | 2 | CP-101 | 000Y619 | |
| P-7621(2) | CALCIUM THIOSULFATE FEED SKID 2 | SPEED COMMAND | AO | 2 | CP-101 | 000Y619 | |
| LCP-7101(2) | ALUM FILL STATION CP | TANK LEVEL SIGNAL | AI | 2 | CP-302 | 000Y620 | |
| LCP-7101(2) | ALUM FILL STATION CP | TANK LOW LEVEL | DI | 2 | CP-302 | 000Y620 | |
| LCP-7101(2) | ALUM FILL STATION CP | TANK HIGH LEVEL | DI | 2 | CP-302 | 000Y620 | |
| | | | | | | | |
| P-7111(2) | ALUM FEED SKID | REMOTE | DI | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | RUN STATUS | DI | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | FAULT | DI | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | TUBE FAILURE | DI | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | RUN COMMAND | DO | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | SPEED FDBK | AI | 2 | CP-302 | 000Y620 | |
| P-7111(2) | ALUM FEED SKID | SPEED COMMAND | AO | 2 | CP-302 | 000Y620 | |
| | | | | | | | |
| SWS-7102 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y620 | |
| LSH-7141 | ALUM CONTAINMENT SUMP | HIGH LEVEL | DI | 1 | CP-302 | 000Y620 | |
| LCP-7501 | CAUSTIC FILL STATION CP | TANK LEVEL SIGNAL | AI | 1 | CP-302 | 000Y621 | |
| LCP-7501 | CAUSTIC FILL STATION CP | TANK LOW LEVEL | DI | 1 | CP-302 | 000Y621 | |
| LCP-7501 | CAUSTIC FILL STATION CP | TANK HIGH LEVEL | DI | 1 | CP-302 | 000Y621 | |
| | | | | | | | |
| LSH-7531 | CAUSTIC SECONDARY CONTAINMENT SUMP | HIGH LEVEL | DI | 1 | CP-302 | 000Y620 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| P-7511(3) | CAUSTIC METERING PUMPS | REMOTE | DI | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | RUN STATUS | DI | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | FAULT | DI | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | TUBE FAILURE | DI | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | RUN COMMAND | DO | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | SPEED FDBK | AI | 3 | CP-302 | 000Y621 | |
| P-7511(3) | CAUSTIC METERING PUMPS | SPEED COMMAND | AO | 3 | CP-302 | 000Y621 | |
| | | | | | | | |
| SWS-7502 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y621 | |
| SWS-7503 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y621 | |
| LCP-7202 | SETTLING AID POLYMER FILL STATION CP | TANK LEVEL SIGNAL | AI | 1 | CP-302 | 000Y622 | |
| LCP-7202 | SETTLING AID POLYMER FILL STATION CP | TANK LOW LEVEL | DI | 1 | CP-302 | 000Y622 | |
| LCP-7202 | SETTLING AID POLYMER FILL STATION CP | TANK HIGH LEVEL | DI | 1 | CP-302 | 000Y622 | |
| | | | | | | | |
| MX-7201 | POLYMER TANK MIXER | HS REMOTE | DI | 1 | CP-302 | 000Y622 | |
| MX-7201 | POLYMER TANK MIXER | RUN STATUS | DI | 1 | CP-302 | 000Y622 | |
| MX-7201 | POLYMER TANK MIXER | FAULT | DI | 1 | CP-302 | 000Y622 | |
| MX-7201 | POLYMER TANK MIXER | RUN COMMAND | DO | 1 | CP-302 | 000Y622 | |
| | | | | | | | |
| PBU-7211 | POLYMER BLENDING UNIT | HS REMOTE | DI | 1 | CP-302 | 000Y622 | |
| PBU-7211 | POLYMER BLENDING UNIT | RUN STATUS | DI | 1 | CP-302 | 000Y622 | |
| PBU-7211 | POLYMER BLENDING UNIT | FAULT | DI | 1 | CP-302 | 000Y622 | |
| PBU-7211 | POLYMER BLENDING UNIT | LOSS OF WATER | DI | 1 | CP-302 | 000Y622 | |
| PBU-7211 | POLYMER BLENDING UNIT | SPEED COMMAND | AO | 1 | CP-302 | 000Y622 | |
| PBU-7211 | POLYMER BLENDING UNIT | RUN COMMAND | DO | 1 | CP-302 | 000Y622 | |
| | | | | | | | |
| LSH-7200 | POLYMER CONTAINMENT BASIN | HIGH LEVEL | DI | 1 | CP-302 | 000Y622 | |
| LCP-7302 | FILTER AID POLYMER FILL STATION CP | TANK LEVEL SIGNAL | AI | 1 | CP-302 | 000Y623 | |
| LCP-7302 | FILTER AID POLYMER FILL STATION CP | TANK LOW LEVEL | DI | 1 | CP-302 | 000Y623 | |
| LCP-7302 | FILTER AID POLYMER FILL STATION CP | TANK HIGH LEVEL | DI | 1 | CP-302 | 000Y623 | |
| | | | | | | | |
| MX-7301 | POLYMER TANK MIXER | HS REMOTE | DI | 1 | CP-302 | 000Y623 | |
| MX-7301 | POLYMER TANK MIXER | RUN STATUS | DI | 1 | CP-302 | 000Y623 | |
| MX-7301 | POLYMER TANK MIXER | FAULT | DI | 1 | CP-302 | 000Y623 | |
| MX-7301 | POLYMER TANK MIXER | RUN COMMAND | DO | 1 | CP-302 | 000Y623 | |
| | | | | | | | |
| PBU-7311 | POLYMER BLENDING UNIT | HS REMOTE | DI | 1 | CP-302 | 000Y623 | |
| PBU-7311 | POLYMER BLENDING UNIT | RUN STATUS | DI | 1 | CP-302 | 000Y623 | |
| PBU-7311 | POLYMER BLENDING UNIT | FAULT | DI | 1 | CP-302 | 000Y623 | |
| PBU-7311 | POLYMER BLENDING UNIT | LOSS OF WATER | DI | 1 | CP-302 | 000Y623 | |
| PBU-7311 | POLYMER BLENDING UNIT | SPEED COMMAND | AO | 1 | CP-302 | 000Y623 | |
| PBU-7311 | POLYMER BLENDING UNIT | RUN COMMAND | DO | 1 | CP-302 | 000Y623 | |
| LCP-7701 | SODIUM HYPOCHLORITE FILL STATION CP | TANK LEVEL SIGNAL | AI | 1 | CP-302 | 000Y624 | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| LCP-7701 | SODIUM HYPOCHLORITE FILL STATION CP | TANK LOW LEVEL | DI | 1 | CP-302 | 000Y624 | |
| LCP-7701 | SODIUM HYPOCHLORITE FILL STATION CP | TANK HIGH LEVEL | DI | 1 | CP-302 | 000Y624 | |
| | | | | | | | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | REMOTE | DI | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | RUN STATUS | DI | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | FAULT | DI | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | TUBE FAILURE | DI | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | RUN COMMAND | DO | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | SPEED FDBK | AI | 3 | CP-302 | 000Y624 | |
| P-7411(3) | SODIUM HYPOCHLORITE METERING PUMPS | SPEED COMMAND | AO | 3 | CP-302 | 000Y624 | |
| | | | | | | | |
| SWS-7402 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y624 | |
| SWS-7403 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y624 | |
| LSH-7431 | SODIUM HYPOCHLORITE SUMP | HIGH LEVEL | DI | 1 | CP-302 | 000Y624 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | REMOTE | DI | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | RUN STATUS | DI | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | FAULT | DI | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | TUBE FAILURE | DI | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | RUN COMMAND | DO | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | SPEED FDBK | AI | 2 | CP-302 | 000Y625 | |
| P-7111(2) | SODIUM CARBONATE FEED SKID | SPEED COMMAND | AO | 2 | CP-302 | 000Y625 | |
| | | | | | | | |
| SWS-7702 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-302 | 000Y625 | |
| LIT-5001 | INTERMEDIATE SUMP LEVEL TRANSMITTER | LEVEL SIGNAL | AI | 1 | CP-301 | 000Y626 | |
| LSLL-5001 | INTERMEDIATE SUMP LOLO LEVEL SWITCH | LOW-LOW LEVEL | DI | 1 | CP-301 | 000Y626 | |
| SWS-5001 | EMERGENCY SHOWER/EYE WASH | ACTIVATED | DI | 1 | CP-301 | 000Y626 | |
| | | | | | | | |
| FIT-5001 | COMBINED EFFLUENT FLOWMETER | FLOW SIGNAL | AI | 1 | CP-301 | 000Y626 | |
| AIT-5001 | COMBINED EFFLUENT pH ANALYZER | pH SIGNAL | AI | 1 | CP-601 | 000Y626 | |
| AIT-5001 | COMBINED EFFLUENT CL2 ANALYZER | CHLORINE RESIDUAL | AI | 1 | CP-601 | 000Y626 | |
| | | | | | | | |
| P-5011(3) | INTERMEDIATE PUMPS | REMOTE | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | FAULT | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | RUN COMMAND | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | SPEED COMMAND | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | VFD FAULT | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | SPEED FDBK | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | MOTOR CURRENT | IP | 3 | CP-301 | 000Y626 | |
| P-5011(3) | INTERMEDIATE PUMPS | RUN STATUS | IP | 3 | CP-301 | 000Y626 | |
| AIT-5201 | POTABLE WATER | CHLORINE RESIDUAL | AI | 1 | CP-601 | 000Y627 | |
| | | | | | | | |
| ZSC-5201(2) | CLEARWELL HATCH LIMIT SWITCH | HATCH CLOSED | DI | 2 | CP-501 | 000Y627 | |
| LIT-5011(2) | CLEARWELL LEVEL TRANSMITTER | LEVEL SIGNAL | AI | 2 | CP-501 | 000Y627 | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| LSH-5201(2) | CLEARWELL HI LEVEL SWITCH | HI LEVEL | DI | 2 | CP-501 | 000Y627 | |
| | | | | | | | |
| BFV-5411 | BACKWASH FLOW CONTROL VALVE | ZK AUTO | DI | 1 | CP-303 | 000Y627 | |
| BFV-5411 | BACKWASH FLOW CONTROL VALVE | POSITION FDBK | AI | 1 | CP-303 | 000Y627 | |
| BFV-5411 | BACKWASH FLOW CONTROL VALVE | POSITION COMMAND | AO | 1 | CP-303 | 000Y627 | |
| | | | | | | | |
| FIT-5211A | BACKWASH SUPPLY FLOWMETER | FLOW SIGNAL | AI | 1 | CP-303 | 000Y627 | |
| P-6001(3) | CROWSON PUMPS | REMOTE | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | FAULT | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | RUN COMMAND | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | SPEED COMMAND | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | VFD FAULT | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | SPEED FDBK | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | MOTOR CURRENT | IP | 3 | CP-601 | 000Y628 | |
| P-6001(3) | CROWSON PUMPS | RUN STATUS | IP | 3 | CP-601 | 000Y628 | |
| SOL-3031 | SOLAR POWER | PV OUTPUT POWER | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | PV OUTPUT CURRENT | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | PV POWER FACTOR | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | INVERTER FAULT | IP | 4 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | BACK OF PANEL TEMP | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | AMBIENT TEMP | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | WIND SPEED | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | WIND DIRECTION | IP | 1 | CP-301 | 000Y629 | |
| SOL-3031 | SOLAR POWER | IRRADIANCE | IP | 2 | CP-301 | 000Y629 | |
| | | | | | | | |
| BES-3041 | BATTERY STORAGE (FUTURE) | ENERGY PARAMETERS | IP | 1 | CP-301 | 000Y629 | |
| | | | | | | | |
| SWBD-300 | WTP MAIN SWITCHBOARD POWER METER | ENERGY PARAMETERS | IP | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD SURGE PROT DEVICES | LOSS OF PROTECTION | DI | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD ATS | FAULT | DI | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD ATS | NORMAL POWER AVAIL | DI | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD ATS | ON NORMAL PWR | DI | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD ATS | STBY POWER AVAIL | DI | 1 | CP-301 | 000Y629 | |
| SWBD-300 | WTP MAIN SWITCHBOARD ATS | ON STBY POWER | DI | 1 | CP-301 | 000Y629 | |
| | | | | | | | |
| GEN-301 | STANDBY GENERATOR | NOT IN AUTO | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | RUN STATUS | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | WARNING | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | GENERAL ALARM | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | FUEL LEVEL LOW | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | FUEL LEVEL LOLO | DI | 1 | CP-301 | 000Y629 | |
| GEN-301 | STANDBY GENERATOR | FUEL TANK LEAK | DI | 1 | CP-301 | 000Y629 | |
| | | | | | | | |

PLC Input/Output Usage Table
Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| EACP-8302 | EMERGENCY ALARM CONTROL PANEL | EMERGENCY ALARM | DI | 1 | CP-301 | 000Y629 | |
| FACP-8302 | FIRE ALARM CONTROL PANEL | FIRE ALARM | DI | 1 | CP-301 | 000Y629 | |
| CP-101 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-101 | -- | |
| CP-101 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-101 | -- | |
| CP-101 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-101 | -- | |
| CP-101 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-101 | -- | |
| CP-101 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-101 | -- | |
| | | | | | | | |
| CP-301 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-301 | -- | |
| CP-301 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-301 | -- | |
| CP-301 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-301 | -- | |
| CP-301 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-301 | -- | |
| CP-301 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-301 | -- | |
| CP-301 | ALARM DIALER TRIGGERS | ALARM | DO | 8 | CP-301 | -- | |
| | | | | | | | |
| CP-302 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-302 | -- | |
| CP-302 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-302 | -- | |
| CP-302 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-302 | -- | |
| CP-302 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-302 | -- | |
| CP-302 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-302 | -- | |
| | | | | | | | |
| CP-303 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-303 | -- | |
| CP-303 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-303 | -- | |
| CP-303 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-303 | -- | |
| CP-303 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-303 | -- | |
| CP-303 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-303 | -- | |
| | | | | | | | |
| CP-401 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-401 | -- | |
| CP-401 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-401 | -- | |
| CP-401 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-401 | -- | |
| CP-401 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-401 | -- | |
| CP-401 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-401 | -- | |
| | | | | | | | |
| CP-501 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-501 | -- | |
| CP-501 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-501 | -- | |
| CP-501 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-501 | -- | |
| CP-501 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-501 | -- | |
| CP-501 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-501 | -- | |
| | | | | | | | |
| CP-601 | CONTROL PANEL UPS | ON BATTERY | DI | 1 | CP-601 | -- | |
| CP-601 | CONTROL PANEL UPS | BATTERY LOW | DI | 1 | CP-601 | -- | |
| CP-601 | CONTROL PANEL UPS | UPS ALARM | DI | 1 | CP-601 | -- | |
| CP-601 | SURGE SUPPRESSOR FAULT | FAULT | DI | 2 | CP-601 | -- | |

# PLC Input/Output Usage Table
## Attachment B

| DEVICE(S) | DESCRIPTION | FUNCTION | TYPE | QTY | PANEL | P&ID | NOTES |
|---|---|---|---|---|---|---|---|
| CP-601 | PS REDUNDANCY MODULE | INPUT FAULT | DI | 2 | CP-601 | – | |

**PLC PANEL LOCATIONS:**

CP-101: PRETREATMENT BUILDING
CP-301: ELECTRICAL ROOM
CP-302: CHEMICAL ROOM
CP-303: FILTER AREA
CP-401: BACKWASH WASTE BASINS
CP-501: CLEARWELL
CP-601: CROWSON PUMP STATION

**PLC INPUT/OUTPUT TYPE:**

AI - ANALOG INPUT CHANNEL
AO - ANALOG OUTPUT CHANNEL
DI - DISCRETE INPUT POINT
DO - DISCRETE OUTPUT POINT
IP - ETHERNET/IP COMMMUNICATIONS

**NOTES:**

1. NONE

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# SECTION 40 63 44
## POWER GENERATION SYSTEM SCADA CONTROL SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Power generation SCADA equipment shall be provided in accordance with the requirements defined herein.
      a. Packaged PV SCADA control system(s), including hardware, software, programming, documentation, and training.
      b. The PV SCADA system shall contain all necessary network devices for connection to the Plant SCADA system
      c. Packaged BESS SCADA control system(s), including hardware, software, programming, documentation, and training.
      d. The BESS SCADA system shall contain all necessary network devices for connection to the Plant SCADA system
      e. The power generation systems shall be designed to provide for automatic, unattended operation. The control system design(s) shall also provide for local manual operation, remote operation from a web-based portal, or dispatch of the generation system from the Plant SCADA system or remote access point.
      f. The control system shall provide all modes of operation suited to the applicable use cases described herein or in the applicable electrical power generation specification section, and its operational set-point functionality shall have the ability to be prioritized and remotely configured through the Plant SCADA system.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. ICS 1, Industrial Control and Systems General Requirements, as applicable.
   2. NERC-CIP-002 to 009 – BES Cyber System Identification, as applicable.
   3. IEC 62443 Industrial network and system security, as applicable.
   4. Underwriters Laboratories (UL)
      a. 746C – Polymeric Materials, Use in Electrical Equipment Evaluations
      b. 508A – Standard for Industrial Control Panels

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and startup of at least three similar installations within the last five years.
   2. Programmer(s) shall have had experience in SCADA system for at least two projects of similar size and complexity.

### 1.3 DEFINITIONS

A. SCADA: Supervisory Control and Data Acquisition

B. DAS: Data Acquisition System

C. RTU: Remote Terminal Unit

D. RTAC: Real-Time Automation Controller

### 1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
    a. Communication Schematics and Topology.
    b. Wiring Diagrams.
    c. Electrical requirements.
    d. Installation instructions and Operation & Maintenance manual.
    e. Results of all simulation procedures.
    f. List of manufacturer's recommended spare parts.
    g. All login and Passwords for device accessibility. (To be submitted via secure methods to OWNER)
    h. A well-documented SCADA Points List
    i. Assigned IP addresses (to be confirmed with OWNER).
    j. Results of commissioning and acceptance testing.
    k. Wiring and Interconnection diagrams.
        1) Power Supplies.
        2) I/O Points.
        3) Communications.
2. Certifications:
    a. Qualifications of installation supervisor.
    b. Qualifications of programmer(s).
3. Software Licenses:
    a. Documentation proving all software package licenses are assigned to owner.

B. Operation and Maintenance Data:
1. Submit maintenance procedures available to Owner.
    a. Include the location and phone numbers of service centers.
    b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

## PART 2 - PRODUCTS

### 2.1 PV SCADA SYSTEM

A. The system shall be capable of providing real-time information on the solar PV system to the Plant SCADA system.

B. Monitoring points shall have the ability to be recorded at a minimum frequency of 1 point per minute, with the capability for instantaneous collection of data when data is outside of set parameters.

C. System should have the ability to remotely access and monitor the data as well as have a sixty (60) calendar day on-site memory storage capacity.

D. The system shall provide remote and local means for resetting alarms.

E. The system shall have the necessary hardware and software (i.e. firewalls and malware detection) such that it is compliant with the latest standards at the time of commissioning for control system security requirements.

F. The SCADA system shall be designed for isolation, testing, diagnostic monitoring, and removal without interruption of the PV system availability.

G. Provide a minimum 5-year manufacturer's warranty of service, support, and replacement, if required.

H. A PV controller shall be supplied that is able to dispatch commands to all inverters and control the PV system as an aggregate generator – include, but are not limited to:
Controls:
    a. Real Power Dispatch.

b. Active Power Dispatch.
c. Shutdown/Turn-On commands.

Statuses:

d. Inverter status.
e. Inverter alarms/fault states.
f. Inverter temperatures.

Metering:

g. Inverter DC voltage, current, and power.
h. Inverter AC voltage, current, and power.
i. Power factor.
j. Frequency.

1. The control system and all control modes should operate via a logical closed-loop PID controller with set-points dynamically adjustable by the Owner.
2. Limits to each operational mode shall be configurable, including ramp rate limits
3. The PID control loop shall be tuned after initial energization to provide the quickest response with no overshoot.
4. Plant control shall be made available in the following modes:
    a. Power Factor Control Mode.
    b. Fixed Reactive Power Control Mode.
    c. Voltage Regulation Mode with associated droop and deadband settings.
    d. Voltage and Current data shall be obtained from Owner supplied Voltage Transformer and Current Transformers.

I. Power requirements.
1. Site power will be provided to the SCADA rack at 120Vac via a 20A Outlet. SCADA/DAS provider power supplies shall be included if required input power to device(s) is not 120V AC.
2. Backup power shall be provided by DAS/SCADA provider in the case of a power outage for 4 hours for RTU, RTAC or SCADA Server and Historian through a UPS.

J. Meteorology Station Interface:
1. Any equipment required to collect data from the weather station instruments shall be installed.
2. Weather Stations point list shall include but not limited to-
    a. Ambient temperature
    b. Panel temperature
    c. Global horizontal irradiance
    d. Plane of array irradiance
    e. Wind Speed
    f. Work with Owner for approval on the SCADA points list.

K. Network Communication:
1. An Ethernet switch shall be included to facilitate communication back to the Plant SCADA system.
2. A failure or power down of a single inverter/device shall not interrupt communications to the remaining inverters/devices.
3. The system shall be capable of two-way communication with the Plant SCADA system via a compatible network medium/protocol such as Ethernet/IP.

L. Enclosure:
a. All above mentioned equipment, with the exception of instrumentation devices that need to be exposed, shall be housed in a non-corrosive, NEMA 4X rated enclosure or higher.

b. Enclosure shall be UL 746C rated. All AC powered monitoring and control panels shall be UL508A listed.
c. All equipment should be securely mounted to a DIN rail.

## 2.2 BESS SCADA SYSTEM

A. The BESS SCADA system shall be provided as an integral component of the overall BESS system. The BESS SCADA system shall meet the instrumentation and control requirements of Section 48 17 00 – BATTERY GENERATION EQUIPMENT.

B. The system shall be capable of providing real-time information on the BESS system to the Plant SCADA system.

C. Monitoring points shall have the ability to be recorded at a minimum frequency of 1 minute, with the capability for instantaneous collection of data when data is outside of set parameters.

D. System should have the ability to remotely access and monitor the data as well as have a sixty (60) calendar day on-site memory storage capacity.

E. The system shall have the necessary hardware and software (i.e. firewalls and malware detection) such that it is compliant with the latest standards at the time of commissioning for control system security requirements.

## 2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. The system shall accomplish the control requirements of the Descriptions, Drawings, and Specifications.

B. SCADA programming shall be documented and factory tested.

C. The system shall operate in ambient conditions of 32 to 140 DEGF temperatures and 5 to 95 PCT relative humidity without the need for purging or air conditioning.

D. Environmental Controls:
1. Furnish circulation fans in solid state control system enclosures.
2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.

## 2.4 SOURCE QUALITY CONTROL

A. Provide well documented source code for controller(s) in pdf format.
1. Source Quality Control Article addresses tests, inspections, and certifications required to be performed at the shop prior to shipment to site.

B. Provide a performance test after factory completion and prior to shipment.
1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, and alarm responses.
2. Provide all accessories required to install and test.
3. Conduct testing with simulated I/O to verify each control loop operation.
4. If deem required, allow for Owner and Engineer representatives to witness program testing.
   a. Provide minimum of 15 days' notice prior to testing.

## 2.5 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra materials:
1. For larger sites, one spare UPS for the entire system.

B. Include a complete bill of materials indicating detailed part model number.

## PART 3 - EXECUTION

### 3.1 FUNCTIONALITY

A. Complete System.
   1. Provide all programming, configuration, coordination, integration, and testing required for furnishing a fully functioning system.
   2. Programming and commissioning of the SCADA system(s) shall be performed by the manufacturer's qualified field service representative.
   3. The Seller shall develop and submit for approval a functional test procedure to demonstrate the performance of the SCADA system(s).
   4. The functional tests shall be performed in accordance with industry standards and in reference to IEEE and NREL guidance.

### 3.2 INSTALLATION

A. Install system in accordance with manufacturer's written instructions.

### 3.3 FIELD QUALITY CONTROL

A. Equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Engineer.
      b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
   4. Conduct startup of equipment and perform operational checks.
   5. Submit a site test report indicating how the system was tested and which items were tested.
   6. Prior to energization provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

### 3.4 COMMISSIONING AND ACCEPTANCE

A. Demonstrate system in accordance with Acceptance Testing.

### 3.5 TRAINING

A. Employee of the manufacturer or certified representative to provide one week of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

B. As a minimum, training shall cover:
   1. Hardware overview.
   2. Software overview.
   3. Documentation.
   4. Maintenance.
   5. Trouble shooting.
   6. Operation, e.g., changing set points, passwords, etc.

### 3.6 DOCUMENTATION

A. Update O&M manuals to reflect as-built conditions.

### 3.7 SUPPORT

A. Provide on-call technical support for a period of one year after substantial completion. Include a minimum of two site visits to work with owner on any final modifications to the logic.

## END OF SECTION

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# SECTION 40 67 00
## CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for control panels and enclosures utilized as follows:
      a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Section 27 21 00, Section 40 71 00, Section 40 72 00, Section 40 73 00, Section 40 63 43, or Section 40 97 00.

B. This Section is only applicable to panels furnished with Division 11 equipment packages when so stated in the applicable Division 11 Section.

C. This Section is only applicable to panels housing Division 26 specified equipment (e.g., motor starters, lighting controls, etc.) when so stated in the applicable Division 26 section.

D. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Division 11 - Equipment.
   5. Division 26 - Electrical.
   6. Section 27 21 00 - Telemetry Systems.
   7. Section 40 61 13 - Process Controls Systems General Requirements.
   8. Section 40 61 43 - Surge Protection Devices (SPD) for Instrumentation and Control Equipment.
   9. Section 40 63 43 - Programmable Logic Controller (PLC) Control System.
   10. Section 40 63 44 – SCADA Control System.
   11. Section 40 71 00 - Flow Instrumentation.
   12. Section 40 72 00 - Level Instrumentation.
   13. Section 40 73 00 - Pressure Instrumentation.
   14. Section 40 74 00 - Temperature Instrumentation.
   15. Section 40 75 00 - Process Liquid Analytical Measurement.
   16. Section 40 79 00 – Miscellaneous Instruments and Appurtenances.
   17. Section 40 97 00 - Control Auxiliaries.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. B75, Standard Specification for Seamless Copper Tube.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 409, Industrial Control Panels.
         2) Article 504, Intrinsically Safe Systems.
   5. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Safety Industrial Control Panels.
      b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

c. 913, Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Miscellaneous:
   1. Approved supplier of Industrial Control Panels under provisions of UL 508A or UL 698A.
      a. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
      b. Control panel(s) without an affixed UL 508A or UL 698A label shall be rejected and sent back to the Contractor's factory.

## 1.3 DEFINITIONS

A. Panel: Control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:
   1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
   2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

F. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

G. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

H. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

I. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

K. Highway Addressable Remote Transducer (HART): An open, master-slave protocol for bus addressable field instruments.

L. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, etc.

M. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

N. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

## 1.4 SUBMITTALS

A. Shop Drawings:

1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. See Section 40 61 13.
3. Prepared with computer aided design (CAD) software.
4. Printed on 11 by 17 IN sheets.
5. Drawings shall include a title block containing the following:
   a. Plant or facility name where panel(s) are to be installed.
   b. Drawing title.
   c. Drawing number.
   d. Revision list with revision number and date
   e. Drawing date.
   f. Drawing scale.
   g. Manufacturer name, address, and telephone number.
6. Cover sheet for each drawing set shall indicate the following:
   a. Plant or facility name.
   b. Project name.
   c. Submittal description.
   d. Revision number.
   e. Issue date.
7. Table of contents sheet(s) shall indicate the following for each drawing in the set:
   a. Drawing number.
   b. Drawing title.
   c. Sheet number.
8. Legend and abbreviation sheet shall indicate the following:
   a. Description of symbols and abbreviations used.
   b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
   c. Confirmation that the panel(s) are to be affixed with a UL 508A or UL 698A label prior to shipment from the factory.
9. Bill of Material for each panel shall include the following component information:
   a. Instrument tag number.
   b. Quantity.
   c. Functional name or description.
   d. Manufacturer.
   e. Complete model number.
   f. Size or rating.
10. Panel exterior layout drawings to scale and shall indicate the following:
   a. Panel materials of construction, dimensions, and total assembled weight.
   b. Panel access openings.
   c. Conduit access locations.
   d. Front panel device layout.
   e. Nameplate schedule:
      1) Nameplate location.
      2) Legend which indicates text, letter height and color, and background color.
      3) Short Circuit Current Rating (SCCR) marking per NFPA 70 or statement of exception. Include any required calculations.
   f. Alarm annunciator window engraving schedule.
   g. Layouts of graphic panels or mosaic displays.
11. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
   a. Sub-panel or mounting pan dimensions.
   b. Interior device layouts.
   c. PLC general arrangement layouts.
   d. Wire-way locations, purpose, and dimensions.
   e. Terminal strip designations.
   f. Location of external wiring and/or piping connections.

g. Location of lighting fixtures, switches and receptacles.

12. Wiring diagrams shall consist of the following:
    a. Panel power distribution diagrams.
    b. Control and instrumentation wiring diagrams.
    c. PLC I/O information:
        1) Model number of I/O module.
        2) Description of I/O module type and function.
        3) Rack and slot number.
        4) Terminal number on module.
        5) Point or channel number.
        6) Programmed point addresses.
        7) Signal function and type.
    d. Wiring diagrams shall identify each wire as it is to be labeled.

B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

C. Electrical load calculations for each panel:
    1. Total connected load.
    2. Peak electrical demand for each panel.

D. Climate control calculations for each panel.
    1. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

E. Contract Closeout Information:
    1. Operation and Maintenance Data:
        a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
    2. See Section 40 61 13.

F. Informational Submittals:
    1. Record Drawings:
        a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
        b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Enclosures:
        a. Hoffman Engineering Co.
        b. Rittal.
        c. Hammond Manufacturing.
        d. Millbank Mfg. Co.
    2. Panel heaters:
        a. Hoffman Enclosures, Inc.
        b. Rittal.
        c. Hammond Manufacturing.
    3. Heat exchangers and air conditioners:
        a. Hoffman Enclosures, Inc.
        b. Rittal.
        c. Hammond Manufacturing.
    4. Cooling fans and exhaust packages:
        a. Hoffman Enclosures, Inc.
        b. Rittal.

5. Internal corrosion inhibitors:
    a. Hoffman Enclosures, Inc.; Model A-HCI.
    b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
    c. Cortec Corporation; Model VpCl Emitting Systems.

B. Submit request for substitution in accordance with Section 01 25 13.

## 2.2 ACCESSORIES

A. Panel Nameplates and Identification:
    1. See Section 10 14 00.

## 2.3 FABRICATION

A. General:
    1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
    2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
    3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
        a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
        b. The window shall maintain the required NEMA rating of the enclosure.
    4. Panel(s) shall be completely assembled at the Contractor's factory.
        a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
    5. Painting:
        a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
            1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
            2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
            3) Utilize solvent or chemical methods to clean panel surfaces.
            4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
            5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
            6) Bake powder coating at high temperatures to bond coating to enclosure surface.
                a) Panel interior shall be white with semi-gloss finish.
                b) Panel exterior shall be ANSI #61 gray with flat finish.
            7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
        b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
    6. Finish opening edges of panel cutouts to smooth and true surface conditions.
        a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
    7. Panels shall meet all requirements of UL 508A or UL 698A.
        a. If more than one disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one disconnect switch required to de-energize the equipment before servicing."
    8. Provide control panel in accordance with NFPA 70, Article 409.
        a. In the event of any conflict between NFPA 70, Article 409 and UL 508A or UL 698A, the more stringent requirement shall apply.
    9. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.

a. Determine the SCCR rating by one of the following methods:
    1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
    2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
    3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

B. Free-Standing Panels:
1. Welded construction.
2. Completely enclosed, self-supporting, and gasketed, dust-tight.
3. Rolled lip around all sides of enclosure door opening.
4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
5. Full height, fully gasketed flush pan doors.
6. Full length piano hinges rated for 1.5 times door plus instrument weight.
7. Doors with keyed alike locking handles and three-point catch.
8. Appropriate conduit, wiring, and instrument openings shall be provided.
9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:
1. Seams continuously welded and ground smooth.
2. Rolled lip around all sides of enclosure door opening.
3. Gasketed dust tight.
4. Three-point latching mechanism operated by oil tight key-locking handle.
5. Key doors alike.
6. Continuous heavy GA hinge pin on doors.
    a. Hinges rated for 1.5 times door plus instrument weight.
7. Front full opening door.
8. Brackets for wall mounting.

D. Internal Panel Wiring:
1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
    a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
    b. Follow wire-duct manufacturer's recommended fill limits.
    c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
    d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Wiring shall be installed such that if wires are removed from one device, source of power will not be disrupted to other devices.
3. Splicing and tapping of wires permitted only at terminal blocks.
4. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
    a. Protect bend area with sleeve.
5. Arrange wiring neatly, cut to proper length, with surplus wire removed.
    a. Arrange wiring with sufficient clearance.
    b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
6. AC circuits shall be routed separate from analog signal cables and digital signal cables.
    a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.

7. Separation of intrinsically safe circuit conductors and non-intrinsically safe circuit conductors:
    a. Secure conductors so that any intrinsically safe circuit conductor that might come loose from a terminal is unlikely to come into contact with another terminal.
    b. Separate non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by one of the following methods:
        1) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by at least 2 IN (50 MM).
        2) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of a grounded metal partition 0.0359 IN (0.91 MM) or thicker.
        3) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of an approved insulating partition that extends to within 0.0625 IN (1.5 MM) of the enclosure walls.
        4) Where either (1) all of the intrinsically safe circuit conductors or (2) all of the non-intrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.
8. Separate different intrinsically safe circuit conductors from each other by one of the following means:
    a. The conductors of each circuit are within a grounded metal shield.
    b. The conductors of each circuit have insulation with a minimum thickness of 0.01 IN (0.25 MM).
9. Provide minimum clearance of 0.125 IN (3 MM) between uninsulated parts of intrinsically safe field wiring conductors connected to terminals and grounded metal or other conducting parts.
10. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
11. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DEGC.
    a. Conductor size shall be as required for load and 16 AWG minimum.
    b. Internal panel wiring color code:
        1) AC circuits:
            a) Power wiring: Black.
            b) Control interconnections: Yellow.
            c) Neutral: White.
            d) Ground: Green.
        2) Low voltage DC circuits:
            a) Power wiring: Blue.
            b) Control interconnections: Violet.
        3) Foreign voltage circuits: Pink.
        4) Annunciator circuits: Red.
        5) Intrinsically safe circuits: Light Blue.
12. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
    a. Conductor size: 18 AWG minimum.
    b. Terminate shield drain conductors to ground only at one end of the cable.
13. High precision 250 ohm resistors with 0.25 PCT accuracy shall be used where 4 - 20 mA DC analog signals are converted to 1 - 5 VDC signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
14. Analog signals for devices in separate enclosures shall not be wired in series.

a. Loop isolators shall be used where analog signals are transmitted between control enclosures.

15. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.
    b. Wire tags:
        1) Slip-on, PVC wire sleeves with legible, machine-printed markings.
        2) Adhesive, snap-on, or adhesive type labels are not acceptable.
    c. Markings as identified in the Shop Drawings.

E. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
    a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus.
5. It is imperative that good electrical connections are made at the point between the ground bus and enclosure.
6. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
7. Sub-panels and doors shall be bonded to ground.
8. Associated apparatus (connected to intrinsically safe circuits) and associated cable shields:
    a. Ground in accordance with the associated control drawing (drawing provided for the intrinsically safe circuit and which contains manufacturer's entity parameters).

F. Termination Requirements:
1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
4. One side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
5. Terminal block markings:
    a. Marking shall be the same as associated wire marking.
    b. Legible, machine-printed markings.
    c. Markings as identified in the shop drawings.
6. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
7. Terminal blocks with continuous marking strips.
    a. Each terminal block shall be identified with machine printed labels.
8. Terminals shall facilitate wire sizes as follows:
    a. 120 VAC applications: Conductor size 12 AWG minimum.
    b. Other: Conductor size 14 AWG minimum.
9. Analog signal cable shield drain conductors shall be individually terminated.
10. Install minimum of 20 PCT spare terminals.
11. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.
12. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.
13. Fused terminal blocks shall be provided with blown fuse indicators.
14. When control circuits require more than one field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one field conductor per terminal block.

15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.
17. Intrinsically safe circuit termination:
    a. Provide at least 0.25 IN (6 MM) clearance between two terminals for connection of field wiring of different intrinsically safe circuits, unless this clearance is permitted to be reduced by the control drawing this is provided for the intrinsically safe circuit and which contains manufacturer's entity parameters.
    b. Identify intrinsically safe circuits at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing as required by NEC, Article 504.

G. Component Mounting and Placement:
1. Components shall be installed per manufacturer instructions.
2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
3. Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor, unless otherwise shown in the Contract Documents.
4. PLC and I/O rack installation:
    a. Located such that the LED indicators and switches are readily visible with the panel door open.
    b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
5. Locate power supplies with sufficient spacing for circulation of air.
6. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC system components, provide a barrier of at least 6 IN of separation between the "power area containing the electromagnetic devices" and the "control area".
7. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
    a. Fastening devices shall not project through the outer surface of the panel enclosure.
8. Excess mounting space of at least 20 PCT for component types listed below to facilitate future expansion:
    a. Fuse holders.
    b. Circuit breakers.
    c. Control relays.
    d. Time delay relays.
    e. Intrinsically safe barriers and relays.
9. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.
    a. Minimum of 2 IN separation between terminal strips and wire ducts.
10. Pneumatic tubes and appurtenances:
    a. Connect panel air piping and tubing penetrations with bulkhead fittings.
    b. Pneumatic control tubing shall be 1/4 IN OD.
        1) Tubing material: Either soft annealed ASTM B75 copper or flame-resistant polyethylene.
    c. Main headers within panels shall be minimum 1 IN.
    d. Compression-type pressure fittings.
    e. Equip panel instrument leads with ball type isolation valve.
    f. Route tubing neatly and mount securely.
    g. Do not route tubing in front of or in wire ducting.
    h. Code terminal plates.
    i. Pneumatic devices shall be served by a dual function filter regulator.

H. Power Distribution:

1. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
   a. Limit load to maximum of 80 PCT of circuit breaker rating.
2. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
   a. PLC power supply modules.
   b. Manual loading stations.
3. Each control panel with PLC components shall be furnished with power protection in the form of a double conversion UPS.
4. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 PCT spare capacity.
5. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.

I. Internal Panel Lighting and Service Receptacles:
   1. Panels less than or equal to 4 FT wide:
      a. One electrical GFCI duplex receptacle.
      b. One LED light fixture with manual switch(es).
   2. Panels or panel faces greater than 4 FT wide:
      a. One duplex electrical GFCI receptacle per 6 FT of length.
      b. Continuous LED strip with manual switches.

J. Environmental Controls:
   1. Indoor panels located in a designated electrical room or control room:
      a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
      b. Internal corrosion inhibitors.
   2. Indoor panels not located within a designated electrical room or control room:
      a. Thermostat controlled heaters to maintain temperature approximately 10 DEGF above ambient for condensation prevention inside the panels.
      b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
      c. Internal corrosion inhibitors.
   3. Outdoor panels:
      a. Outdoor temperature range of 0 DEGF through 120 DEGF.
      b. Thermostat controlled heaters to maintain temperature approximately 10 DEGF above ambient dew point for condensation prevention inside the panels.
      c. Outdoor temperature range of 0 DEGF through 120 DEGF.
      d. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
      e. Internal corrosion inhibitors.
   4. Environmental control components:
      a. Panel heaters:
         1) Thermostat controlled.
         2) Fan driven.
         3) Components mounted in an anodized aluminum housing.
         4) Designed for sub-panel mounting.
         5) Powered from 120 VAC and protected with a dedicated circuit breaker.
      b. Cooling fans and exhaust packages:
         1) Cooling fan with louver or grill and replaceable filter.
         2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.
         3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.

4) Fitted with replaceable, high-density foam or synthetic fiber.
5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
6) Powered from 120 VAC and protected with a dedicated circuit breaker.

c. Heat exchangers and air conditioners:
1) Dual-loop design to isolate panel interior air from exterior air.
2) Thermostat controlled.
3) Operate from 120 VAC and protected with a dedicated circuit breaker.

d. Internal corrosion inhibitors:
1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

### 2.4 MAINTENANCE MATERIALS

A. Extra Materials:
1. Quantity of 25 PCT replacement lamps for each type installed (minimum of 12 of each type).
2. Minimum 12 replacement filters for each type installed.
3. 1 QT of exterior finish touch-up paint.
4. One complete set of replacement corrosion inhibitors in sealed packages for each panel.

## PART 3 - EXECUTION

### 3.1 FACTORY TESTING

A. Scope: Inspect and test entire panel assembly to verify readiness for shipment.

B. Location: Contractor's factory.

C. Factory Tests:
1. Tests shall be fully documented and signed by the Contractor's factory supervisor.
2. The panel shop shall fully test the control panel for correct wiring.
   a. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.
3. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.
4. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.
5. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.
6. The following functions shall be tested as a minimum:
   a. Demonstrate functions of the panel(s) required by the Contract Documents.
   b. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
   c. Simulate and test each discrete signal at the field terminal strips.
   d. Simulate and test each analog signal using loop calibrators.
   e. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases.
   f. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
   g. Correct operation of all digital communication devices.
   h. Demonstrate online and offline diagnostic tests and procedures.
   i. Notify the Engineer in writing a minimum of 15 calendar days prior to the Factory Tests.
      1) Engineer has the option to witness all required tests.

7. Make following documentation available to the Engineer at test site during the tests:
   a. Contract Documents.
   b. Factory Demonstration Testing procedures.
   c. List of equipment to be testing including make, model, and serial number.
   d. Shop Drawing submittal data for equipment being tested.
8. Deficiencies shall be corrected prior to shipment from the Contractor's factory.

## 3.2 INSTALLATION

A. Install free-standing panels on 4 IN high concrete housekeeping pads.

B. Anchor panels in a manner to prevent enclosure deformation, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

## 3.3 SCHEDULE

| TAG NUMBER | PROCESS AREA | ENCLOSURE RATING | UPS REQUIRED | ELEVATION DRAWING |
|---|---|---|---|---|
| CP-101 | PRETREATMENT BUILDING | NEMA 12 | YES | 000Y013 |
| CP-301 | ELECTRICAL ROOM | NEMA 12 | YES | 000Y014 |
| CP-302 | CHEMICAL ROOM | NEMA 4X | YES | 000Y015 |
| CP-303 | FILTER AREA | NEMA 4 | YES | 000Y016 |
| CP-401 | BACKWASH WASTE BASIN | NEMA 4 | YES | 000Y017 |
| CP-501 | CLEARWELL | NEMA 4 | YES | 000Y018 |
| CP-601 | CROWSON PUMP STATION | NEMA 12 | YES | 000Y019 |
| CP-7101 | ALUM FILL STATION | NEMA 4X | NO | 000Y020 |
| CP-7202 | SETTLING AID POLYMER FILL STATION | NEMA 4X | NO | 000Y020 |
| CP-7302 | FILTER AID POLYMER FILL STATION | NEMA 4X | NO | 000Y020 |
| CP-7401 | SODIUM HYPOCHLORITE FILL STATION | NEMA 4X | NO | 000Y020 |
| CP-7501 | CAUSTIC FILL STATION | NEMA 4X | NO | 000Y020 |

**END OF SECTION**

# SECTION 40 71 00
## FLOW INSTRUMENTATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Flow Transmitters:
      a. Magnetic Flow Meters (Inline).
      b. Thermal Mass Flow Meters.
   2. Flow Indicators:
      a. Rotameters - High Accuracy.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
   2. ASTM International (ASTM):
      a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Sanitation Foundation (NSF):
      a. 61, Drinking Water System Components – Health Effects.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

### 1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.

B. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 FLOW TRANSMITTERS

A. Magnetic Flow Meters (Inline):
   1. Acceptable manufacturers:
      a. ABB (WaterMaster).
      b. Endress + Hauser (ProMag).
      c. Krohne (OPTIFLUX).
      d. Rosemount (8700 Series).
      e. Siemens (SITRANS F M).
      f. Or approved equal.
   2. Materials:
      a. Liner material: polyurethane, EPDM, or natural rubber unless noted otherwise.
      b. Electrode material: 316 stainless steel unless noted otherwise.
      c. Grounding rings: same material as the provided electrodes.
      d. Meter tube: 304 stainless steel.
      e. Meter flanges: 304 stainless steel.
   3. Design and fabrication:
      a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
      b. All meters for drinking water service shall be NSF 61 certified.
      c. Each flow meter shall be furnished with a separately-mounted transmitter, unless noted otherwise.
         1) Provide interconnecting cable between flow tube and transmitter.
         2) Cable lengths shall be as required to accommodate locations shown on Drawings. Field verify actual conduit lengths prior to fabrication.
         3) Cables shall be continuous, without splices.
      d. Pulsed DC magnetic field excitation.
      e. Inaccuracy: ±0.4 PCT of rate.
      f. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
      g. Flow Tube (Sensor):
         1) Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions.
         2) Operating pressure: 0 to 150 psi.
         3) Operating temperature: 20 to 150 DegF.
         4) Inlet and outlet grounding rings for each flow tube.
         5) Flow Tube sensor coil resistance:
            a) Normal service: 350 Ohms maximum.
            b) High noise service: 12 Ohms maximum.
      h. Transmitter:
         1) Transmitter electronics shall use microprocessor-based architecture and be configured using field adjustable parameters via front panel keypad and HART calibrator.
         2) Housing requirements: watertight, NEMA 4X rated, wall-mount enclosure.
         3) Power supply: 117 V +10 percent, 60 Hz.
         4) Indication of flow rate and totalized flow in engineering units.
         5) Adjustable low flow cutoff.
         6) Automatic zero.

7) Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
8) High input impedance pre-amplifiers.
   a) Minimum impedance: $10^{10}$ ohms.
9) 4-20 mA DC isolated output into maximum 800 ohms.
10) Signal damping: adjustable between 2 and 256 seconds.
11) HART communications.

4. Schedule:

| TAG NUMBER | APPLICATION DESCRIPTION | OUTPUT RANGE | METER SIZE | NOTES |
|---|---|---|---|---|
| FE/FIT-1001 | RAW WATER | 0-7,000 GPM | 20 IN | 2 |
| FE/FIT-4111 | FILTER 1 EFFLUENT | 0-2,500 GPM | 12 IN | 1 |
| FE/FIT-4121 | FILTER 2 EFFLUENT | 0-2,500 GPM | 12 IN | 1 |
| FE/FIT-4131 | FILTER 3 EFFLUENT | 0-2,500 GPM | 12 IN | 1 |
| FE/FIT-4141 | FILTER 4 EFFLUENT | 0-2,500 GPM | 12 IN | 1 |
| FE/FIT-4703 | BACKWASH WASTE DRAIN | 0-2,500 GPM | 12 IN | 2 |
| FE/FIT-5001 | INTERMEDIATE PUMP STATION | 0-7,000 GPM | 24 IN | 2 |
| FE/FIT-5411 | BACKWASH SUPPLY | 0-8,000 GPM | 14 IN | 2 |

**NOTES:**
1. Transmitter integrally mounted with flow tube.
2. Flow tube shall be rated for accidental submergence. IP68 submergence protection.

B. Thermal Mass Flowmeters:
1. Acceptable manufacturer:
   a. Endress + Hauser (Proline T-mass).
   b. Fluid Components International LLC.
   c. Kurz Instruments, Inc.
   d. Magnetrol (Thermatel TA2).
   e. Or approved equal.
2. Materials:
   a. All wetted surfaces: 300 series stainless steel.
3. Design and fabrication:
   a. Sensors:
      1) Sensor assembly of 300 series stainless steel thermowells with precisely matched RTDs and a heating element.
      2) Operating temperature: 0-250 DegF.
      3) Process connection: Manufacturer Standard.
      4) Process pressure: 0-30 psig.
      5) Field adjustable insertion length.
      6) Compression fitting.
   b. Transmitter:
      1) Painted steel enclosure with hinged cover, NEMA 4 rating.
      2) Turndown ratio: 100:1, compatible with flow ranges listed in the schedule below.
      3) Accuracy: +3 percent of reading down to +0.3 percent of full scale
      4) Repeatability: +1 percent of reading.
      5) Output signal: 4-20 mA DC into 600 Ohms maximum.
      6) 115 Vac, 60 Hz power.
      7) Microprocessor based electronics with field adjustable instrument performance parameters and build-in testing and diagnostics and nonvolatile memory.

8) Provide digital LCD display at transmitter.
9) Transmitter shall be remotely mounted to the sensor.
10) Operating temperature: 0-125 DegF.

c. Provide all interconnecting cable(s) between sensor and transmitter. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings. Field verify actual conduit lengths prior to fabrication.
d. Supply two (2) programmers to allow reconfiguration of process parameters.
e. Provide N.I.S.T. traceable calibration certificate for each flow meter.
f. In-line flow conditioner:
1) Required where shown in schedule.
2) Stainless steel pipe section with flanged end sections.
a) Pipe schedule and flange connections to match installed piping.
3) Flow conditioner to be approximately seven pipe diameters long.
4) Flow conditioner section to include radial swirl and profile conditioning tab.
5) Flow conditioner to include provision for sensor installation.

4. Schedule:

| TAG NUMBER | APPLICATION DESCRIPTION | OUTPUT RANGE | LINE SIZE |
|---|---|---|---|
| FE/FIT-4511 | FILTER AIR SCOUR | 0-2,000 GPM | 10 IN |

## 2.3 FLOW INDICATORS

A. Rotameters - High Accuracy:
1. Acceptable manufacturers:
a. ABB.
b. Brooks Instrument.
c. Krohne.
d. Or approved equal.
2. Materials:
a. Tube: Borosilicate glass.
b. Floats and fittings: 316 stainless steel.
c. Gaskets and packing: Teflon.
d. Side plates and bezels: 300 series stainless steel.
3. Design and fabrication:
a. Variable area flow meter.
b. Provide acrylic plastic safety enclosure where operating pressures may exceed 50 PSIG.
c. Meter end fittings fully rotatable through 360 DEG.
d. Provide frost shield to maintain dry dead air space between metering tube and atmosphere.
e. Fabricate metal scale calibrated to read directly in units of flow with range of twice design flow.
f. Tube length: 10 IN.
g. Process fluid: Water, unless otherwise noted.
h. Accuracy: ±2 PCT of full scale over a 10:1 turndown ratio.
i. Unit shall be straight-through construction with vertical NPT end connections.
4. Schedule:

| TAG NUMBER | APPLICATION | LINE SIZE | FLOW CAPACITY |
|---|---|---|---|
| FI-3003 | RAW WATER OZONE ANALYZER | ½ IN | 0-1000 mL/min |
| FI-4111 | FILTER 1 TURBIDIMETER SAMPLE WATER | ¼ IN | 0-1000 mL/min |

| TAG NUMBER | APPLICATION | LINE SIZE | FLOW CAPACITY |
|---|---|---|---|
| FI-4121 | FILTER 2 TURBIDIMETER SAMPLE WATER | ¼ IN | 0-1000 mL/min |
| FI-4131 | FILTER 3 TURBIDIMETER SAMPLE WATER | ¼ IN | 0-1000 mL/min |
| FI-4141 | FILTER 4 TURBIDIMETER SAMPLE WATER | ¼ IN | 0-1000 mL/min |
| FI-4200 | FTW TURBIDIMETER SAMPLE WATER | ½ IN | 0-1000 mL/min |
| FI-5001 | FE TURBIDIMETER SAMPLE WATER | ½ IN | 0-1000 mL/min |
| FI-7221 | BALLASTED SEDIMENTATION TRAIN 1 SPC | ½ IN | 0-100 mL/min |
| FI-7222 | BALLASTED SEDIMENTATION TRAIN 2 SPC | ½ IN | 0-100 mL/min |
| FI-7513 | OZONATED WATER PIPELINE SHY CARRIER WATER | ½ IN | 0-20 GPM |
| FI-8075 | IPS SHY CARRIER WATER | ½ IN | 0-20 GPM |

### 2.4 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
      b. Mounting brackets:
         1) Standard: 316 stainless steel.
         2) Highly corrosive areas: Fiberglass.
      c. Mounting plates, angles:
         1) Standard: 316 stainless steel.
         2) Corrosive areas: Fiberglass.
      d. Instrument pipe stands:
         1) Standard and corrosive areas:
            a) 316 stainless steel.
            b) 2 IN schedule 40.

B. Provide handheld communicator compatible for all intelligent transmitters furnished.
   1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
   2. If these features are provided with the intelligent transmitter that is accessible, the hand held communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

### 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

**END OF SECTION**

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# SECTION 40 72 00
LEVEL INSTRUMENTATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Level Transmitters:
      a. Ultrasonic Level Sensor and Transmitter.
      b. Non-Contact Type Radar Level Transmitter.
   2. Level Switches:
      a. Float-Tilt Type Level Switch, Non-Mercury.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
   2. ASTM International (ASTM):
      a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

### 1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.

B. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 LEVEL TRANSMITTERS

A. Ultrasonic Level Sensor and Transmitter:
   1. Acceptable manufacturers:
      a. Endress + Hauser (*Prosonic* S).
      b. Siemens Milltronics (*MultiRanger* 100/200).
      c. Or approved equal.
   2. Materials:
      a. Sensor wetted parts: PVC, polypropylene, KYNAR or polyvinylidene fluoride (PVDF).
   3. Design and fabrication:
      a. Sensor:
         1) Emits ultrasonic sound.
         2) Detects return echo reflected from surface and converts it to electrical energy proportional to level.
         3) Integral temperature sensor for time-of-flight correction.
         4) FM approved for Class 1, Division 1, Group A, B, C, and D.
         5) Provide all interconnecting cable(s) between sensor and transmitter. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings. Field verify actual conduit lengths prior to fabrication.
      b. Capable of being configured to ignore false targets.
      c. Operating temperature: -40 to 140 DegF.
      d. Humidity: 95 percent non-condensing.
      e. Transmitter:
         1) Capable of producing output signal proportional to level or flow.
         2) Capable of accepting one or two sensors, depending on the application.
         3) Power supply: 120 VAC, 60 Hz.
         4) Outputs:
            a) One or two Isolated 4-20mA into 600 ohms max with HART. Programmable scale for level, volume, or open channel flow.
            b) Three multipurpose relay outputs with SPDT contacts:
         5) Inaccuracy: 0.2 percent of the maximum span of the sensor.
         6) Resolution: 0.04 IN.
         7) Display: Four-digit LED or LCD scalable to engineering units with selectable decimal point.
         8) Temperature: -20 to 140 DegF.
         9) Humidity: 95 percent noncondensing.
         10) Memory: EEPROM (non-volatile).
         11) Keypad programmer.
   4. Schedule (or Instrument List):

| TAG NUMBER | SERVICE | OUTPUT RANGE | NOTES |
|---|---|---|---|
| LE/LIT-4701 | BACKWASH RECOVERY BASIN 1 | 0-25 FT | HANDRAIL MOUNTED PER SHEET 000Y024/DETAIL 3 |
| LE/LIT-4702 | BACKWASH RECOVERY BASIN 2 | 0-25 FT | HANDRAIL MOUNTED PER SHEET 000Y024/DETAIL 3t |
| LE/LIT-5001 | INTERMEDIATE SUMP | 0-22 FT | FLANGE MOUNTED PER SHEET 000Y021/DETAIL 7 |
| LE/LIT-5201 | CLEARWELL TANK 1 | 0-45 FT | TANK MOUNTED PER SHEET 000Y023/DETAIL 2 |

A. Non-Contact Type Radar Level Transmitter:
   1. Manufacturers:
      a. Siemens (Sitrans LR150).
      b. Ohmart Vega (Vegapuls 21).
      c. Or approved equal.
   2. Specifications:
      a. General:
         1) Measurement Principle: Continuous level measurement via non-contact radar signal measuring the "time of flight" for the signal to travel from the sensor to the measured surface and back again.
            a) Level measurement.
            b) Blanking distance: Up to 12 IN.
            c) Application: Liquids or solids that may be re viscous or corrosive.
            d) Mearing frequency: W-band, 80 GHz.
            e) Beam angle: 8 degrees.
         2) Measurement range (see schedule):
         3) Maximum range: 49 FT.
         4) Accuracy: ±2 mm.
      b. Process Connection:
         1) Threaded (NPT): 1-1/2 inch.
         2) Flange (ASME): See Schedule.
         3) Bracket mount: See Schedule.
      c. Display and Configuration:
         1) Integral display for live measurement and configuration.
         2) Adjustable zero and span.
         3) Output variable: Level.
         4) Output Units: Feet, inches, meters, or millimeters (mm).
      d. Electrical:
         1) Signal Power: Loop-powered, 2-wire, 24 VDC.
         2) Current Output: Analog 4-20 Ma into a 400 ohm loop.
         3) High/Low signal alarms (4.0 mA and 20.0 mA).
         4) Bluetooth connectivity for configuration with mobile device application.
         5) Cable entry: 1/2 IN NPT connection.
         6) Complies with FCC Part 15.
      e. Materials of Construction:
         1) Antenna: Materials chemically inert in the mounting environment.
         2) Housing: PBT or PVDF, hermetically sealed enclosure and antenna.
         3) Process seal: PVDF or FKM.
         4) Flanges (ASME B16.5): Plastic.
      f. Environment:
         1) Ambient Temperature: -40 to 158 DEGF.
         2) Process Temperature: -40 to 158 DEGF.
         3) Process Pressure: 0 to 43 PSIG.
         4) Protection: Refer to Area Classification Drawings.
   3. Schedule (or Instrument List):

| TAG NUMBER | SERVICE | OUTPUT RANGE | NOTES |
|---|---|---|---|
| LT-4001 | SETTLING TANK EFFLUENT CHANNEL LEVEL | 0-20 FT | BRACKET MOUNT PER SHEET 000Y024/DETAIL 5 |
| LT-4111 | FILTER 1 LEVEL | 0-20 FT | BRACKET MOUNT PER SHEET 000Y024/DETAIL 5 |
| LT-4121 | FILTER 2 LEVEL | 0-20 FT | BRACKET MOUNT PER SHEET 000Y024/DETAIL 5 |
| LT-4131 | FILTER 3 LEVEL | 0-20 FT | BRACKET MOUNT PER SHEET 000Y024/DETAIL 5 |
| LT-4141 | FILTER 4 LEVEL | 0-20 FT | BRACKET MOUNT PER SHEET 000Y024/DETAIL 5 |
| LT-7101 | ALUM STORAGE TANK 1 | 0-15 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |
| LT-7102 | ALUM STORAGE TANK 2 | 0-15 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |
| LT-7201 | SETTLING AID POLYMER TANK | 0-5 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |
| LT-7301 | FILTER AID POLYMER TANK | 0-3 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |
| LT-7401 | SODIUM HYPOCHLORITE STORAGE TANK | 0-15 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |
| LT-7501 | CAUSTIC STORAGE TANK | 0-10 FT | TANK MOUNTED PER SHEET 000Y024/DETAIL 4 |

## 2.3 LEVEL SWITCHES

A. Float-Tilt Type Level Switches, Non-Mercury:
   1. Acceptable manufacturers:
      a. SJE Rhombus, Milliampmaster control switch.
      b. Flygt, NNM-10 level regulator.
      c. Or approved equal.
   2. Materials:
      a. Float material: Polypropylene or Teflon coated type 316 stainless steel.
      b. Cable jacket: PVC, neoprene.
      c. Cable clamp: Polypropylene or 316 stainless steel.
   3. Design and fabrication:
      a. Mechanically-activated control switch designed to activate low current control panels and alarms. Sealed gold cross-point contacts designed for low current (non-sparking) operation.
      b. Provide switch complete with flexible electrical cables of length as noted or as necessary per mounting requirements.
      c. Cable type SJOW, nitrile PVC jacket, 2-No. 18 AWG.
      d. Float: 2.74 inch diameter x 4.83 inch long, high-impact, corrosion resistant housing.
      e. Mounting Device: cable weight or mounting clamp as shown in the schedule.
      f. Fail-safe contacts:
         1) High level applications – normally closed:
            a) The contact switch turns on (closes) when the switch drops below horizontal signaling a not at high level condition, and turns off (opens) when the switch tips above horizontal.
         2) Low level applications – normally open.
            a) The contact switch turns on (closes) when the switch tips above horizontal signaling a not at low level condition, and turns off (opens) when the switch drops below horizontal.

g. Contacts shall activate/deactivate at 1.5 IN above and below horizontal with a 3.5 IN tether.
h. The float operation shall not be sensitive to rotation.
i. Maximum water depth: 30 FT.
j. Terminate cables in junction box.
k. Process temperature: 60 DegF.
l. Pipe-mounted, corrosion-proof cable clamp for 1 IN pipe.
m. Fiberglass connection junction box sized to allow the connection of up to five floats.
n. UL Listed.

4. Schedule (or Instrument List):

| TAG NUMBER | APPLICATION | MOUNTING DEVICE | MOUNTING ELEVATION |
|---|---|---|---|
| LSH-4111 | FILTER 1 HIGH LEVEL | SUSPENDED | 2299.00 FT |
| LSH-4121 | FILTER 2 HIGH LEVEL | SUSPENDED | 2299.00 FT |
| LSH-4131 | FILTER 3 HIGH LEVEL | SUSPENDED | 2299.00 FT |
| LSH-4141 | FILTER 4 HIGH LEVEL | SUSPENDED | 2299.00 FT |
| LSH-5201 | CLEARWELL TANK HIGH LEVEL | PIPE | 2365.50 FT |
| LSH-7141 | ALUM SECONDARY CONTAINMENT SUMP | PIPE | 6 IN ABOVE THE BOTTOM OF SUMP |
| LSH-7200 | POLYMER SECONDARY CONTAINMENT SUMP | PIPE | 6 IN ABOVE THE BOTTOM OF SUMP |
| LSH-7431 | SODIUM HYPOCHLORITE SECONDARY CONTAINMENT SUMP | PIPE | 6 IN ABOVE THE BOTTOM OF SUMP |
| LSH-7531 | CAUSTIC SECONDARY CONTAINMENT SUMP | PIPE | 6 IN ABOVE THE BOTTOM OF SUMP |
| LSH-7741 | SODIUM CARBONATE SECONDARY CONTAINMENT SUMP | PIPE | 6 IN ABOVE THE BOTTOM OF SUMP |
| LSLL-5001 | INTERMEDIATE SUMP | SUSPENDED | AS REQUIRED BY PUMP MANUFACTURER FOR LOW-LOW LEVEL PROTECTION |

## 2.4 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets:
1) Standard: 316 stainless steel.
2) Highly corrosive areas: Fiberglass.
c. Mounting plates, angles:
1) Standard: 316 stainless steel.
2) Corrosive areas: Fiberglass.
d. Instrument pipe stands:
1) Standard and corrosive areas:
a) 316 stainless steel.
b) 2 IN schedule 40.

B. Provide handheld communicator compatible for all intelligent transmitters furnished.
   1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
   2. If these features are provided with the intelligent transmitter that is accessible, the hand held communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:
   1. Orient stems for proper operation.
   2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
   3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
   4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
      a. When cool, reassemble the valves.
   5. Support each valve individually.
      a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Threaded Connection Seals:
   1. Use Tite-Seal or acceptable alternate.
   2. Use of lead base pipe dope or Teflon tape is not acceptable.
   3. Do not apply Tite-Seal to tubing threads of compression fittings.

I. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protect from heat, shock, and vibrations.
      b. Provide accessibility for maintenance.
      c. Free from interference with piping, conduit and equipment.

### 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

## END OF SECTION

# SECTION 40 73 00
## PRESSURE INSTRUMENTATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pressure Transmitters.
      a. Pressure Transmitters (Gauge).
      b. Differential Pressure Transmitters.
   2. Pressure Switches.
      a. Electro-Mechanical.
   3. Pressure Indicators.
      a. Pressure Gauges – Mechanical.
   4. Isolation Devices.
      a. Diaphragm Seals.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

### 1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.

B. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PRESSURE TRANSMITTERS

A. Pressure Transmitters (Gauge):
   1. Acceptable manufacturers:
      a. Emerson Rosemount (3051).
      b. Endress + Hauser (Cerabar S).
      c. Schneider Electric / Foxboro (IGP/IAP).
      d. Siemens (SITRANS P500).
      e. Or approved equal.
   2. Materials:
      a. Process flanges and adapters: 316 stainless steel.
      b. Vent/drain valve: 316 stainless steel.
      c. Isolating diaphragm: 316 stainless steel.
      d. Housing: Aluminum.
      e. Fill fluid:
         1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMN04, FeCl, Na0H, and Na0Cl.
         2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
   3. Design and fabrication:
      a. Smart transmitters utilizing microprocessor based electronics.
      b. Integral LCD type display.
      c. Signal Output: 4-20 mA DC proportional to pressure.
      d. Optional Communication: HART.
      e. Nonvolatile EEPROM memory.
      f. Power supply: 24 VDC Loop Power.
      g. Adjustable zero and span.
      h. Temperature limits:
         1) -20 to 180 DEGF (without digital display).
         2) -4 to 175 DEGF (with digital display).
      i. Overpressure limits: Withstand 150 PCT of stated maximum service pressure without damage.
      j. Humidity limits: 0 to 100 PCT relative humidity.
      k. Damping: Adjustable between 0 and 60 seconds.
      l. Accuracy (includes effects of linearity, repeatability and hysteresis): ±0.10 PCT of calibrated span for 15:1 rangeability.
      m. Stability: ±0.2 PCT of upper range limit for 12 months.
      n. Temperature effect:
         1) Total effect including span and zero errors: + 0.2 PCT of upper range limit per 100 DEGF for minimum 15:1 rangeability.
      o. Minimum 1/2 IN pressure connection.
      p. Equip with test jacks or accessible terminals for testing output.
      q. Equip with isolation valve and test connections with isolation valves and/or plugs.
   4. Schedule: (or Instrument List).

| TAG NUMBER | APPLICATION | OUTPUT RANGE | DIAPHRAGM SEAL REQ'D |
|---|---|---|---|
| PIT-1500 | RAW WATER | 0-100 PSI | NO |
| PIT-4511 | FILTER AIR SCOUR FLOW | 0-25 PSI | NO |

B. Differential Pressure Transmitters:
   1. Acceptable manufacturers:
      a. Emerson Rosemount (3051).
      b. Endress + Hauser (Deltabar S).
      c. Honeywell (ST 3000 Series 100).
      d. Schneider Electric / Foxboro (IGP/IAP).
      e. Siemens (SISTRANS P500).
   2. Materials:
      a. Process flanges and adapters: 316 stainless steel.
      b. Vent/drain valve: 316 stainless steel.
      c. Isolating diaphragm: 316 stainless steel.
      d. Housing: Aluminum.
      e. Fill fluid:
         1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMN04, FeCl, Na0H, and Na0Cl.
         2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
   3. Design and fabrication:
      a. Smart transmitter utilizing microprocessor based electronics.
      b. Integral LCD type display.
      c. Signal Output: 4-20 mA DC proportional to differential pressure.
      d. Optional Communication: HART.
      e. Nonvolatile EEPROM memory.
      f. Power supply: 24 VDC Loop Power.
      g. Adjustable zero and span.
      h. Temperature limits:
         1) -20 to 180 DEGF (without digital display).
         2) -4 to 175 DEGF (with digital display).
      i. Overpressure limits:
         1) Withstand body rated pressure on either side without damage or loss of calibration.
         2) Withstand 150 PCT of stated maximum service pressure without damage.
      j. Humidity limits: 0 to 100 PCT relative humidity.
      k. Damping: Adjustable between 0 and 60 seconds.
      l. Accuracy (includes effects of linearity, repeatability and hysteresis): ±0.10 PCT of calibrated span for 15:1 rangeability.
      m. Stability: ±0.2 PCT of upper range limit for 12 months.
      n. Temperature effect:
         1) Total effect including span and zero errors: ±0.2 PCT of upper range limit per 100 DEGF for minimum 15:1 rangeability.
      o. Minimum 1/2 IN pressure connection.
      p. Equip with test jacks or accessible terminals for testing output.
      q. Equip with a three-valve manifold as follows:
         1) Two transmitter isolating valves.
         2) One transmitter equalizing valve.
      r. Provide with test connections with isolation valves and/or plugs.
   4. Schedule: (or Instrument List).

| TAG NUMBER | APPLICATION | SPAN (FT H2O) | DIAPHRAGM SEAL REQ'D |
|---|---|---|---|
| DPIT-4111 | FILTER 1 HEAD LOSS | -10 TO 25 | NO |
| DPIT-4121 | FILTER 2 HEAD LOSS | -10 TO 25 | NO |
| DPIT-4131 | FILTER 3 HEAD LOSS | -10 TO 25 | NO |

| TAG NUMBER | APPLICATION | SPAN (FT H2O) | DIAPHRAGM SEAL REQ'D |
|---|---|---|---|
| DPIT-4141 | FILTER 4 HEAD LOSS | -10 TO 25 | NO |

## 2.3 PRESSURE SWITCHES

A. Electro-Mechanical:
   1. Acceptable manufacturers:
      a. Allen-Bradley (Model 836).
      b. Emerson / ASCO (S Series).
      c. Ashcroft (B Series).
   2. Materials:
      a. Wetted switch elements: 316 stainless steel.
      b. Diaphragm seal housing: 316 stainless steel.
      c. Pressure snubber:
         1) Filter disc: 316 stainless steel.
         2) Housing: 316 stainless steel.
   3. Accessories:
      a. Provide ball valve to isolate pressure switch from source.
      b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on pressure switch as shown on schedule.
      c. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
   4. Design and fabrication:
      a. Utilize "Snap Action" type contact switches.
      b. No external power needed.
      c. One SPDT contact rated:
         1) 0.5 amps inductive at 125 VDC.
         2) 5 amps inductive at 120 VAC.
      d. Switch set points:
         1) Set points between 30 and 70 PCT of switch rated working range.
         2) Operating pressure not to exceed 75 PCT of switch rated working range.
      e. Accuracy: ±1 PCT of full scale.
      f. Process connection: Minimum of 1/4 IN.
      g. Conduit connection: Minimum of 1/2 IN.
   5. Schedule:

| TAG NUMBER | APPLICATION | TRIP SETTING | DIAPHRAGM SEAL REQ'D | SNUBBER REQ'D |
|---|---|---|---|---|
| PSH-3011 | SAMPLE PUMP | 5 PSI | NO | YES |
| PSH-3231 | SAMPLE PUMP | 5 PSI | NO | YES |
| PSH-6001 | CROWSON PUMP 1 | 100 PSI | NO | YES |
| PSH-6002 | CROWSON PUMP 2 | 100 PSI | NO | YES |
| PSH-6003 | CROWSON PUMP 3 | 100 PSI | NO | YES |

## 2.4 PRESSURE INDICATORS

A. Pressure Gauge - Mechanical:
   1. Acceptable manufacturers:
      a. Ametek / USGauge (Solfrunt Model 1980).

b. Ashcroft (Type 1279 or 1379).
c. Trerice (450 Series).
d. Wika (XSEL).

2. Materials:
   a. Bourdon tube, socket, connecting tube: 316 stainless steel.
   b. Case: Phenolic.
   c. Pressure snubber:
      1) Filter disc: 316 stainless steel.
      2) Housing: 316 stainless steel.
3. Accessories:
   a. Provide valve at point of connection to equipment and at panel if panel mounted.
   b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on gauge applications as shown on schedule.
   c. Provide 1/2 IN stainless steel anti-siphon pigtail inlet connection for hot water and steam applications.
4. Design and fabrication:
   a. All components suitable for service at:
      1) 250 DEGF.
      2) The maximum process temperature to which the gauge is to be exposed.
   b. Provide viewer protection from element rupture.
   c. Calibrate gauges at jobsite for pressure and temperature in accordance with manufacturer's instructions.
   d. Stem mounted.
   e. Dial size: 4-1/2 IN
   f. Equip with white faces, black numerals and black pointers.
   g. Gauge tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
      1) Gauge to be readable from an accessible standing position.
   h. Gauge accuracy: 1 PCT of full range.
   i. Select gauge range so that:
      1) The normal operating value is in the middle third of the dial.
      2) Maximum operating pressure does not exceed 75 PCT of the full scale range.
5. Schedule:

| TAG NUMBER | APPLICATION | RANGE (PSI) | DIAPHRAGM SEAL REQ'D | SNUBBER REQ'D |
|---|---|---|---|---|
| PI-1001 | RAW WATER | 0-160 | NO | NO |
| PI-3011 | SAMPLE PUMP | 0-30 | NO | YES |
| PI-3231 | SAMPLE PUMP | 0-30 | NO | YES |
| PI-5011 | INTERMEDIATE PUMP 1 | 0-60 | NO | YES |
| PI-5012 | INTERMEDIATE PUMP 2 | 0-60 | NO | YES |
| PI-5013 | INTERMEDIATE PUMP 3 | 0-60 | NO | YES |
| PI-6001 | CROWSON PUMP 1 | 0-160 | NO | YES |
| PI-6002 | CROWSON PUMP 2 | 0-160 | NO | YES |
| PI-6003 | CROWSON PUMP 3 | 0-160 | NO | YES |
| PI-8072 | SETTLING AID POLYMER BLENDING UNIT WATER | 0-100 | NO | NO |

| TAG NUMBER | APPLICATION | RANGE (PSI) | DIAPHRAGM SEAL REQ'D | SNUBBER REQ'D |
|---|---|---|---|---|
| PI-8073 | FILTER AID POLYMER BLENDING UNIT WATER | 0-100 | NO | NO |
| PI-8075 | CAUSTIC CARRIER WATER | 0-100 | NO | NO |

## 2.5 ISOLATION DEVICES

A. Diaphragm Seal:
   1. Acceptable manufacturers:
      a. Ametek.
      b. Ashcroft.
      c. Emerson Rosemount.
   2. Materials:
      a. Lower housing: to match process pipe material.
      b. Diaphragm material: 316 stainless steel.
   3. Design and fabrication:
      a. Isolates instrument from process fluids which are corrosive or contain solids.
      b. Upper housing with bleed screw.
      c. Lower housing with flushing connection.
      d. Fill fluid:
         1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
         2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
      e. Process connections:
         1) Instrument: 0.25 IN female NPT.
         2) Process: 0.5 IN female NPT.
         3) PVC pipe applications: Use a socket weld connection.
   4. Installed where specified or shown on Drawings.

## 2.6 ACCESSORIES

A. Furnish one hand-held HART Communicator with carrying case for this project to be used to configure the smart instruments specified with HART communications capabilities.
   1. Acceptable manufacturers:
      a. Rosemount – Model 475 Field Communicator.
      b. Submit request for substitution in accordance with Specification Section 01 25 13.
   2. Design and Fabrication:
      a. Universal support for HART capable devices.
      b. User interface:
         1) Keypad with 25-keys including alphanumeric, shift, function, and action keys.
         2) 1/4 VGA (240 by 320 pixels) color, 3.5 in. display with touchscreen and anti-glare coating.
      c. Bluetooth communications.
      d. Processor and Memory:
         1) Microprocessor: 80 MHz Hitachi® SH3
         2) Memory Internal Flash: 32 MB
         3) System Card: 1 GB secure digital card
         4) RAM: 32 MB
      e. Rechargeable battery with charger.
      f. Hazardous location certification: Class I, Division 1, Groups A-D.
      g. Three year upgrade option to allow users to add new System Application software and device descriptions.

h. Field accessory kit:
    1) Protective rubber boot.
    2) Ruggedized 250 ohm load resistor.
    3) Magnetic hanger.
    4) Stylus pack.
    5) Technical training CD.

B. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
    1. Materials, unless otherwise specified, shall be as follows:
        a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
        b. Mounting brackets:
            1) Standard: 316 stainless steel.
            2) Highly corrosive areas: Fiberglass.
        c. Mounting plates, angles:
            1) Standard: 316 stainless steel.
            2) Corrosive areas: Fiberglass.
        d. Instrument pipe stands:
            1) Standard and corrosive areas: 316 stainless steel, 2 IN schedule 40.

C. Provide handheld communicator compatible with all intelligent transmitters furnished.
    1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
    2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

D. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:
    1. Orient stems for proper operation.
    2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
    3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
    4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
        a. When cool, reassemble the valves.
    5. Support each valve individually.
        a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Threaded Connection Seals:
    1. Use Tite-Seal or acceptable alternate.
    2. Use of lead base pipe dope or Teflon tape is not acceptable.

3. Do not apply Tite-Seal to tubing threads of compression fittings.

I. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protection from heat, shock, and vibrations.
      b. Accessibility for maintenance.
      c. Freedom from interference with piping, conduit and equipment.

## 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

**END OF SECTION**

# SECTION 40 74 00
## TEMPERATURE INSTRUMENTATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Temperature Transmitters.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control System General Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Type 316 Stainless Steel.
   2. American Society of Mechanical Engineers (ASME):
      a. PTC 19.3, TW – 2016 Thermowells.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13 - Process Control Systems General Requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

### 1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.

B. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 TEMPERATURE TRANSMITTER

A. Temperature Transmitters:
   1. Manufacturers:
      a. Emerson Rosemount (3144).
      b. Endress + Hauser (Omnigrad S).
      c. Schneider Electric / Foxboro (RTT).
      d. Siemens (SITRANS T).
   2. Materials:
      a. Transmitter housing: Aluminum.
      b. Sensor sheath: 316 stainless steel.

c. Thermowell: 316 stainless steel.

3. Design and fabrication:
   a. Smart transmitter utilizing microprocessor based electronics and shall be configured using a HART communicator.
   b. RTD requirements:
      1) Materials:
         a) Sensor: Platinum, 100 Ohm.
         b) Sheath: Type 316 stainless steel.
         c) Insulation: Ceramic or metallic oxide.
         d) Sensor length: 36 IN.
      2) Design and fabrication:
         a) 100 ohms at 0 DegC.
         b) Spring loaded.
         c) Lead wire compensation: Three- or four-wire.
         d) Accuracy: ±0.5 DegF or ±0.5 percent of measured temperature, whichever is greater.
         e) Sheath diameter: ¼ IN.
   c. Thermowell requirements:
      1) Process connection: ¾ IN NPT.
      2) Insertion length: 36 IN.
      3) Constructed in accordance with ASME PTC 19.3, Part 3, Chapter 1, Paragraphs 8-19.
      4) Lagging extension sufficient to provide wrench clearance above lagging.
      5) Seal welded on applications where process pressure exceeds 450 psi.
      6) Test thermowell shall be supplied with watertight cap and chain.
   d. Transmitter mounted with temperature sensor, unless otherwise noted.
   e. Integral LCD display with engineering units.
   f. Stability:
      1) Any of the following drift limits are acceptable:
         a) Greater of: 0.1 percent of reading or 0.1 DegC per 12 months.
         b) 0.05 percent of input reading plus 0.043 percent of span per 12 months.
         c) 0.05 percent of maximum span per 12 months.
   g. Ambient temperature limits:
      1) -40 to 185 DegF.
      2) Integral LCD meter: -4 to 158 DegF.
   h. Output: 4-20 mA DC signal linearly proportional to temperature.
   i. Power supply: 24 VDC.
   j. Adjustable zero and span.

4. Schedule:

| TAG NUMBER | APPLICATION | LINE SIZE | OUTPUT RANGE |
|---|---|---|---|
| TE/TIT-4511 | FILTER AIR SCOUR | 10-INCH | 0-300 DEGF |

## 2.2 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
      b. Mounting brackets:
         1) Standard: Carbon steel.
         2) Corrosive areas: 316 stainless steel.
      c. Mounting plates, angles:

1) Standard: Carbon steel.
2) Corrosive areas: 316 stainless steel.

d. Instrument pipe stands:
1) Standard: carbon steel.
2) Corrosive areas: 316 stainless steel.

B. Provide handheld communicator compatible with all intelligent transmitters furnished.
1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Keep foreign matter out of the system.

D. Threaded Connection Seals:
1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

E. Temperature Elements:
1. Assemble in the following sequence:
a. Remove temperature sensor sheaths and terminal blocks from the head and nipple assembly.
b. Connect nipple and head to thermowell installed in the pipe.
c. Insert sheath and terminal block until it seats in the thermowell.
d. Connect to the head.

F. Instrument Mounting:
1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
a. Protection from heat, shock, and vibrations.
b. Accessibility for maintenance.
c. Freedom from interference with piping, conduit and equipment.

### 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

**END OF SECTION**

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# SECTION 40 75 00
## PROCESS LIQUID ANALYTICAL MEASUREMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. pH Sensor and Analyzer.
   2. Chlorine Residual (Total) Analyzer.
   3. Streaming Current Monitor.
   4. Turbidity Analyzer.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.

### 1.2 QUALITY ASSURANCE

1. ASTM International (ASTM):
   a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. International Electrotechnical Commission (IEC):
   a. 60529:1989, Degrees of protection provided by enclosures (IP Code).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. US Environmental Protection Agency (EPA):
   a. 40 CFR 141.74, Analytical and monitoring requirements.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

### 1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.

B. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 ANALYTICAL ELEMENTS

A. pH Sensor and Analyzer:
1. Manufacturers:
   a. Hach DPS1 sensor and model sc4500 controller (transmitter).
   b. No like, equivalent or or-equal item is acceptable.
2. Materials:
   a. Sensor: Polyethersulfone (PES), KYNAR, (polyvinylidene fluoride (PVDF)), liquid crystal polymer, epoxy (less than 140 DegF).
   b. O-rings: VITON.
3. Design and fabrication:
   a. Sensor:
      1) Digital technology enabling calibration of sensor with a laboratory analyzer/transmitter prior to field installation of sensor with the field-mounted analyzer/transmitter.
      2) Integral pre-amplifier to convert high impedance pH into stable, noise-free signal.
      3) Automatic temperature compensation.
      4) Shielded cable.
      5) Sensitivity: 0.01 pH.
      6) Range: 4-12 pH.
   b. Transmitter:
      1) The controller shall be a microprocessor-based instrument.
      2) Diplay shall continuously display both channels.
      3) Shall include interface to allow operators to control sensor and interface functions with menu-driven software.
      4) Controller shall be capable of accepting up to two sensors. Sensors shall be connected to controllers per the schedule.
         a) Input channel 1 is represented by "01:" in the schedule.
         b) Input channel 2 is represented by "02:" in the schedule.
      5) Input power: 120 VAC.
      6) Outputs:
         a) Two analog 4-20 mA outputs, maximum 500 Ohm.
         b) Two SPDT, form C electromechanical contacts, 5 amp rating.
      7) NEMA-4X/IP66 rated enclosure.
4. Schedule:

| TAG NUMBER | SERVICE | OUTPUT RANGE |
|---|---|---|
| AE/AIT-1512 | RAW WATER | 01: 6.00 - 9.00 PH<br>02: 32.0 - 80.0 DEGF |
| AE/AIT-3003 | OZONATED WATER | 01: 6.00 - 9.00 PH<br>02: 32.0 - 80.0 DEGF |
| AE/AIT-5003 | FILTER EFFLUENT WATER | 01: 6.00 - 9.00 PH<br>02: SPARE |

B. Chlorine Residual (Total) Transmitters:
1. Manufacturers:
   a. Hach – CL17sc.
   b. No like, equivalent or or-equal item is acceptable.
2. Design and fabrication:

a. Type: online colorimetric type chlorine analyzer for continuous monitoring of total residual chlorine in water. Instrument chemistry will employ N, N-diethyl-p-phenylenediamine (DPD) method.
b. Construction features:
    1) Housed in an IP66-rated enclosure.
    2) Capable of measuring free or total residual chlorine by changing the tubing and indicator and buffer solutions.
    3) Measurements are taken every 2.5 minutes and results are displayed on a controller display or web-enabled display in the range of 0 to 10 mg/L.
    4) Utilizes a built-in flow meter.
    5) Real-time flow rate is measured when sample is flowing through the analyzer and results are displayed on a controller display or web-enabled display in mL / min.
    6) Connects to a standard controller, which controls and provides power to the analyzer.
    7) Performs a blank reference measurement check between analysis points to compensate for sample color, turbidity, and changes in light intensity due to voltage fluctuations or light source aging.
    8) Operates with an LED light source at a peak wavelength of 510nm.
    9) Capable of operating unattended for 30 days between chemical reagent changes and measurement cell cleaning.
    10) Utilizes a three-color status light to indicate operating status.
    11) Utilizes three measurement cycle indicator lights to display the phase of the measurement cycle being performed.
    12) Has a colorimeter measurement cell window for viewing sample inside cell.
    13) Provides step-by-step, on-screen instructions for all routine maintenance activities, including reagent changes, tubing changes, and cell cleanings.
c. Certifications:
    1) Complies with US EPA 40 CFR 141.74
d. Controller:
    1) The controller shall be a microprocessor-based instrument.
    2) Controller shall be capable of accepting up to two sensors. Sensors shall be connected to controllers per the schedule.
    3) Display shall continuously display both channels.
    4) Shall include interface to allow operators to control sensor and interface functions with menu-driven software.
    5) Outputs:
        a) Two analog 4-20 mA outputs, maximum 500 Ohm.
        b) Two SPDT, form C electromechanical contacts, 5 amp rating.
        c) NEMA-4X/IP66 rated enclosure.
    6) Power Supply: 105 to 130 VAC, 50/60 Hz, 15 watts.
e. Performance requirements:
    1) Measurement range: 0 to 10 mg/L (ppm) free or total residual chlorine
    2) Accuracy: ± 5% of reading or ±0.04 mg/L (ppm), whichever is greater from 0 to 5 mg/L as Cl2; +/- 10% from 5 to 10 mg/L as Cl2
    3) Precision: 5% of reading or 0.01 mg/L (ppm), whichever is greater
    4) Lower Limit of Detection (LOD): 0.03 mg/L (ppm)
    5) Resolution: 0.01 mg/L (ppm)
    6) Repeatability: 5% of reading or 0.01 mg/L (ppm), whichever is greater
    7) Cycle time: 2.5 minutes
f. Environmental requirements:
    1) Operational Criteria:
        a) Sample flow rate: 60 to 200 mL/minute through the analyzer.
        b) Sample Filtration: Y-strainer with 40-mesh screen or higher.
        c) Inlet Pressure:
            (1) 4.5 to 75 psig supplied to Y-strainer

(2) 1.5 to 5 psig (0.1 to 0.3 bar) supplied to analyzer
d) Sample temperature: 41 to 104 degF
e) Operating temperature: 41 to 104 degF
f) Operating humidity: 0 to 90% non-condensing relative humidity

g. Accessories:
1) Calibration verification kit.
2) Calibration verification refill kit.
3) Pressure regulator installation kit.

h. Reagents and consumables.
1) Provide sufficient quantities for a one year of operation assuming routine calibration.
a) Indicator, indicator solution, and buffer solutions.
b) Cell cleaning kit.
c) Calibration verification kit.
d) Analyzer tubing replacement kit.

3. Schedule:

| TAG NUMBER | APPLICATION | OUTPUT RANGE |
|---|---|---|
| AE/AIT-5002 | FILTER EFFLUENT WATER | 0-4.00 PPM |
| AE/AIT-5201 | PLANT EFFLUENT WATER | 0-4.00 PPM |

C. Streaming Current Monitor:
1. Manufacturers:
a. ChemTrac HydroACT with DuraTrac 4.
b. Milton Roy SC5200.
c. MicroMetrix.

2. Design and fabrication:
a. Sensor:
1) Range: -1000 to +1000.
2) Adjustable signal gain.
3) Adjustable zero offset.
4) Wetted Materials: 316 Stainless Steel, UHMW (Ultra-high molecular weight Polyethylene, Delrin (polyoxymethylene), Polyethersulfone (PES), Kynar, Polyvinylidene fluoride (PVDF). Liquid crystal polymer, Epoxy (less than 140F), Nylon.
a) O-Rings: Viton.
5) Self-diagnostics with dry contact alarm output.
6) Self-cleaning.
7) Power: 120 VAC.
8) Enclosure: NEMA 4X.
9) Operating temperature: 1-49 DegC.
10) Shielded cable.

b. Transmitter:
1) Up to three measured parameters.
2) One 4-20mA output per measured parameter.
3) Measurement range selectable.
4) Display: LED or LCD.
a) Minimum 3-1/2 digit.
5) Power: 120 VAC.
6) Enclosure: NEMA 4X.
7) Ambient temperature: 20 to 122 DEGF.
8) Ambient humidity: 0-95 PCT.

9) Response time: 1 s to 1 min adjustable.
10) Zero setting available via operator keypad or touchscreen interface.

c. Sampling:
1) Sampling flow range: 1 liter/min to 4 liters/min.

3. Schedule:

| TAG NUMBER | APPLICATION | OUTPUT RANGE |
|---|---|---|
| AE/AIT-3004 | RAW WATER | -1000 to +1000 |

D. Turbidity Analyzer:
1. Manufacturers:
a. Hach TU5 series turbidimeter with sc4500 controller:
b. No like, equivalent or or-equal item is acceptable.
2. Design and fabrication:
a. General:
1) Measuring range: 0 - 700 NTU.
2) Accuracy:
a) +2 percent from 0 - 40 NTU
b) +10 percent from 40 - 1000 NTU.
3) Repeatability: +1 percent or +0.002 NTU (whichever is greater) or 0.0004 NTU below 0.1 NTU when higher resolution is selected.
4) Response Time: For a full scale step change, 90 percent response in 30 minutes at 100mL/min flow rate.
5) Resolution: 0.0001 NTU, selectable.
6) Sample requirements:
a) Temperature range: 36 - 140 DegF.
b) Flow rate: 100 to 1000 mL/min; optimal flow rate 200 to 500mL/min.
7) Pressure: 6 bar (87 psi) maximum compared to air.
8) Output: 4- 20 mADC programmable over any portion of the NTU range.

b. Sensor:
1) Utilizes a laser-based 360 degree x 90 degree optical system that measures turbidity from multiple different angles.
2) Continuous particle removal using a vortex created by the fluid path.
3) Optical and hydraulic components housed in turbidimeter body. Optical components mounted on a head assembly for easy removal for servicing without disturbing sample flow.
4) Body constructed of corrosion-resistant structural plastic.
5) Sample inlet and outlet: 1/4-IN OD tubing
6) Mounting: Wall.

c. Transmitter:
1) The controller shall be a microprocessor-based instrument.
2) Connections between the sensors and the controller shall be "plug and play."
3) The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4) The interface unit shall have a built-in data logger with the capacity to store data on 15-minute intervals for up to 6 months with two sensors per controller.
5) The interface unit shall include two analog 4-20 mA outputs and 3 SPDT form 'C' alarm contacts.
6) The interface unit shall include two independent PID control functions.
7) The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
8) The controller shall be mounted horizontal or vertical on surface, panel, or pipe.

9) The AC power supply shall be housed in the interface unit and automatically accept input in the range of 120 VAC, 15 watts.

d. Accessories:
1) Include sufficient quantities for a one-year operation assuming routine calibration.
2) Include calibration cylinder, formazin calibration kit, and maintenance kit for turbidimeter body.
3) Glass verification rod.

3. Schedule:

| TAG NUMBER | APPLICATION | OUTPUT RANGE |
|---|---|---|
| AE/AIT-1511 | RAW WATER | 0-100 NTU |
| AE/AIT-4111 | FILTER 1 | 0-5.00 NTU |
| AE/AIT-4121 | FILTER 2 | 0-5.00 NTU |
| AE/AIT-4131 | FILTER 3 | 0-5.00 NTU |
| AE/AIT-4141 | FILTER 4 | 0-5.00 NTU |
| AE/AIT-4200 | FILTER TO WASTE | 0-1,000 NTU |
| AE/AIT-5001 | COMBINED EFFLUENT | 0-5.00 NTU |

## 2.3 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets:
1) Standard: 316 stainless steel.
2) Highly corrosive areas: Fiberglass.
c. Mounting plates, angles:
1) Standard: 316 stainless steel.
2) Corrosive areas: Fiberglass.
d. Instrument pipe stands:
1) Standard and corrosive areas:
a) 316 stainless steel.
b) 2 IN schedule 40.

B. Provide handheld communicator compatible with all intelligent transmitters furnished.
1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter, the hand held communicator is not required (provided the transmitter is easily accessible by an operator without the need for a ladder/step stool).

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protection from heat, shock, and vibrations.
      b. Accessibility for maintenance.
      c. Freedom from interference with piping, conduit and equipment.

## 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

**END OF SECTION**

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# SECTION 40 79 00
## MISCELLANEOUS INSTRUMENTS AND APPURTENANCES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Weight measuring components.
   2. Position switch components.
   3. Sampling Probes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 61 13 - Process Control Systems General Requirements.
   2. Section 40 61 96 - Process Control Descriptions.
   3. Section 40 75 00 – Process Liquid Analytical Measurement.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "Y" series Drawings and specified in Specification Section 40 61 96.
   1. These instruments are integrated with other control system components specified under Specification Section 40 61 13 series to produce the functional control defined in the Contract Documents.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

### 2.2 WEIGHT MEASURING COMPONENTS

A. Drum scale with integral containment:
   1. Acceptable manufacturers:
      a. Force Flow – SOLO G2 with SPILLSAFE LX DRUM SCALE.
      b. Scaletron – Model 4042ECO-WB-26.
      c. Or approved equal.

2. Materials:
   a. Platform: two-part epoxy powder coated steel.
   b. Containment vessel: polyethylene.
   c. Containment bladder: double-layer polyethylene.
3. Design and fabrication:
   a. Electronic load cell type scale for 55 GAL drums with digital readout.
   b. Capacity: 1000 LBS.
   c. Drum scale:
      1) Integral containment pan with a minimum capacity of 11 GALS.
      2) Integral secondary spill containment bladder with a minimum capacity of 55 GALS.
      3) Scale shall be sized to accept drums up to 24 IN in diameter.
      4) Overall platform height shall be less than 7.0 IN.
      5) Weight shall be transferred via platform to electronic load cells.
   d. Indicator:
      1) Single channel.
      2) Six-digit numerical display with 0.56 IN high characters and with backlighting.
      3) Bar graph display.
      4) Accuracty: ±0.25%.
      5) A dual mode TARE key shall allow user to enter the tare weight of the vessel or enter the net weight of the chemical depending on application needs.
      6) A diagnostics menu shall allow recalibration without the need to apply field test weights.
      7) Readout in LB, KG, GAL, or L.
      8) Output signal: 4-20ma DC.
      9) User adjustable setpoints for alarms.
      10) Input power: 120VAC.
      11) NEMA 4X rated enclosure.
      12) UL listed.
   e. Provide 20 FT cable between scale platform to the indicator.
4. Schedule:

| TAG NUMBER | SERVICE | OUTPUT SCALE |
|---|---|---|
| WE/WIT-7601 | CALCIUM THIOSULFATE DRUM | 0-1000 LBS. |

## 2.3 POSITION SWITCH COMPONENTS

A. Hatch Position Switches:
   1. Acceptable manufacturers:
      a. Honeywell/Microswitch.
      b. Allen-Bradley.
      c. Eaton Cutler-Hammer.
   2. Materials:
      a. Case: cast aluminum.
      b. Roller arm: stainless steel.
   3. Design and fabrication:
      a. Enclosed, heavy-duty limit switch with top roller arm actuator, adjustable with roller.
      b. Elastomer boot designed to protect the actuating mechanism and the internal switch from contaminants.
      c. Contacts: DPDT, 2 NC and 2 NO snap action.
      d. NEMA 4X rated enclosure. Seal gasket between cover plate and the enclosure.
      e. Switch rating:

f. 0.5 HP at 125 VAC, 50/60 Hz
g. 10 amps 125 VAC, 50/60 Hz
h. Third party testing laboratory approval: UL, FM or CSA.
i. Reference detail in plans for installation application and requirements.
j. Installation detail shall be included as part of the submittal.
k. UL Listed.

4. Schedule:

| TAG NUMBER | SERVICE |
|---|---|
| ZSC-5201 | CLEARWELL TANK 1 HATCH POSITION SWITCH |

### 2.4 SAMPLING PROBES

A. Furnish all fittings, supports, pipe including weld-o-let, bushings and appurtenances required for a complete and functional non-retractable sampling probe.
1. Materials:
a. Sample probe:
1) PVC.
2) 316 SST.
a) Required for process pipes larger than 18 IN ID.
2. Pressure rating: 150 PSI.
3. Process connection size: 1/2 IN.
4. Probe nominal size: 3/8 IN.
5. Tip configuration: 45 degree bevel.
6. Isolation ball valve material: matching sample probe material.
7. Provide one spare sampling probe assembly for each size provided.

### 2.5 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets: aluminum.
c. Mounting plates, angles: aluminum.

B. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Keep foreign matter out of the system.

C. Plug all open ends and connections to keep out contaminants.

D. Instrument Mounting:
1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
a. Protection from heat, shock, and vibrations.
b. Accessibility for maintenance.

c. Freedom from interference with piping, conduit and equipment.

## 3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

**END OF SECTION**

# SECTION 40 96 52

## CONFIGURATION REQUIREMENTS - HUMAN MACHINE INTERFACE (HMI) AND REPORTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Configuration requirements for HMI and reports which includes but is not necessarily limited to.
      a. Specific software functional descriptions.
      b. Graphics requirements.
      c. HMI functionality requirements.
      d. Plant overview screens.
      e. Process overview screens.
      f. Detail displays.
      g. Trend displays.
      h. PLC hardware/HMI status screen.
      i. Alarm monitoring.
      j. Report generation.
      k. Configuration standards and conventions.
      l. Screen configuration review meetings.
      m. Report configuration review meetings.
      n. Coordination.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 - Process Control Systems General Requirements.
   4. Section 40 61 96 – Process Control Descriptions.

### 1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Programmer(s) shall have had experience in software configuration and installation for at least two projects of similar size and complexity.

### 1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. I/O: Input/Output.

C. OLE: Object Linking and Embedding, a document standard developed by Microsoft that enables the creation of an object with one application and the linking or embedding of the object in a second application.

D. OPC: "OLE for Process Control"; a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

E. PC: Personal Computer.

F. PLC: Programmable Logic Controller.

### 1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 40 61 13.
3. Software Configuration Standards and Conventions document.
4. Graphic screen displays; provide in actual colors utilized.
5. Sample reports.
6. Certifications:
    a. Qualifications of programmer(s).

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Software Configuration Standards and Conventions - final version.

C. Informational Submittals:
1. Results of factory testing procedures.
2. Proposed training agendas and schedule.

## 1.5 GENERAL FUNCTIONAL REQUIREMENTS

A. Software Functional Requirements:
1. General functional requirements for system configuration are indicated on the Drawings and described in the Specifications.
2. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system.
3. The Contractor is responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Owner.

B. Available Process Values:
1. All process alarm, equipment status, and process variable values shall be available at any HMI.
2. If communications to a particular I/O point has failed for any reason, then wherever that data is displayed, the software shall post a visual indication that the point is not valid.

C. Provide comprehensive on-line help for all development functions.

D. Manual Entry of Data:
1. All PC-based HMIs must allow manual entry of surrogate data and other variables, which must then be available for display and use in reports.
    a. Operator-entered commands from any of the operator workstations must be logged by the computer servers.

E. System Failure:
1. Failure of any PLC, remote I/O hardware, or network communication link must be individually alarmed at HMIs.
2. Unless otherwise specified, each alarm must be specific to a single point of failure.

F. Software licensing shall allow a minimum of five plant HMIs to be active simultaneously.

G. All process related functions, calculations, timers, and numeric manipulations, shall be accomplished in the PLC hardware and not in the HMI.
1. The HMI shall function as a monitoring system, not as a process controller.
2. The HMI shall transfer data to the PLC system and the PLC system shall perform all control algorithms.

## 1.6 SECURITY

A. Fully integrate security into the SCADA system to allow only users with appropriate security levels access to individual parts of the system.

## PART 2 - PRODUCTS

### 2.1 SPECIFIC SOFTWARE FUNCTIONAL DESCRIPTIONS

A. Specific functional requirements for various software control blocks within the computer system are as follows.

B. Descriptions are general and are not intended to fully indicate the complete functionality of the system.
   1. Monitoring of process values:
      a. Process values derived from analog process variable signals must be historically archived.
         1) Store all historical data with time and date of occurrence.
         2) Make values available for use in reports.
         3) Assign high and low alarms to process values as defined below and otherwise deemed appropriate.
      b. Provide capability for computer server(s) to retrieve real-time values from the PLC system at adjustable time periods.
      c. Alarm limits:
         1) Set per direction from the Owner.
         2) An operator having proper security authorization must be able to enable, disable, and adjust the setpoint of any individual alarm.

C. Utilize graphic screen displays at the HMI(s) to provide monitoring and control functionality.
   1. Hierarchy of HMI screens is in descending order as follows:
      a. Plant overview screen(s).
      b. Process overview screens.
      c. Process screens.
      d. Pop-up/control screens.

D. HMI operator interface functionality shall include:
   1. Indication of process variables.
   2. Configuration of control loop parameters (e.g., setpoints, gains, etc.).
   3. Adjustment of controller output.
   4. Display of real time and historical process trends.
   5. Selector switch and pushbutton station controls.
   6. System and process status indicators.
   7. Graphic representation of plant operations with interactive status and measurement symbols.
   8. Annunciation.

E. Graphics:
   1. Utilize dynamic variables with unique tags per graphic.
   2. Dragging the mouse over designated process areas of screen shall allow the operator to select predetermined processes or equipment and drill down to site-specific detail screens.
   3. Critical "overview" information such as tank levels, flows and pressures shall be indicated through data fields or animation effects such as level fills or color change.
   4. All monitored and or controlled process equipment shall be animated or color-highlighted to indicate status changes.
      a. For example, a pump "running" condition shall be signified by the pump color changing to bright green.
   5. Tank and vessel levels shall be indicated with a tabular data field and by graphic "fill" simulating a rising or falling level within the tank or vessel.
   6. Provide the ability to "drill down" to detail screens or graphics.
      a. Clicking on a device or process area shall generate a detail graphic or pop-up window to access specific data or control functions.
      b. All operator adjustments (e.g., set point adjustment, mode selection) shall be accomplished via a pop-up display, and shall not be allowed on the process screen.

7. Standard symbol library:
    a. User defined.
    b. Must not require software programming.
8. Single keystroke access from graphic to group display or other custom graphic displays.
9. Capable of being edited by moving, copying, or grouping user defined areas of screen.
10. Utilize a navigation bar.
    a. Navigation bar utilized on every screen.
    b. Navigation bar to include navigation functions, active alarm notification, security functions, current date/time display, "PRINT SCREEN" pushbutton, and other functions as required and as agreed upon at the Screen Configuration Review Meetings.

F. Plant Overview Screens:
1. As a minimum, provide Plant Overview screens as listed below.
    a. This list is meant to serve as an initial guide; final determination of overview screen requirements will be made during the Configuration Conferences.

G. Process Overview Screens:
1. As a minimum, provide screens as listed below.
    a. This list is meant to serve as an initial guide; final determination of process and equipment screen requirements will be made during the Configuration Conferences.
2. At a process overview screen, the operator shall be able to select a specific process screen for monitoring/control purposes.
    a. Monitoring and control functions available at the selected process screen include but are not limited to the following:
        1) Select individual equipment items for monitoring and control.
        2) Select a control loop or point for control action.
        3) Change control mode of loop selected (manual, automatic, cascade).
        4) Change setpoint.
        5) Issue commands to start/stop and open/close two-state equipment.
        6) For manual loading output stations, the operator shall be able to manipulate analog output values.
        7) Select a loop and initiate further display, such as the detail display, trend, or hourly averaging.
        8) Display and change ratio and bias values.
        9) Control field equipment such as motor-operated valves and switches.

H. Detail Display:
1. Provide separate display for each point.
    a. Representations of each analog and digital point shall be single user configured faceplate.
    b. Display shall include alphanumeric representations of all variables and parameters for single loops including but not limited to:
        1) Alarm points.
        2) Limits.
        3) Constants.
        4) Interconnections to other loops.
        5) Calculating functions.

I. Trend Displays:
1. Real time historical trend displays.
2. Real time on-line trend displays.
3. Capable of displaying multiple points per display.
4. Operator shall be able to select any desired sample time interval.
5. Provide flexibility and easy access to real time and historical trend information for any variable TAG defined within the SCADA application.
    a. As a minimum, provide the following:
        1) Provide capability for the user to define trend scenarios.

2) Provide a button to open a dialog window to select multiple variable TAGS and save them as a trend scenario for future use.
3) Provide a pull-down menu to allow the user to open saved trend scenarios.
4) Provide a button to allow the user to select real-time or historical trends.
5) Provide a button to save displayed trend info to a file for export to external software applications (such as Microsoft Excel).
6) Provide a Print Trend button to allow user to print current trend.

6. Utilize Historical Data Server(s) to collect and manage data.

J. PLC Hardware/HMI Status Screen:
1. Provide a status screen to depict status conditions and diagnostic information for all major networked equipment.
2. Depict communication status for all networked communicating devices, such as PLC processors, Ethernet switches, PCs, and radios.

K. Alarm Monitoring:
1. Provide standard alarm screen functionality to ensure flexibility and quick access to live alarms, alarm history and alarm grouping parameters.
   a. As a minimum, include the following features and functionality:
      1) An Alarm Screen header bar to head all alarm pages and reside below the Navigation Bar.
      2) Buttons to dynamically switch between Alarm Summary and Alarm History.
      3) A menu to allow user to select and open historical alarm archives.
         a) Utilize a time-date stamp file structure.
      4) Pull-down menu bar to select operator configured alarm groups.
      5) Capability to sort alarms by priority and to define priority for all system alarms.
      6) Capability to filter or group alarms.
2. Analog alarms:
   a. The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition.
   b. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
      1) Low-low.
      2) Low.
      3) High.
      4) High-high.
      5) Deviation low.
      6) Deviation high.
      7) Rate of change.
   c. Provide adjustable dead bands and delay timers for all analog alarms.
3. Present alarms in order of:
   a. Priority.
   b. Time of occurrence.
   c. Non-acknowledged presented ahead of acknowledged.
4. Utilize single keystroke or pushbutton to:
   a. Acknowledge alarms.
5. Alarm list presented to operator shall include:
   a. Time of occurrence.
   b. Time of acknowledgement.
   c. Description.
   d. Acknowledgement status.
6. Alarm list printed by either of the following:
   a. On command.
   b. Periodically.
7. Audible alarming capability for user selected alarms.

L. Report Generation:

1. Base bid on the generation of the following reports:
    a. Minimum of three formatted reports.
        1) Report form and content shall be determined at the Report Configuration Review Meetings.
        2) Each report shall contain daily, weekly, and monthly average calculated values.
        3) Each report shall contain between 40 and 60 measured parameters.
    b. List of all entries initiated by operator including the following:
        1) Console key changes.
        2) Beginning and final values of setpoint and output changes.
        3) Mode changes (i.e., auto to manual).
        4) Time change was made.
    c. Event list:
        1) Description of selected events.
        2) Time of event.
2. Custom report capabilities:
    a. User configurable.
    b. Contain selected information from any log, event, or alarm list.
    c. Capable of producing custom log report for periodic and on-demand printing of a list of process or calculated variables.
    d. Reports shall not require software programming by the user to setup.
3. Control of programs:
    a. Protect access to configuration via password protection.

### 2.2 SOURCE QUALITY CONTROL

A. Include performance test of HMI software in factory with the overall PLC System test.
    1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
    2. Allow for Owner and Engineer representatives to witness testing program.
        a. Provide minimum of 15 calendar days notice prior to testing.

## PART 3 - EXECUTION

### 3.1 CONFIGURATION REQUIREMENTS

A. Provide all programming and configuration required for all HMIs furnished under this Contract:

### 3.2 CONFIGURATION STANDARDS AND CONVENTIONS

A. Prepare and submit a "Software Configuration Standards and Conventions."
    1. Submit for review and approval prior to commencing with software configuration.
    2. Describe and define such items as:
        a. Proposed graphic display process colors/representations.
        b. Color standards for "ON," "OFF," and "ALARM" conditions.
        c. Font type and size.
        d. Alarm handling conventions.
        e. Methods for navigation between displays.
        f. Address usage/naming conventions.
        g. Security setup.
    3. Prior to submitting the initial draft document, the Contractor must meet with the Owner to review any of the Owner's existing standards and conventions.
    4. In addition to submitting the initial document for review, submit an updated version of the document as part of the Operation and Maintenance Manuals.
        a. Revise this document to include any additional standards that are established throughout the configuration process.

B. It is the intent of these specifications to provide the end user with state-of-the-art functionality.

1. Minimum standards are as follows:
    a. Depict the actual process equipment configuration as accurately as possible.
2. All overview and site-specific screens shall incorporate a "navigational header bar" similar in function and appearance to *Microsoft Edge*.
    a. The intention of this Specification is to provide a familiar, user-friendly navigation throughout the graphical displays.

## 3.3 SCREEN CONFIGURATION REVIEW MEETINGS

A. Conduct a minimum of three configuration conferences with the Owner to review and discuss system configuration programming and related topics.
    1. The purpose of the conference(s) will be to discuss, in detail, how each I/O point will be handled and the types, quantities, hierarchies, and functioning of display screens.
    2. Review of the Owner's existing systems, standards, conventions, file and tag naming requirements, font type and size requirements, and reporting requirements must be part of each conference.
    3. Review the navigation bar to be utilized.
    4. Conferences will be held at a site designated by the Owner.
    5. Each screen will be reviewed at each conference.
        a. If required, to review all screens, each conference will occur on multiple days.
    6. Submit 10 color copies of printed screens via shop drawing submittal process 10 calendar days before each conference.
    7. Bring equipment to project screens on wall or provide multiple monitors for viewing by attendees.

B. Proposed graphic screens and report formats must be reviewed with the Owner throughout the configuration process.

## 3.4 REPORT CONFIGURATION REVIEW MEETINGS

A. Conduct a minimum of two configuration conferences with the Owner to review and discuss the reports and report formats.
    1. Review of the Owner's existing systems, standards, conventions, and reporting requirements must be part of each conference.
    2. The conference(s) will be held at a site designated by the Owner.
    3. Each report will be reviewed at each conference.
        a. If required, to review all reports, each conference will occur on multiple days.
    4. Provide 10 copies of printed sample reports via shop drawing submittal process 10 calendar days before each conference.

B. Proposed report formats must be reviewed with the Owner throughout the configuration process.

## 3.5 COORDINATION

A. Coordinate as required with other contractors and vendors to seamlessly integrate all HMI monitoring and control functions.
    1. To the greatest extent possible, integrate graphics presentation for all systems into screens utilizing one common HMI software.

B. Examples of systems that utilize separate application software packages and thus require coordination include, but are not necessarily limited to:
    1. Generator Controls.
    2. Photovoltaic System.
    3. Battery Energy Storage System.
    4. Ozone System.
    5. Ballasted Flocculation System.
    6. Switching Manifold System.

## 3.6 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Engineer.
      b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

## 3.7 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01 75 00.

B. On-Site Training:
   1. Provide employee of the manufacturer or certified representative to provide 1 week of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
      a. As a minimum, training shall cover:
         1) Hardware overview.
         2) Software overview.
         3) Maintenance.
         4) Trouble shooting.
         5) Operation, e.g., changing set points, passwords, etc.

**END OF SECTION**

# SECTION 40 97 00
CONTROL AUXILIARIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Process signal modules.
   2. Pilot devices.
   3. Panel meters.
   4. Manual loading stations.
   5. Relays/timers.
   6. Termination equipment.
   7. Power supplies.
   8. Industrial Ethernet components.
   9. Voltage surge protection devices.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 61 13 – Process Control Systems General Requirements.
   4. Section 40 61 43 – Surge Protection Devices for Instrumentation and Control Equipment.
   5. Section 40 61 96 – Process Control Descriptions.
   6. Section 40 67 00 – Control System Equipment Panel and Racks.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

B. Miscellaneous:
   1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 61 13.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

C. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 SIGNAL MODULE

A. Loop Isolators:
   1. Acceptable manufacturers:
      a. AGM Electronics.
      b. Moore Industries.
      c. Or approved equal.
   2. Design and fabrication:
      a. Solid state electronics.
      b. Transmit analog output signal directly proportional to measured input signal.
      c. Power source: 24 VDC.
      d. Analog input: 4-20 mA DC or 1-5 VDC.
      e. Output signal: 4-20 mA DC into 1400 ohms.
      f. Impedance:
         1) Voltage input: 10 Meg.
         2) Current input: 50 ohms.
         3) Voltage output: 1 ohm.
         4) Current output: 1650 ohms.
      g. Accuracy: Better than ± 0.10 PCT of span.
      h. Isolation: Up to 500 V rms (input, output and case).
      i. Temperature effect: ±0.0025 PCT of span per DEGF.
      j. Ambient temperature range: 0-140 DEGF.
      k. Factory calibrated.

## 2.3 PILOT DEVICES

A. Selector Switches:
   1. Acceptable manufacturers:
      a. Eaton.
      b. Allen-Bradley.
      c. ABB/GE.
      d. Or approved equal.
   2. Design and fabrication:
      a. Heavy-duty type, NEMA 4X rating.
      b. Rotary cam units conforming to NEMA ICS 2-216.22.
      c. Mounting hole: 30.5 mm.
      d. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
      e. UL listed.
      f. Maintained contact type.
      g. Knob type operators.
      h. Black colored operators.
      i. Designed with cam and contact block with approximate area of 2 IN SQ.
      j. Legend plate marked per Contract Documents.
      k. Contact block requirements:
         1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.

B. Pushbuttons:
   1. Acceptable manufacturers:
      a. Eaton.
      b. Allen-Bradley.
      c. ABB/GE.

d. Or approved equal.

2. Materials:
   a. Backing diaphragm: Buna-N.
3. Design and fabrication:
   a. Heavy-duty type, NEMA 4X rating.
   b. Conforming to NEMA ICS 2-216.22.
   c. Mounting hole: 30.5 mm.
   d. Diaphragm backed.
   e. UL listed.
   f. Emergency stop pushbuttons to have mushroom head operator and maintained contact.
   g. Non-illuminated type:
      1) Momentary contact with necessary contact blocks.
      2) Molded, solid color melamine buttons.
      3) Standard flush, full shroud.
      4) Appropriate contact blocks to fulfill functions shown or specified.
   h. Contact block requirements:
      1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
      2) Legend plate marked per Contract Documents.

C. Indicating Lights:
1. Acceptable manufacturers:
   a. Eaton.
   b. Allen-Bradley.
   c. ABB/GE.
   d. Or approved equal.
2. Design and fabrication:
   a. Heavy duty.
   b. NEMA 4X.
   c. Type allowing replacement of bulb without removal from control panel.
   d. LED.
   e. UL listed.
   f. 24 V lamp.
   g. Legends marked per Contract Documents.
   h. Nominal 2 IN SQ face.
   i. Mounting hole: 30.5 MM.
   j. Push-to-test indicating lights.
   k. Plastic lens.
   l. Color code lights as follows:
      1) Green: ON or running; valve open.
      2) Amber: Standby; auto mode; ready.
      3) Red: OFF or stopped; valve closed.
   m. Legend plate engraved for each light.

## 2.4 PANEL METERS

A. Digital Process Meters:
1. Acceptable manufacturers:
   a. Red Lion – Model PAXLA.
   b. Or approved equal.
2. Design and fabrication:
   a. Analog input.
   b. Display:
      1) 5 digit, 14-segment.
      2) 0.56-inch high, red LED.
   c. Programmable scaling and decimal points

d. Programmable user input.
e. Dual 5 amp form C relay
f. Input power: 120VAC.
g. Excitation power: 24VDC.
h. Status display for two setpoints.
i. Accuracy: 0.03 percent.
j. Non-volatile memory with no battery backup.
k. UL Listed.

B. Graphical Panel Meters:
1. Acceptable manufacturers:
a. Red Lion– Model PX-50.
b. Or approved equal.
2. Design and fabrication:
a. Analog input.
b. Display: 3.5 inch color TFT display with resistive analog touch screen.
c. Input power: 120VAC.
d. Excitation power: 24VDC.
e. Dual setpoint relay output module.
1) Relay 1: configured for low level alarm.
2) Relay 2: configured for high level alarm.
f. Analog output module.
1) Retransmitted analog output.
2) Signal type: 4-20 maDC.
g. Display configuration: circular bar chart in gallons.
h. Operating temperature: -10 to 55 DegC.
i. UL Listed.

## 2.5 MANUAL LOADING STATIONS

A. 1/4 DIN Auto/Manual Stations:
1. Acceptable manufacturers:
a. Moore Industries – Model 532.
b. Or approved equal.
2. Design and fabrication:
a. Provides automatic and hard manual back-up for analog loop controls systems.
1) Auto mode: unit will display and pass a remotely generated control signal.
2) Manual mode: control variable shall be adjustable from the front of the device.
b. Front panel-mounted.
c. Front panel controls:
1) Auto/Manual mode selection.
2) Manual mode adjustments (increase/decrease) of control variable.
d. Indicators and displays:
1) Process Variable.
2) Control Variable.
3) Auto/Manual Mode indication.
e. Input power: 120 VAC.
f. Analog signals: 4-20 maDC or 1-5 VDC.
g. Isolated output signal.
h. SPDT relay contact discrete outputs.
i. NEMA 4X enclosure rating.
j. UL Listed.

## 2.6 RELAYS/TIMERS

A. Control Relays:
1. Acceptable manufacturers:

a. Idec.
b. Potter & Brumsfield.
c. Allen-Bradley.
d. Or approved equal.

2. Design and fabrication:
a. Plug-in general purpose relay.
b. Blade connector type.
c. Switching capacity: 10 A.
d. Contact material: Silver cadmium oxide.
e. Provide relays with a minimum of 3 SPDT contacts.
f. Coil voltage: 120 VAC or 24 VDC.
g. Relay sockets are DIN rail mounted.
h. Internal neon or LED indicator is lit when coil is energized.
i. Clear polycarbonate dust cover with clip fastener.
j. Check button.
k. Temperature rise:
1) Coil: 85 DEGF max.
2) Contact: 65 DEGF max.
l. Insulation resistance: 100 Meg min.
m. Frequency response: 1800 operations/hour.
n. Operating temperature: -20 to +150 DEGF.
o. Life expectancy:
1) Electrical: 500,000 operations or more.
2) Mechanical: 50,000,000 operations or more.
p. UL listed or recognized.

B. Time Delay Relays:
1. Acceptable manufacturers:
a. Eagle Signal Controls.
b. Idec.
c. Or approved equal.
2. Design and fabrication:
a. Melt design test and performance requirements of NEMA ICS 2-218.
b. Heavy-duty.
c. Solid-state construction.
d. External adjusting dial.
e. Auxiliary relays as required to perform functions specified or shown on Drawings.
f. Operates on 117 VAC (±10 PCT) power source.
g. Contact rating: A150 per NEMA ICS 2-125.
h. Furnish with "on" and "timing out" indicators.

## 2.7 TERMINATION EQUIPMENT

A. Terminal Blocks:
1. Acceptable manufacturers:
a. Phoenix Contact.
b. Allen-Bradley.
c. Or approved equal.
2. Design and fabrication:
a. Modular type with screw compression clamp.
b. Screws: Stainless steel.
c. Current bar: Nickel-plated copper allow.
d. Thermoplastic insulation rated for -40 to +90 DEGC.
e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
f. Install end sections and end stops at each end of terminal strip.
g. Install machine-printed terminal markers on both sides of block.

h. Spacing: 6 MM.
i. Wire size: 22-12 AWG.
j. Rated voltage: 600 V.
k. Din rail mounting.
l. UL listed.

3. Standard-type block:
   a. Rated current: 30 A.
   b. Color: Gray body.
4. Bladed-type block:
   a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
   b. Rated current: 10 A.
   c. Color:
      1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
      2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
   a. Electrically grounded to mounting rail.
   b. Use to terminal ground wires and analog cable shields.
   c. Color: Green and yellow body.

B. Fuse Holders:
1. Acceptable manufacturers:
   a. Phoenix Contact.
   b. Allen-Bradley.
   c. Or approved equal.
2. Design and fabrication:
   a. Modular-type with screw compression clamp.
   b. Screws: Stainless steel.
   c. Current bar: Nickel-plated copper alloy.
   d. Thermoplastic insulation rated for -40 to +105 DEGC.
   e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
   f. Blocks can be ganged for multi-pole operation.
   g. Install end sections and end stops at each end of terminal strip.
   h. Install machine-printed terminal markers on both sides of block.
   i. Spacing: 9.1 MM.
   j. Wire size: 30-12 AWG.
   k. Rated voltage: 300 V.
   l. Rated current: 12 A.
   m. Fuse size: 1/4 x 1-1/4.
   n. Blown fuse indication.
   o. DIN rail mounting.
   p. UL listed.

## 2.8 POWER SUPPLIES

A. Industrial Uninterruptible Power Supplies (UPS):
1. Acceptable manufacturers:
   a. Tripp Lite – SU1000XLCD with relay output module.
   b. Or approved equal.
2. Design and fabrication:
   a. Power rating: 1000 VA.
   b. Input and output voltage: 120Vac, 1PH, 60 Hz.
   c. Configuration:
      1) Tower.
      2) Topology: True online double-conversion.
      3) True sine wave AC output.

d. Battery type: sealed, lead-acid, maintenance-free.
e. Field replaceable surge protection.
f. Provide UPS and battery with the following, as a minimum:
    1) UPS rating VA shall be as required for the associated control panel loads with 20 percent spare capacity. Multiple UPS's shall be used if necessary for the required loads.
    2) UPS shall provide battery run-times of 5 minutes minimum with fully operational control panel loads.
g. Communications:
    1) USB port to allow UPS to communicate with computer.
    2) Relay output card to provide the following status/alarms:
        a) ON Battery.
        b) Battery low.
        c) UPS fault.
h. UL Listed.

3. Installation:
    a. The following control panel loads shall be UPS protected as a minimum:
        1) Programmable Logic Controller (PLC) hardware.
        2) Panel control power – field contact power.
        3) Power supplies.
        4) Ethernet switches, taps, and media convertors.
        5) Loop Isolators.
    b. The following control panel loads shall not be UPS protected:
        1) Convenience receptacles.
        2) Primary elements with 4-wire type transmitters associated with the PLC panel as shown on the drawings.
        3) Enclosure light fixtures.
        4) Environmental control devices.
    c. Provides backup power in the event of a temporary power outage or multiple power supply failures.
    d. Mount in such that dissipated heat does not adversely affect other components.

B. DC Power Supplies:
1. Acceptable manufacturers:
    a. PULS – Dimension Q-Series.
    b. Phoenix Contact.
    c. Rockwell Automation.
    d. Or approved equal.
2. Design and fabrication:
    a. Converts 120 Vac input to DC power at required voltage.
    b. DIN rail mount with enclosure (i.e., not open frame).
    c. Switching type.
    d. AC input: 120 Vac +/-15 percent, nominal 60 Hz.
    e. Efficiency: Minimum 86 percent.
    f. Rated mean time between failure (MTBF): 500,000 HRS.
    g. Voltage regulation:
        1) Static: Less than 1.0 percent $V_{out}$.
        2) Dynamic: +/-2 percent $V_{out}$ overall.
    h. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
    i. Overload, short circuit and open circuit protection.
    j. Temperature rating: 0 to 60 DegC full rated, derated linearly to 50 percent at 70 DegC.
    k. Humidity rating: Up to 90 percent, non-condensing.
    l. LED status indication for DC power.

C. DC Power Supply Redundancy Modules:
1. Acceptable manufacturers:

a. PULS – Dimension Y-Series.
b. Rockwell Automation.
c. Or approved equal.

2. Design and fabrication:
   a. Contains decoupling diodes and monitoring circuit.
      1) May be used to build 1+1 and N+1 redundant systems.
      2) Two input channels which can be connected to 10A power supplies.
      3) One output channel which can carry nominal currents up to 20A.
      4) Two diodes, common cathode.
   b. DIN-rail mount with enclosure (i.e., not open frame).
   c. Both input voltages are individually monitored. If one input voltage is too low or completely lost, it will be indicated by an alarm relay contact.
   d. Temperature rating: 0 to 60 DegC full rated.
   e. Humidity rating: Up to 95 percent, non-condensing.
   f. UL Listed.

## 2.9 INDUSTRIAL ETHERNET COMPONENTS

A. Fiber Patch Panels (FPP), Wall-Mounted:
   1. Acceptable manufacturers:
      a. Corning ICH-02P with two CCH Connector Panels.
      b. Siecor WIC-012 or 024 with WIC-CP1-15 and guard.
      c. Siemon SWIC3-M-01 with RIC-F-SA12-01 Adapter Plate.
      d. Or approved equal.
   2. Design and fabrication:
      a. Provide at each fiber optic trunk cable termination point located within control panels and as shown on the Drawings:
      b. Wall mount fiber optic cable interconnect center.
      c. Adapter plates with 6 duplex ST adapters (for 12 fibers).
      d. Two compartment with hinged doors and integrated hinged fiber guard.
      e. Enclosure doors with full, 180 degree opening to provide complete access to front and side.
      f. Door with label holder for storing fiber documentation.
      g. Cables enter enclosure through dust proof grommets.

B. Ethernet Switches, Industrial:
   1. Acceptable manufacturers:
      a. Cisco:
         1) Switch: IE-2000-4TS-GB.
         2) SFP Module: GLC-SX-MM-RGD.
      b. No like, equivalent, or or-equal item is acceptable.
   2. Design and fabrication:
      a. Managed industrial Ethernet switch with 8 ports minimum. More ports shall be provided when required to provide a complete and functional system. Ethernet switch must include a minimum of 2 spare RJ-45 ports.
         1) Six 10/100BaseTX RJ-45 ports.
         2) Two gigabit combo ports: SFP.
         3) FO jumper (drop cable): LC-ST duplex fiber 62.5/125 MM OM1 for connections between patch panels and SFP modules.
      b. Ruggedized steel enclosure, DIN rail mounted.
      c. Operating Temperature: -40 to 70 DegC.
      d. Redundant Power Inputs: 10 to 30 VDC.
      e. One alarm output relay.
      f. Full IEEE 802.3 & 100BaseFX Compliance.
      g. 256 MB DRAM with ECC memory.
      h. IEEE 1588v2 FPGA.

i. 64 MB on-board flash memory.
j. 1 GB removable SD flash memory card.
k. Mini-USB connector.
l. Industrial partner applications: EtherNet/IP.
m. UL Listed.

### 2.10 VOLTAGE SURGE PROTECTION DEVICES

A. See Specification Section 40 61 43.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

**END OF SECTION**

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# DIVISION 41

## MATERIAL PROCESSING AND HANDLING EQUIPMENT

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# SECTION 41 22 23
## HOISTS, TROLLEYS, AND MONORAILS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Hoists, trolleys, and monorails.

B. Equipment Numbers:
   1. H-4101
   2. H-4102

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Society of Mechanical Engineers (ASME):
      a. B30.11, Safety Code for Underhung Cranes and Monorail Systems.
      b. B30.16, Safety Code for Overhead Hoists.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

B. Comply with ASME B30.11 and ASME B30.16.

### 1.3 DEFINITIONS

A. Hook Height: The minimum acceptable distance in feet from bottom of hook in full raised position to the nearest floor surface.

B. Lift Height: The distance in feet from the bottom of the hook in full raised position to the surface of the lowest floor from which items may be hoisted.

C. Total Trolley Capacity: The ultimate load-carrying capacity of the trolley based on the ultimate strength of the material used (with a 5:1 safety factor) and the bearing life.

D. Ultimate Load-Carrying Capacity: Live load, weights of all equipment and an allowance for impact.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Section 01 61 03.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.
   4. Fabrication and/or layout drawings.
      a. Track layout including supports, splices, connections, switches, and end trucks.
   5. Test reports verifying strength of inserts and rail.

6. Load test results.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Hoists:
      a. Yale.
      b. Acco.
      c. Robbins and Myers.
      d. Wright.
   2. Trolleys:
      a. Yale.
      b. Acco.
      c. Wright.
   3. Monorails:
      a. Spanmaster.
      b. Twin City Monorail.

B. Submit request for substitution in accordance with Section 01 25 13.

### 2.2 MANUFACTURED UNITS

A. Trolleys:
   1. Hand-geared.
   2. Completely compatible with hoists, cranes, and monorails specified.
   3. Meet NEC standards according to classifications shown on Drawings.
   4. Capable of maneuvering curves without binding or scraping the track.
   5. Minimum ABMA L-10 bearing life of 5000 HRS based on 75 PCT of the wheel load, excluding impact.
   6. Plain trolleys:
      a. Frame consisting of thick rolled steel sections extending beyond wheel flanges to protect wheels.
      b. Alloy steel hardened axles, ball-bearings and pressed steel wheels.
         1) Carburized and hardened ball tread wheels.
         2) Factory lubricated requiring no additional lubrication.

B. Hoists:
   1. Hand chain hoists:
      a. Spur-geared.
      b. Design load-carrying parts so that the calculated static stress in the material, based on rated capacity, does not exceed 25 PCT of the average ultimate strength of the material.
      c. For all hand chain hoists, provide hook-type mounting.
      d. Load chain and wheels:
         1) Close link coil or roller-type chain.
         2) Links of uniform size and shape and free from scale.
         3) Manufacture load chain wheels from steel, pearlitic malleable iron or modular cat-iron.
            a) Form load and idler sheaves to fit chain.
      e. Hand chain and wheels:

1) Hand chain of the endless coil-type with a drop that is about 2 FT less than the specified lift of the hoist.
2) Chain yield point at least three times the required hand chain pull for rated load.
3) Manufacture hand chain wheels from steel, malleable iron, high strength cast iron, or aluminum alloy.
4) Equip hand wheel with suitable chain guard to prevent the hand chain from slipping or jumping the wheel rim.

f. Hooks:
1) Forged steel.
2) Bottom hook free to swivel in the loaded condition without twisting the chain.
3) Gate or swing type latch hooks.

g. Automatic mechanical load brake which will prevent lowering of the load unless manual power is applied to the hand chain.
h. Sleeve or antifriction type bearings.
i. Enclose gearing in sealed construction and provide life-time lubrication.
j. Load limit clutch to automatically prevent hoist from lifting loads greater than rated capacity.

2. Mark each hoist with the following information:
a. Name and address of manufacturer.
b. Manufacturer's unit identification number.
c. Rated load.

C. Monorails:
1. Straight track: ASTM A36 steel S10x35 beams.
2. Where track curves are required, supply straight track and curves which are standard items of monorail manufacturer.
3. Design track to support hoist capacity plus 25 PCT for impact load plus the weight of hoist and accessories without exceeding allowable working stress of track material with maximum deflection of 1/450 of span.
4. Brace track to prevent sideways movement under full load conditions.
5. Provide end stops at all track ends.
6. Assure that track splices have been designed by track supplier and are located at support points.

### 2.3 ACCESSORIES

A. Trolley stops design to engage the trolley frame rather than trolley wheels.

B. Furnish chain containers for hand hoists.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Support track as shown on Drawings.

B. Arrange supports for easy removal of track for repair or replacement.

C. Align track true and level.

D. Warning Signs:
1. Affix to the hoist or the lower load block or the controls in a readable position a durable label or labels displaying the following information concerning safe operating procedures:
a. The word WARNING or other legend designed to bring the label to the attention of an operator.
b. Cautionary language against:
1) Lifting more than rated load.
2) Operating hoist when hook is not centered under hoist.
3) Operating hoist with twisted, kinked or damaged rope or chain.

4) Operating damaged or malfunctioning hoist.
5) Operating hoist with a rope that is not properly seated in its groove (if applicable).
6) Lifting people or lifting loads over people.
7) Removing or obscuring warning label.

## 3.2 FIELD QUALITY CONTROL

A. Test each hoist, trolley, and monorail using 110 PCT rated load.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start-up adjustments, installation checks and all field tests.
3. Conduct initial start-up of equipment and perform operational checks.
4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
5. Instruct Owner's personnel for 8 HRS at jobsite on operation and maintenance of the hoist, trolley, monorail and crane equipment.

## 3.3 SCHEDULE

A. Hoist, trolley, and monorail systems include but are not necessarily limited to the following:

| TAG NUMBER | LOADING (TONS) | HOIST | TROLLEY | HOOK HEIGHT (FT)* | LIFTING HEIGHT (FT)* | HP | OPERATING SPEED FPM |
|---|---|---|---|---|---|---|---|
| H-4101 | 2 | C | HG | 14 | 24 | N/A | N/A |
| H-4102 | 2 | C | HG | 14 | 24 | N/A | N/A |

* Distances listed are approximate as they will vary depending on hoist and trolley selection.

C = Chain
HG = Hand Geared
WR = Wire Rope
NA = Not Applicable

**END OF SECTION**

# DIVISION 43

## PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

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# SECTION 43 11 33
## ROTARY LOBE BLOWERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Packaged rotary lobe blowers with sound-attenuating enclosures and appurtenances.

B. Equipment Numbers:
   1. BLW-4501

C. Related Requirements: Include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 40 61 13 - Process Control System General Requirements.
   3. Section 40 67 00 - Control System Equipment Panels and Racks.
   4. Section 40 97 00 - Control Auxiliaries.

### 1.2 REFERENCES

A. Abbreviations:
   1. "ACFM" means "actual cubic feet per minute", referring to volumetric flow rate of air or gas measured at actual, local conditions of temperature, absolute pressure, and relative humidity.
   2. "ICFM" means "inlet cubic feet per minute", referring to ACFM entering blower equipment, measured at blower's inlet flange (or similar connection).
   3. "PSIA" means "pounds (force) per square inch absolute", referring to measured pressure of air or gas, expressed as atmospheric pressure at local conditions plus locally-measured gauge pressure (i.e., above atmospheric pressure).
   4. "PSIG" means "pounds (force) per square inch gauge", referring to pressure measured above local atmospheric pressure.
   5. "SCFM" means "standard cubic feet per minute", referring to volumetric flow rate of air or gas at 68 DEGF, 14.70 PSIA (i.e., ambient, atmospheric air pressure at sea level), and 36 percent relative humidity.

B. Reference Standards:
   1. Acoustical Society of America (ASA):
      a. ANSI/ASA S2.19, Standard Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications.
   2. American Bearing Manufacturers Association (ABMA):
      a. ABMA/ANSI 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. ABMA/ANSI 11, Load Ratings and Fatigue Life for Roller Bearings.
   3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
      a. ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size,
   4. American Society of Mechanical Engineers (ASME):
      a. Boiler and Pressure Vessel Code (BPVC), Section VIII, Construction of Pressure Vessels (Division 1).
      b. ASME/ANSI B16, Standards for Pipes and Fittings:
         1) B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   5. ASTM International (ASTM):
      a. ASTM SAE AISI 1045, Carbon Steel Heat Treatment Chemical Composition Properties.
   6. International Organization for Standardization (ISO):

a. 1217, Displacement Compressors – Acceptance Tests.

7. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
8. Underwriters Laboratories (UL):
   a. 508, Industrial Control Panels.

## 1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer of Rotary Lobe Blower Equipment:
      a. Manufacturer shall be corporation regularly engaged in the business of manufacturing rotary lobe blower equipment of the type required for the Work.
      b. Manufacturer shall have furnished blowers for not less than three separate facilities in the United States of America each operating satisfactorily for not less than one year. Document not less than six rotary lobe blowers (total) operating at the facilities. To qualify under this provision, each such rotary lobe blower shall have air flow capacity and motor horsepower equal to or greater than that required for the rotary lobe blowers required for the Work.
      c. In addition, equipment manufacturer shall be able to submit satisfactory documentation of not less than 20 installations and 50 operating rotary lobe blowers, regardless of installation location.
      d. Manufacturer shall have an established base of operation in North America that employing experienced, factory-trained technical personnel, resources, and services. Personnel available from such service base facility shall perform checkout, startup, and troubleshooting of installed rotary lobe blower equipment.
      e. Manufacturer shall have service network in North America responding to technical inquiries within 24 HRS and able to furnish replacement parts replacement within 48 HRS of Supplier's receipt of order from Contractor, Owner, or facility manager.
      f. Upon Engineer's request, Submit to Engineer documentation of compliance with qualifications requirements.

## 1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule (table) of proposed blower equipment, indicating proposed performance, manufacturer and model, and similar information.
      b. Schedule (table) of electric motors, indicating manufacturer, model, enclosure type, motor size, and similar information.
      c. Bill of materials for all equipment, components, and appurtenances.
      d. Equipment fabrication drawings indicating arrangement, materials, dimensions, weight, and similar matters, showing plan, section, and cutaway views of blower units, enclosures, and blower system package.
      e. System process and instrumentation (P&ID) drawings for the rotary lobe blower Work.
      f. Control panel layout drawings and wiring diagrams.
   2. Product Data:
      a. Component manufacturer's published product data, including brochures, specifications, and blower data.
      b. Factory-certified performance curves from previous tests of identical blower units, indicating speed, capacity, horsepower, and efficiency over the range of operation.
      c. Catalog information showing the details of blower, motor, belt drives, valves, and other accessory construction.
      d. Blower weight and weights of each separate item of equipment, as well as total package weight, including enclosure and control panel.
      e. Blower enclosure and associated enclosure accessories data.
      f. Flexible connection data.
      g. Control valves and actuators furnished by blower equipment manufacturer.

h. Silencers technical data.
i. Product data for control panel and associated components, including microprocessors, indicators, transmitters, relays, human-machine interfaces, cabling, and similar items.
j. Product data for blower system instrumentation provided by blower equipment manufacturer, including: vibration monitoring and control; ammeter; switches; pressure and temperature sensors and transmitters; temperature protection devices; limit switches; and similar items.
k. VFDs: Furnish Submittals under, and in accordance with, Section 26 29 23 – Variable Frequency Drives – Low Voltage.

3. Samples:
   a. Color Samples of finish coat of blower and enclosure, from Manufacturer's standard finish coat colors.
4. Testing Plans:
   a. Plan for performing required source quality control activities (including shop testing). Indicate limitations of testing facility. Include copies of most-recent certification of calibration for test instruments.
   b. Plan for performing required field quality control activities.

B. Informational Submittals: Submit the following:
1. Certifications:
   a. Manufacturer's written statement of installation, checkout, and startup, in accordance with Section 01 75 00 - Checkout and Startup Procedures.
2. Manufacturer's Instructions:
   a. Instructions and recommendations for handling, storing, protecting, and installing the equipment.
3. Source Quality Control Results:
   a. Written results of required source quality control activities.
      1) Results of blower equipment manufacturer's standard factory tests and inspections.
      2) Results of motor manufacturer's standard factory tests and inspections.
      3) Report of dynamic balancing and maximum vibration amplitude.
4. Field Quality Control Results:
   a. Written results of required field quality control activities, including:
      1) Field performance testing.
      2) Vibration testing.
      3) Sound test.
   b. Written results of motor tests at the Site.
5. Supplier Reports:
   a. Submit written report of results of each visit to the Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
6. Qualifications Statements:
   a. Manufacturer, when requested by Engineer.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
   a. Submit in accordance with Section 01 33 04 - Operation and Maintenance Manuals.
   b. Indicate serial number and Project equipment designation (or tag number).
   c. For each protective relay, PLC, or microprocessor with programmable requirements, provide the final as-constructed settings for all devices..

D. Maintenance Materials Submittals: Furnish the following items and submit documentation of delivery to and acceptance by the Owner or facility manager (as applicable):
1. Spare Parts and Extra Materials:
   a. One complete set of bearings, seals, and O-rings for one blower-and-motor unit.
   b. Multiple V-belts and sheaves for each type and size of blower furnished.
   c. One complete set of inlet filters for each type and size of blower furnished.

d. One complete set of gaskets for one blower-and-motor unit.
e. Lubricants, recommended by blower equipment manufacturer, sufficient for first year of operation.
f. One quart of touch-up coating of finish coat of blower and enclosure.

2. Tools:
   a. Two sets of special tools, if any, required for normal maintenance.

# PART 2 - PRODUCTS

## 2.1 EQUIPMENT MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Aerzen, "Delta Blower Generation 5".
   2. Howden, "Roots EasyAir X2".
   3. Gardner Denver, "IQ".
   4. Kaeser, "Com-paK".

## 2.2 PERFORMANCE AND DESIGN CRITERIA

A. Description:
   1. Contractor shall provide labor, materials, equipment, tools, and services to furnish and install rotary lobe blowers, motors, enclosures, instrumentation and controls, and appurtenances as shown, indicated, and necessary for a complete, operational system.
   2. Provide all rotary lobe blowers and accessories from one manufacturer, which has sole responsibility for compatibility of all materials and components necessary for a complete, operating, efficient system as required by the contract Documents.
   3. Comply with Section 01 61 03 - Equipment - Basic Requirements.
   4. Provide each blower and its associated motor and inlet and discharge silencers, frame-mounted in sound-attenuating enclosure.
   5. Factory-assemble each blower package with associated, factory-installed wiring.
   6. Blower Size Selection and Design Point: For oil splash lubricated equipment, design point shall be not more than 80% of manufacturer's published maximum speed of the blower.

B. Required Blower Performance:
   1. BLW-4501:
      a. Service Application: Backwash Air for Filters.
      b. Blower Elevation: 2285 FT above mean sea level
      c. Inlet Air Temperature Range: 0 to 104 DEGF.
      d. Maximum Blower Discharge Air Temperature: 229 DEGF.
      e. Maximum Relative Humidity at Maximum Inlet Air Temperature: 95%.
      f. Design Point 1: 1625 SCFM at 8 PSIG blower discharge pressure.
      g. Maximum Acceptable Inlet Pressure Loss: 0.20 PSI.
      h. Blower Inlet Air Connection Size: 10 IN diameter.
      i. Blower Discharge Air Connection Size: 10 IN diameter.
      j. Provide piping reducers and increasers, when necessary, to connect blowers to inlet and discharge piping.

## 2.3 ASSEMBLY AND MATERIALS

A. General:
   1. Blower connections to process air piping, silencers, control valves furnished by blower equipment manufacturer, and similar items, shall have flanged connections in accordance with ASME/ANSI B16.1.

B. Inlet Filter/Silencer:
   1. Provide blower inlet filter/silencer for each blower, to attenuate pulsation noise.
   2. Provide unit that minimizes pressure loss.

3. Heavy-duty units of all-welded metal construction.
4. Material: Heavy gage steel, suitable for outdoor installation
5. Provide with replaceable dry filter elements.
    a. Washable.
    b. Filter particle size as deemed appropriate by blower manufacturer.
6. Average efficiency in accordance with ANSI/ASHRAE 52.2: MERV 7 (50-70% @3-10 microns).
7. Inlet Size: As indicated above in this Section's "Performance and Design Criteria" Article.
8. On blower enclosure wall, provide maintenance indicator to indicate when inlet filter is to be replaced or cleaned.

C. Blower:
1. Type: Positive displacement rotary lobe blower.
2. Blower Housing:
    a. Material: Close-grained iron, ribbed.
    b. Fabrication: One-piece construction to ensure accurate operating clearances
    c. Dowel bearing carriers to housing for proper alignment.
3. Rotors: Symmetrical, straight, three-lobe design.
4. Rotors and Shafts:
    a. Solid, one-piece, drop-forged.
    b. Material: ASTM SAE AISI 1045 (medium tensile steel)
    c. All surfaces precision machined to final dimensions.
    d. Dynamically balanced in accordance with ANSI/ASA S2.19 G6.3.
5. First critical speed shall be greater than 1.2 times maximum rotating speed.
6. Timing Gears:
    a. Material: Alloy steel, single helical type
    b. AGMA Class 12 or equivalent quality
        1) Service Factor: 1.7 at equipment's maximum operating point.
    c. Provide precise rotor synchronization, so that operating clearances are satisfactorily maintained.
    d. Secure gears with interference fit on ground, tapered shaft ends.
    e. Provide constant oil bath for gears and gear end bearings.
7. Bearings:
    a. Provide bearings to achieve mean of five years or more between overhauls, with normal maintenance. Comply with AGMA 9 and AGMA 11, as applicable.
    b. Proper axial and radial rotor positioning, maintaining required clearances under rated loads.
    c. Heavy and ground, combined with ground spacers to set axial clearances, and ensure uniform bearing loading.
    d. Size drive shaft bearing for overhung V-belt drive under equipment's maximum continuous operating loads.
    e. Minimum B-10 bearing life of 100,000 HRS.
    f. Provide with an oil seal on each bearing preventing lubricant from leaking into the process air stream and minimizing process air leakage.
8. Shaft Connection to Head Plate:
    a. Provide four rotary piston ring shaft seals, oil deflector ring, grooved multiple labyrinth bushing, and O-ring between the shaft and ring retainer at point where shaft passes through head plate.
    b. Vent labyrinth to atmosphere to eliminate possible carry-over of lubricant into process air stream.
9. Lip Seal:
    a. Provide at drive shaft only.
    b. Seal Design: Radial lip seal riding on replaceable shaft sleeve.
10. Drives:
    a. Belt-driven from electric motor mounted on a common motor slide base.

b. Provide motor mounts to tension automatically without adjustment.

11. Belts:
    a. Provide multiple V-belts with sheaves
    b. Matched cogged type V-belts or equivalent quality.
    c. Rated for 160% of motor horsepower.
    d. Provide OSHA compliant belt guard.
12. Dynamically balanced sheaves for linear tip speeds > 6500 FT/MIN.
13. Ensure that the rotation of blower is in proper direction.

D. Motor:
1. Provide high-efficiency, 480V, three-phase, 60 Hz, electric motor appropriate for the associated blower equipment.
2. Maximum Speed: 1800 RPM.
3. Enclosure Type: Totally-enclosed fan cooled (TEFC).
4. Rated for constant speed, continuous operation.
5. Service Factor: 1.15.
6. Maximum Motor Size: 125 HP.
7. Comply with Section 01 61 03 - Equipment - Basic Requirements, regarding motor requirements.

E. Equipment Base:
1. Base shall support and be appropriate for blower, motor, belt drive, inlet filter/silencer, and discharge silencer.
2. Material: Fabricated steel.
3. Provide vibration isolating mounting.

F. Discharge Air Assembly:
1. Provide at process air discharge from each blower a multi-chamber silencer.
    a. Provided to reduce noise emitted from blower's discharge process air piping to 85 dBA or less
        1) Based on carbon steel, Schedule 40 piping of a diameter equal to the blower package's discharge air nominal connection size.
    b. Materials: Either cast iron or pressure vessel steel. Fibrous materials or any absorption materials, which could deteriorate over time, are unacceptable.
    c. Fabrication: Single shell with continuous welds.
    d. Internal diffusers are unacceptable for silencers.
    e. Provide fully-closable port sufficient for inspecting and cleaning.
    f. Account for silencer pressure loss in blower power calculation.
2. Discharge Air Check Valve:
    a. Provide in discharge process air piping of each blower, between pressure relief valve and discharge silencer.
    b. Full-port type without obstructing process air flow when valve is open.
    c. Internal spring is unacceptable.
    d. Flap constructed of corrosion-free material suitable for continuous operation of blower system.
    e. Seat Rating: 15 PSIG at 275 DEGF.
3. Pressure Relief Valve:
    a. Provide field-adjustable pressure relief valve installed in each blower's process air discharge piping, upstream of discharge air check valve.
    b. Factory-set at a relief pressure recommended by blower equipment manufacturer for the associated blower's operating conditions.
4. Flexible Connector:
    a. Provide elastomer material sleeve with industrial quality clamps for blower package's discharge air connection.
    b. Provide suitable for continuous exposure to temperatures up to 300 degrees F and process air discharge pressure up to 15 PSIG.

c. Provide sufficient distance between blower package and connecting discharge process air piping for sufficient thermal expansion without touching.

G. Lubrication:
1. Provide oil fill level sight glass, visible without opening or removing panels.
2. Provide one, easy access oil drain.
3. Provide lubricants recommended by equipment manufacturer, in quantity sufficient for checkout, startup, field quality control, and first year of operation.

H. Sound-Attenuating Enclosures:
1. Provide freestanding, rigid, noise-reducing, acoustical, factory-mounted enclosure for each blower package housing the following:
a. Blower.
b. Motor.
c. V-belt drive.
d. Silencers.
e. Cooling fan.
f. Interconnecting piping between blower and silencers.
2. Enclosure Panel Material:
a. Material: Galvanized ("galvaneal") steel sheet.
b. Thickness: 16 gage.
c. Finish: Painted exterior, in accordance with this Section's "Factory Finishes" provision, below.
3. Fabrication and Assembly:
a. Provide enclosure so that belt tensioning, oil level checks, and oil changes are performed without removing enclosure or any part thereof. Provide in enclosure panels latched and hinged access doors and lintels, on each side, for such purposes.
b. Weight Limit: Removable panels shall weigh less than 50 LBS each.
c. Enclosure shall be suitable for blower's permanent installation outdoors, exposed to sunlight and weather elements, without adverse effect on equipment's service life. Enclosure shall be rated NEMA 3, in accordance with NEMA 250, or greater.
d. Install gauges at enclosure's exterior to allow convenient reading by personnel standing adjacent to enclosure.
4. Sound Attenuation:
a. Provide enclosure with flame-retardant acoustic lining.
b. Maximum allowable noise, when blower is operating at maximum speed, shall not exceed 85 dBA measured thee feet from any part of blower enclosure.
5. Enclosure Cooling and Ventilation:
a. Provide mechanical cooling fan, properly sized for appropriate cooling and ventilating of blower enclosure.

I. Finishes:
1. Provide equipment manufacturer's standard factory finish for blowers, motors, enclosures, silencers, valves, and appurtenances.
2. Color: When more than one standard color is available for finish coat of blower and enclosure, submit color Samples. When only one standard color is available, provide standard color.
3. Materials:
a. Finishes shall be appropriate for the substrate to which they are applied and the equipment's service environment at its installed location.
b. Where equipment will be installed outdoors, factory finish shall be suitable for prolonged exposure to sunlight and weather elements without deterioration or fading.
4. Furnish touch-up paint for repair of scratches and blemishes following installation.

## 2.4 INSTRUMENTATION AND CONTROLS

A. Instrumentation:

1. Comply with Section 40 61 13 - Process Control System General Requirements.
2. Provide inlet filter/silencer differential pressure gauge suitable for the intended service, environment, and operating conditions.
3. Provide discharge process air temperature gauge with integral shutdown switch that will cause blower system controls provided by blower equipment manufacturer to automatically shut down the blower upon detection of over-temperature condition..
4. Provide discharge process air pressure gauge suitable for blower service, environment, and operation conditions.
5. Provide filter vacuum gauge.
6. Provide discharge process air pressure switch.
7. Provide appropriate vibration switches.
8. Provide appropriate RTDs.

B. Factory Wiring:
1. Provide appropriate junction boxes, with terminal boards, at blower motor and blower equipment to serve as termination points for the wiring to associated blower VFD.
2. Provide factory-installed wiring for all motor and blower equipment control and instrumentation devices to the terminal boards in blower manufacturer-provided junction boxes, for Contractor's connection of external cabling for electrical power and controls.
3. Properly identify each wiring unit when disassembly required for shipping to the Site.
4. Provide separate junction boxes for AC and DC control signals.

C. Control Panels:
1. Control panels shall be in accordance with, and labeled as complying with, UL 508.
2. Provide in accordance with Section 40 67 00 - Control System Equipment Panels and Racks.
3. Provide control panels sufficient for controlling each individual blower packaged and blower system as a whole.

D. Controls:
1. Provide blower equipment manufacturer's standard controls for proper control of the blowers in manual and automatic modes.

## 2.5 SOURCE QUALITY CONTROL

A. Tests and Inspections:
1. Test Plan:
   a. Prior to performing factory testing, prepare and submit to Engineer plan describing proposed source quality control activities, testing facility limitations relative to the equipment being furnished, and criteria for acceptance.
2. Inspections:
   a. For all items furnished, perform manufacturer's normal inspections and source quality control activities.
   b. Submit to Engineer documentation that such inspections and source quality control activities were completed successfully.
3. Factory Performance Testing:
   a. Except as required below, test at blower manufacturer's production facility one blower of each type and size furnished, in accordance with ISO 1217 and blower factory test plan approved by Engineer.
   b. Measure power consumption with wattmeter (with current, valid calibration) on the electrical power feed to a calibrated test motor identical to that required for the blowers furnished.
   c. Measure volumetric process air flow rate by a rotary meter (with valid, current calibration) installed on the blower's process air inlet.
   d. Measure and record vibration and temperature measurements to determine its mechanical integrity.
   e. Measure and record temperature of bearing housing near end of test run.

f. Criteria for Acceptance: In accordance with factory test method indicated in this provision.
g. Performance Test Results:
1) Submit to Engineer written report of blower's factory performance testing, including blower's as-tested performance curves.
2) Factory test report shall be certified as complete and accurate by person (who may be manufacturer's employee) possessing a current, valid, license and registration as a professional engineer (not necessarily in the same jurisdiction as the Site), whose seal and signature shall appear on all factory test reports.
3) Test report shall also indicate: serial number(s) of tested equipment. test method used, deviations (if any) from test method and approved test plan, explicit indication whether testing had acceptable results, and relevant comments.

4. Controls Factory Test:
a. Factory-test at control panel manufacturer's shop all microprocessors with programming specific to the Project. There is no contractual requirement to factory-test blower equipment manufacturer's standard controls not modified for the Project.
b. Owner and Engineer reserve the right to attend and witness factory test. Advise Engineer in writing of scheduled dates for controls factory test not less than 30 days prior to start of the test. If Owner or Engineer attend the test, Engineer will so advise Contractor not less than 10 days prior to the start of the test and Contractor will not be responsible for any of Owner's or Engineer's time or expenses to attend the test, unless initial test does not produce acceptable results and Owner or Engineer must return for a retest. In the latter event, Contractor shall be responsible for costs of Owner's and Engineer's time and travel expenses for the retest, including travel, and such amounts may be deducted (as one or more set-offs) from payment due Contractor.
c. Submit to Engineer written results of successful factory testing of controls.
5. Obtain Engineer's acceptance of source quality control results before shipping equipment to the Site.

B. Defective Work:
1. If required source quality control activities indicate unacceptable results or defects, remedy the defects at the factory and retest.
2. If acceptable results are not obtained after a total of three tests and two cycles of remedial work, submit to Engineer indication of whether further remedies and retesting are expected to achieve the required performance. If required performance cannot be achieved, submit to Engineer a Change Proposal for a suitable reduction in the Contract Price.
3. Owner and Engineer may require either that equipment complying with the Contract Documents be furnished, or further remedial work followed by retesting, request a revised Change Proposal to accept the defective Work, or accept the Change Proposal for defective Work. Owner is under no obligation to accept defective Work.
4. Contractor is responsible for delays resulting from retesting, remedying defective Work, and for negotiating an acceptable Change Proposal for the Owner to accept defective Work..

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Installation – General:
1. Install equipment in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Obtain Engineer's written interpretation or clarification in event of conflict between such requirements.
2. Do not modify structures to install equipment, without Engineer's written approval.
3. Comply with:
a. Section 01 61 03 - Equipment - Basic Requirements.
b. Section 01 75 00 - Checkout and Startup Requirements.

B. Field-Applied Finishes:
   1. Apply field touch-up paint, furnished by blower equipment manufacturer, to scratches and blemishes in equipment's factory-applied coatings.
   2. Apply in accordance with coating manufacturer's written instructions.

## 3.2 FIELD QUALITY CONTROL

A. Field Testing and Inspections:
   1. General:
      a. After equipment installation is complete, Contractor and qualified, factory-trained field service representative of blower equipment manufacturer shall perform tests and inspections required in this Article, in accordance with field testing plan approved by Engineer.
      b. Perform required field tests in Engineer's presence.
   2. Inspect the installed Work and remedy defects as necessary.
   3. Operating Tests:
      a. Field-test each blower together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide necessary testing equipment, labor, and appurtenances. Motor testing shall comply with Section 01 61 03 - Equipment - Basic Requirements.
      b. Verify: (1) equipment operates at design point as intended; (2) vibration limits are not excessive and beyond manufacturer's recommendations; and (3) blower operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify all controls operate as intended in all operating modes. Successfully test-operate each blower in accordance with Section 01 61 03 - Equipment – Basic Requirements, and Section 01 75 00 - Checkout and Startup Requirements.
      c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.
   4. Vibration Testing:
      a. Perform field vibration testing of equipment when required by Section 01 61 03 - Equipment - Basic Requirements.
      b. Vibration testing shall comply with Section 01 61 03 - Equipment - Basic Requirements.
   5. Sound Tests:
      a. Perform sound pressure level test on one blower of each type and size provided. Engineer will select the blower to be so tested following field operating tests.
      b. Present test results in decibels.
      c. Obtain overall sound pressure level at points evenly spaced around blower tested and motor assembly and at three feet from nearest part of blower enclosure. Sound level shall not exceed 85 dBA at distance of three feet from blower enclosure.
   6. Manufacturer shall submit, through Contractor, written statement regarding the blowers' compliance with the Contract Documents and equipment manufacturer's recommendations, regarding whether remedial measures are required, and if so, what remedial measures he proposes.

B. Manufacturer's Services:
   1. Provide services of qualified, factory-trained service person to perform the following:
      a. Instruct Contractor's workers in handling, storing, and installing equipment.
      b. Be present to supervise delivery, unloading, handling, and storage of equipment, and assist Contractor with inspecting condition of equipment and verifying that all required items, including required spare parts and extra materials, were furnished and are appropriate for the equipment,
      c. After installation, inspect and adjust equipment, verify proper operation, and assist with required field testing and inspections.

2. Submit, through Contractor, written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner or facility manager (as applicable).
3. Manufacturer's factory-trained service representative shall revisit the Site as often as necessary until installed equipment is acceptable, and as necessary during the correction period.
4. All costs, including travel, lodging, sustenance, and incidentals, for visits to the Site are included in the Contract Price.

**END OF SECTION**

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# SECTION 43 21 00
## PUMPING EQUIPMENT - BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Pumping equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 01 61 03 - Equipment - Basic Requirements.
   5. Section 43 24 16 - Pumping Equipment - Sump.
   6. Section 43 24 27 - Pumping Equipment - Vertical Turbine (Line Shaft).

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ANSI/Hydraulic Institute (ANSI/HI):
      a. 9.6.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.
      b. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
      c. 9.6.6, Rotodynamic Pumps for Pump Piping.
      d. 9.8, Rotodynamic Pumps for Pump Intake Design
      e. 11.6, Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
      f. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

B. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 01 61 03.

### 1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:
   1. AOR: Allowable Operating Range.
   2. BEP: Best Efficiency Point.
   3. IPS: Iron Pipe Size.
   4. NPSH3: Net Positive Suction Head for 3 PCT head loss.
   5. POR: Preferred Operating Range.
   6. TDH: Total Dynamic Head.
   7. TEFC: Totally Enclosed Fan Cooled.
   8. VFD: Variable Frequency Drive.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03.
   3. Product technical data including:

a. Performance data and curves with flow (GPM), head (FT), horsepower, hydraulic efficiency, rotating speed (RPM), AOR, BEP, POR, NPSH3 requirements, minimum bowl submergence requirements for vertical mixed flow, axial and turbine pumps.
b. Pump accessory data.
c. Bearing supports, shafting details and lubrication provisions.
1) Bearing life calculations.
2) Critical speed calculations.
d. Solids passage information.

4. Certifications:
a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
b. Verification of Primary and Secondary conditions in POR and AOR.

5. Test reports:
a. Factory hydrostatic test.
b. Reed Critical Frequency test.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Certifications:
a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pumps:
a. See individual pump Specification Sections.
2. Mechanical seals:
a. Chesterton.
b. John Crane.
c. Garlock.
d. Flowserve.
e. Or as noted in the individual pump Specification Sections.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to:
1. Shut-off condition.

### 2.3 ACCESSORIES

A. See Specification Section 01 61 03.

B. Each Unit:
1. Lifting eye bolts or lugs.
2. Plugged gage cock connection at suction and discharge nozzles.
3. Tapped and plugged openings for casing and bearing housing vents and drains.
4. Fittings for properly adding flushing lubricant.
5. Pressure relief fittings for grease lubrication.

C. Mechanical Seals:

1. Provide as specified in the narrow-scope pump sections.
2. Provide rotating balanced O-ring type.
3. Provide water lubrication - cooling
4. Materials:
    a. Metal parts except springs: 316 stainless steel.
    b. Springs: Hastelloy C.
    c. Seal faces: Unfilled carbon graphite versus silica-free Grade 99.5 ceramic.
    d. Elastomers: Viton.

### 2.4 FABRICATION

A. Pump Support:
1. Design base to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
4. Mount vertical pumps on single piece pedestal baseplate.
5. Fabricate to withstand all operating loads transmitted from the pump and drive.
6. On vertically configured end suction centrifugal pumps when supplied with a fabricated steel mounting frame and suction elbow, the suction elbow shall be a long radius reducing elbow with greater than 50 PCT area reduction to comply with Table 9.6.6.3.2 of ANSI/HI 9.6.6 standard for straight pipe lengths.

### 2.5 SOURCE QUALITY CONTROL

A. Verification primary design condition in POR.

B. Verification secondary design condition in AOR.

C. Factory hydrostatic test all pumps at 150 PCT of shut-off head for a minimum of five minutes.

D. If specifically required in the individual pump specification sections, provide factory tests:
1. All units:
    a. Conduct tests in accordance with HI.
        1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per ANSI/HI 14.6 for Rotodynamic Pumps.
        2) Shut-off head and design conditions: Positive unilateral performance tolerances meeting Grade 1U per ANSI/HI 11.6 for Rotodynamic Submersible Pumps.
2. All pumps:
    a. Head (FT) versus flow (GPM) pump curves:
        1) Efficiencies along curve.
        2) Brake horsepower along each curve.
3. Results certified by a registered professional engineer.

E. Statically and dynamically balance each pump per ANSI/HI standards.
1. If specifically required in the individual pump specification sections or in Specification Section 01 61 03, field vibration test pumps:
    a. To meet requirements of ANSI/HI 9.6.4 for Rotodynamic Pumps at any point on the pumps and motor.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Specification Section 01 61 03.

B. Floor or Pad-Mounted Units (Non-Submersible):
1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
2. Assure no unnecessary stresses are transmitted to equipment flanges.
3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.

4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    b. Realign as necessary, install flange bolts and make equipment connection.
8. Field paint units as defined in Specification Section 09 96 00.
9. Provide pressure gage, visible from grade or operating floor, on discharge of all pumps and on suction and discharge of all non-submersible units.

C. Submersible Units:
1. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    b. Realign as necessary, install flange bolts and make equipment connection.
2. Field paint units as defined in Specification Section 09 96 00.
3. Provide discharge pressure gage visible from grade or operating floor.

## 3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial start-up of equipment and perform operational checks.
4. Instruct Owner's personnel for the specified minimum number of hours at jobsite per Specification Section 01 30 00 on operation and maintenance of each of following pumping equipment:
    a. Section 43 24 16 - Pumping Equipment - Sump, 8 HRS.
    b. Section 43 24 27 - Pumping Equipment - Vertical Turbine (Line Shaft), 24 HRS.

**END OF SECTION**

# SECTION 43 24 16
## PUMPING EQUIPMENT - SUMP

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Sump pumps (SSP-3001 & ESP-3001).

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 43 21 00 - Pumping Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 43 21 00.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building and Elevator Sump pumps:
      a. WEIL
      b. Flygt.
      c. KSB.
      d. ASB.
      e. Hydromatic.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. Building and Elevator Sump Pumps (SSP-3001 & ESP-3001):
   1. Pump casing:

a. Cast iron, ASTM A48, Class 30B.
2. Impeller:
a. Cast iron, ASTM A48, Class 35A.
3. Shaft:
a. Stainless steel, AISI Type 304.
4. Base elbow: Cast iron.
5. Lifting Cables: Stainless steel.
6. Motor pedestal: Cast iron.

## 2.3 EQUIPMENT

A. Performance and Configuration Requirements:
1. Building Sump Pumps (SSP-3001):
a. Design condition: 35 GPM at 25 FT TDH.
b. Pump configuration: Submersible.
c. Maximum pump speed: 1750 RPM.
d. Drive type: Constant speed.
e. Minimum motor horsepower: 0.5.
f. Motor electrical: 460 V, 3-phase.
g. Duplex Configuration
h. Refer to equipment schedule for additional requirements.
2. Elevator Sump Pump (ESP-3001):
a. Design condition: 50 GPM at 20 FT TDH.
b. Pump configuration: Submersible.
c. Maximum pump speed: 3,450 RPM.
d. Drive type: Constant speed.
e. Minimum motor horsepower: 3/4.
f. Motor electrical: 460 V, 3-phase.
g. Simplex Configuration
h. Refer to equipment schedule for additional requirements.

## 2.4 ACCESSORIES

A. See Sections 43 21 00.

B. See sump pump schedules for additional requirements.

## 2.5 INSTRUMENTATION AND CONTROLS

A. Temperature Monitor – All Sump Pumps:
1. Furnish each phase of the motor with a temperature monitor embedded in the motor windings.
2. Provide pump supervision relay for temperature and moisture sensor control.
3. Set temperature of the pump supervision relay temperature monitors at not higher than 90 PCT of insulation temperature rating.

B. Moisture Sensor – All Sump Pumps:
1. Provide electrical probe as needed for detecting presence of water in the seal chamber and motor housing.
a. If water enters, the probe shall energize electrical circuit through pump supervision relay for external alarm.
b. See pump supervision relay requirements under temperature monitor section.

C. Control Panel - Building Sump Pumps:
1. Furnish and install locally mounted automatic control panel at location shown on Drawings and rated for area classification.
2. Include combination circuit breaker type controller with short circuit, overload, and two overload relays, interior-mounted motor starter(s), and transformer with disconnect and overload protection for control circuit of 24 V.

3. Include a terminal board for connection of level sensors.
4. Provide the following features:
    a. NEMA 4 stainless steel watertight enclosure with continuous hinge, neoprene gasket in cover and continuous seam weld. Include locking mechanism complete with padlock.
    b. Hand-Off-Automatic selector switches.
    c. Automatic alternator and lead lag control.
    d. High level alarm with alarm horn and alarm light.
    e. Pump running lights.
    f. Overload reset button to reset overload relays.
    g. Pump sequence selector switch which overrides automatic alternator.
    h. Lightning protection.
    i. Condensation heater.
    j. Moisture detector alarm light and pump shutdown.
    k. Float switch test pushbuttons.
    l. Auxiliary contacts wired to terminal blocks.
    m. Power ON control relay.
    n. Power OFF control relay.
    o. Remote telemetering contact.
    p. 12 VDC alarm system: A safety device which will actuate when faced with an incoming power failure.
    q. Normal emergency power transfer switch.
    r. Inner door in cabinet-mounted on a continuous vertical steel hinge; size to completely cover wiring and components mounted on the back panel; provide for mounting of controls and instruments on inner door.
    s. Wall mounting.
    t. Pole mounting bracket.
5. Float switch assembly: Provide pumps off, start lead, start lag, and high alarm floats.
6. Design Floats to be field adjustable.
7. Provide floats to operate at elevation as recommended by the equipment manufacturer.
8. Panel to include isolated contacts to monitor pump run, high water, and float conditions for SCADA monitoring.
9. The removal system shall permit removal and re-installation of a pump without disturbing the discharge piping.

D. Control Panel - Elevator Sump Pump:
1. UL Listed.
2. Pump control and high liquid alarm differentiate between oil and water.
3. Oil smart pump control and liquid smart alarm switch. Oil smart pump control shall allow only water to be pumped out without pumping oil/hydraulic fluid from the elevator hoistway pit.
4. Includes indicator lights for power on and pump run
5. Include alarm indicator lights for high liquid, oil, water, pump fault
6. Upgraded pump protection: Motor protective switch, IEC rated contactor, and thermal cutout.
7. Pump Fault reset button
8. Alarm test and silence buttons
9. Hand off auto switch
10. Audible alarm
11. Complete panel remote monitoring dry contacts: oil, water, high liquid, pump run, and pump fault.
12. Type 4X Enclosure.

### 2.6 FABRICATION

A. General:
   1. Pump casing uniform and free from blowholes or other defects and designed to withstand 150 PCT of shutoff head.
   2. Equipped with bolted-on strainer with opening equal to specified solids passage of pump.

B. Impeller:
   1. Key to pump shafts with same material as shaft.
   2. Provide positive means of external axial adjustment of shaft and impeller.

### 2.7 SOURCE QUALITY CONTROL

A. See Section 43 21 00.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with requirements of Section 43 21 00.

B. Install sump pumps, floats, control panels, etc. per manufacturer's installation instructions.

### 3.2 FIELD QUALITY CONTROL

A. See Section 43 21 00.

**END OF SECTION**

# SECTION 43 24 27
## PUMPING EQUIPMENT - VERTICAL TURBINE (LINE SHAFT)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Vertical turbine pumps for the Intermediate Pump Station and Crowson Pump Station.

B. Intermediate Pump Equipment Numbers:
   1. P-5011
   2. P-5012
   3. P-5013

C. Crowson Pump Equipment Numbers:
   1. P-6001
   2. P-6002
   3. P-6003

D. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment: Basic Requirements.
   4. Section 40 61 13 - Process Control Systems General Requirements.
   5. Section 43 21 00 - Pump Equipment - Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Iron and Steel Institute (AISI)
      a. 1045 Medium Carbon Steel
   3. Hydraulic Institute (HI)

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. See Sections 01 61 03 and 43 21 00.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Flowserve.

2. Pentair Fairbanks Nijhuis.
3. Layne-Bowler.
4. Patterson Pumps.
5. Floway.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

## 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Parameters:
1. Intermediate Pump Station - P-5011, P-5012, P-5013:
   a. Notes:
      1) Pumps will operate as Lead-Lag-Standby from the water treatment plant wet well to the Clearwell.
      2) Water fluctuations in the wet well and clearwell result in two parallel system curves spaced 42 ft apart.
      3) Static head of the two system curves is 59 ft and 101 ft.
      4) The following information is based upon the Flowserve 15EHM-1 pump.
   b. Primary design conditions:
      1) 4979 GPM at 106 FT TDH with two pumps operating at minimum 80% efficiency.
      2) 4979 GPM at 64 FT TDH with two pumps operating at minimum 80% efficiency.
      3) Flow Relative to BEP (PCT range): 90% to 115%.
   c. Secondary design condition:
      1) 1400 GPM at 117 FT TDH and 75 PCT efficiency.
      2) Flow Relative to BEP (PCT): >50%.
   d. Runout condition:
      1) 3850 GPM at 62 FT TDH and 70 PCT efficiency.
      2) Flow Relative to BEP (PCT): <135%.
      3) Note: automatic PLC control of the pump will limit pump operation to 125% of BEP.
   e. Maximum speed: 1800 RPM.
   f. Maximum horsepower: 100 HP.
   g. Minimum shutoff condition: 0 GPM at 120 FT.
   h. Column size: 12 IN.
   i. Discharge flange: 12 IN.
   j. Type of discharge head: Surface type, see drawings.
   k. Installation type: wet pit with sole plate (no pump inlet barrel)
      1) Distance from mounting surface to clearwell bottom: 21.8 ft.
      2) Distance from mounting surface to low water level: 17.8 ft.
      3) TDH based on low water level.
2. Crowson Pump Station - P-6001, P-6002, P-6003:
   a. Notes:
      1) Pumps will operate as Lead-Lag-Standby from the Clearwell to Crowson Reservoir.
      2) Water fluctuations in the clearwell and Crowson Reservoir result in two parallel system curves spaced 36 ft apart.
      3) Pump suction pressure ranges between 45 ft and 82 ft based on clearwell level.
      4) Static head of the low and high system curves is 58 ft and 94 ft.
      5) The following information is based upon a Flowserve 12EBM-3 pump.
   b. Primary design conditions:
      1) 3,750 GPM at 120 FT TDH with two pumps operating at minimum 80% efficiency.
      2) 3,750 GPM at 84 FT TDH with two pumps operating at minimum 75% efficiency.
      3) Flow Relative to BEP (PCT range): 90% to 115%.
   c. Secondary design condition:

1) 1875 GPM at 102 FT TDH with a single pump operating at minimum 75 PCT efficiency.
2) 1875 GPM at 64 FT TDH with a single pump operating at minimum 75 PCT efficiency.
3) Flow Relative to BEP (PCT range): 75% to 115%.

d. Runout condition:
1) 2400 GPM at 70 FT TDH and 70 PCT efficiency.
2) Flow Relative to BEP (PCT): <135%.
3) Note: automatic PLC control of the pump will limit pump operation to 125% of BEP.

e. Maximum speed: 1800 RPM.
f. Maximum horsepower: 100 HP.
g. Minimum shutoff condition: 0 GPM at 180 FT.
h. Column size: 10 IN.
i. Discharge flange: 10 IN.
j. Type of discharge head: Surface type, see drawings.
k. Installation type:
1) Canned pump with water supply into the pump inlet barrel. See drawings for inlet clearance from underside of building footing.
2) TDH based on pump inlet.

B. Provide pumps with increasing head characteristics from secondary design conditions to shutoff condition. Provide pumps with net positive suction head requirements (NPSHR) less than the net positive suction head available (NPSHA) at all operating conditions.

## 2.3 ACCESSORIES

A. See Section 01 61 03 and Section 40 61 13.

## 2.4 COMPONENTS

A. General:
1. Furnish units consisting of a vertical shaft turbine, coupled to a vertical solid shaft motor. Design unit with non-reversing ratchets.
2. Weight of revolving parts of pump including unbalanced hydraulic thrust of impeller is carried by thrust bearing in driver.
3. Make provision at driver shaft for adjusting impeller with reference to bowls.
4. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, motors, baseplates, pump inlet barrels, couplings, guards, and other accessories as specified herein.
5. The pumps, motors, drives, couplings and base plates shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without damaging cavitation, and without excessive vibration or noise.
6. Reed Critical Frequency test to be performed and test results provided as a shop drawing submittal.

B. Column:
1. Construct discharge column pipe of steel and supply with flanged connections.
2. Abrasive blast column and coat with a minimum 15 mils dry film thickness epoxy system at the factory.
3. Provide coating recommended by Tnemec or Koppers and NSF-61 approved for use with potable water.

C. Open Line Shaft:
1. Line shaft to be fabricated from 416 stainless steel.
2. Provide rubber bearings at each column connection supported by retainers butted between machined faces of discharge column.

D. Pump Bowl and Suction Bell:

1. Provide bowl and suction bell constructed of close grained cast iron, free from imperfections and accurately machined and fitted.
2. Coat pump bowl water passages with an abrasion-resistant baked enamel, phenolic or epoxy.
3. Provide coating suitable for potable water service.
4. Design to ensure easy removal of bearings and impeller.
5. Furnish suction bell with flared end to reduce entrance losses and with a sufficient number of vanes to support lower guide bearings and weight of impeller and pump shaft when dismantling pump.

E. Bearings:
1. In bowl, provide main bronze bearing immediately above impeller and a lower bronze bearing immediately below impeller.
2. Provide for lubrication of bowl bearings with pumped liquid.
3. Furnish suction bell bearing having minimum length equal to five shaft diameters.

F. Pump Shaft and Impeller:
1. Provide pump shafts and bowl shafts constructed of rolled and ground 416.
2. Furnish enclosed type impellers constructed of bronze and securely attached to impeller shaft.
3. Ensure impeller is accurately fitted and statically and dynamically balanced.
4. Provide bronze replacement wear rings in each bowl to prevent wear on bowls.

G. Discharge Head Assemblies:
1. Design a carbon steel discharge head assembly for 150 PSI working pressure and 250 PSI test pressure.
2. Provide coating recommended by Tnemec or Koppers and NSF-61 approved for use with potable water.
3. Provide discharge head for above ground mounting constructed of fabricated steel with integral discharge flange. Discharge head shall be suitable for pump VFD operation.
4. Furnish ASME B16.1, 125/150LB discharge flange.
5. Construct discharge nozzle with a vertical vane to minimize turbulence.
6. The discharge head base shall be circular with a flat machined lower face and bolt drilling dimensions per a standard ANSI flange size.
7. Sufficient space shall be provided above the gland for access to a spacer-type flanged adjustable solid shaft motor coupling, which shall also be provided. The basic discharge head shall be one-piece type, without separate spacer ring. A bronze shaft guide sleeve bearing shall be furnished below the gland.
8. Protective screens shall be provided to cover the access areas for the coupling and mechanical seal/packing.
9. Provided with the pump head shall be a ½" threaded connection for venting the mechanical seal flush to the pump inlet.
10. Discharge head air release valve:
    a. Intermediate Pump Station: not required.
    b. Crowson Pump Station: provision for an inlet barrel air release valve is to be provided with the pump head lower flange.
11. Sole plate:
    a. Intermediate Pump Station: mount discharge head on fabricated steel sole plate which is of sufficient size to span opening in support structure.
    b. Crowson Pump Station: not required.

H. Pump Inlet Barrel
1. Pump inlet barrels required for the Crowson Pump Station installations.
2. Pump inlet barrels to be design to Hydraulic Institute standards and fabricated from carbon steel.
3. Provide coating recommended by Tnemec or Koppers and NSF-61 approved for use with potable water.

4. The water supply to the pump shall be into the pump inlet barrel below grade. Refer to drawings.
5. The top support plate of the barrel shall be provided, drilled and tapped to accept head base bolts. Flange connection shall be gasketed. The support plate of the barrel shall be provided with studs per a standard ANSI flange size. Inside the stud circle, the plate shall be machine grooved for a nominal 6 mm (1/4") sealing O-ring. This machined groove shall be properly dimensioned for dynamic O-ring sealing when mated with the discharge head. Required O-ring shall also be furnished.
6. Inlet barrel shall be concrete encased as outlined on drawings.

I. Shaft Sealing
1. A sleeve mounted cartridge type inside mechanical seal assembly shall be installed on the pump discharge head.
2. Gland plate shall be of 300 series stainless steel with a 10mm FNPT vent tapping adjacent to the seal face.
3. Sleeve to rotating face seal shall be a full convolution elastomeric bellows with single coil pressure spring.
4. Rotating face shall be self-aligning, tolerant of shaft end play and run out.
5. Contact faces shall be carbon (rotating) / silicon carbide (stationary).
6. Seal hardware, including sleeve, shall be of shall be of 300 series stainless steel.
7. The cartridge sleeve shall be positioned on the pump head shaft by means of at least two setscrews. Removable spacer inserts shall permit the sleeve to be positioned relative to the gland plate before shaft lateral is adjusted.
8. Mechanical seal flushing plans:
   a. Intermediate Pump Station:
      1) Installation type: Plan 11.
      2) A ½" tube shall be installed from downstream of the pump check valve to the seal flush inlet.
   b. Crowson Pump Station:
      1) Installation type:
         a) Plan 13.
         b) A ½" tube shall be installed from flush outlet to a fluid return port on the discharge head base. ½" tube and fittings shall be of 300 series stainless steel.

J. Data Plates:
1. Provide stainless steel data plate securely attached to pump.
2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.

K. Motors:
1. Reduce voltage starting, solid shaft, squirrel cage, induction type.
2. 460 V, 60 HZ, 3 PH, Inverter Duty
3. WP-I type with 1.15 service factor.
4. Size motor to drive pump continuously over the complete head - capacity range without the load exceeding the nameplate rating.
5. Comply with Section 01 61 03.

## 2.5 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish the Owner the following extra parts for each pump service category:
   a. Lower bearing assembly: One set.
   b. Upper bowl bearing: One set.
   c. Line shaft bearing assemblies: One set.
   d. Packing, gland follower, studs and nuts: One set.
   e. Lantern ring: One.
   f. Wearing rings: One set.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

### 3.2 FIELD QUALITY CONTROL

A. See Section 43 21 00.

## END OF SECTION

# SECTION 43 41 13
## WELDED STEEL DIESEL TANKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and design services for shop fabricated welded steel diesel tanks as indicated in this specification, the tank datasheets and in accordance with provisions of the Contract Documents.

### 1.2 QUALITY ASSURANCE

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.
   1. American Petroleum Institute (API):
      a. RP 163, Interior Lining and Periodic Inspection of Underground Storage Tanks
   2. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
      b. B16.9, Factory Made Wrought Buttwelding Fittings
      c. B16.11, Forged Fittings, Socket-Welding and Threaded
      d. B31.1, Power Piping
   3. American Society for Testing and Materials (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel
      b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
      c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications
      d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
      e. A126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
      f. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
      g. B62, Standard Specification for Composition Bronze or Ounce Metal Castings
   4. Federal Specifications (Fed. Spec.):
      a. A-A-60005, Frames, Covers, Grating, Steps, Sump and Catch Basin, Manhole
   5. NACE International (NACE):
      a. 3/SSPC–SP6, Commercial Blast Cleaning
      b. 4/SSPC-SP7, Brush-off Blast Cleaning
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum)
   7. National Fire Protection Association (NFPA):
      a. 30, Flammable and Combustible Liquids Code
      b. 31, Standard for the Installation of Oil-Burning Equipment
      c. 70, National Electrical Code (NEC-2017)
   8. Steel Tank Institute (STI):
      a. F001, Flameshield® Standard for Fire Tested Tanks
      b. F941, Fireguard: Specification for Fireguard Protected Aboveground Storage Tanks
      c. R891, Recommended Practice for Hold Down Strap Isolation
   9. Underwriters Laboratories Inc. (UL):
      a. 142, Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

b. 2085, Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 - Submittals for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Complete detailed drawings of tanks furnished.
      b. Anchor bolt sizing and location drawing (for installation by contractor).
   3. Product technical data.
   4. Certificates:
      a. Certification of welders and welding processes.
   5. Quality Control:
      a. The supplier shall submit a copy of their quality assurance/quality control (QA/QC) procedure for review.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect tanks and accessories from damage during shipping. Cover all flanged nozzles with wooden blanks. Provide plastic caps for all threaded or socket weld openings.

B. Remove all exterior ladders or platforms prior to shipping or provide suitable protection against damage if left on tasks.

C. Keep tank interior and exterior surfaces free of dirt, grease, and other foreign materials.

D. All tanks will receive a final inspection at the job site prior to acceptance by the owner. The owner or owner's representative will provide a final acceptance document. Any damages noted during shipment will be noted and shall be the responsibility of the supplier for repair.

E. All tanks and accessories shall be insured for full value as part of the shipping charges.

### 1.5 EQUIPMENT PERFORMANCE GUARANTEES

A. Supplier shall guarantee that material, equipment, and components in its scope of supply are free of defect and that workmanship will be first class, suitable for heavy industrial usage and environment. Any failures or underperformance due to material defects or poor workmanship shall be corrected free of charge. The guarantee shall be in effect for a period of twelve (12) months after acceptance of the installation. Acceptance shall be given in writing after successful start-up and commissioning, either by purchase or its approved representative. All replacement parts or repairs shall be warranted for twelve (12) months from date of replacement or repair.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

A. Provide a packaged above grade diesel fuel tank with all accessories required to meet applicable local and national standards codes and regulations. The storage tank shall include the following:
   1. 4,000 Gallon Tank Capacity.
   2. Outside Diameter: 6'-8"
   3. Tank Length: 20'-0"
   4. Mounted on Saddles.
   5. Provide (1) Monitoring Cap 2 IN.
   6. Provide (2) 8 IN 8 OZ Emergency Vent Male w/O-ring.
   7. Provide (1) 2 IN Stack Vent (12 FT above grade) w/ 2 IN Mushroom Cap.
   8. Provide (1) 7.5 Gal 4 IN Aluminum Overspill Container 179 Series hinged Style Fill Cap.
   9. Provide (1) Monitoring Well with 2 IN Cap.
   10. Provide (1) Dual Channel Tank Alarm Box W/ Rotating Beacon.

11. Provide (1) Multi Level Sensor Probe.
12. Provide Engineered Hurricane Tie Downs as required.
13. Provide (1) Interstitial Leak Gauge.
14. Provide (1) Tank Decal Kit.
15. Coat tank with a Polyaspartic Urethane for High Performance Finish.
16. Provide (1) Quart of Touch Up Paint.
17. Provide (1) Memco 1 IN Return Line Fitting Only.
18. Provide (1) 1.5 IN Pickup with Drop Tube and Foot Valve 6 IN From Bottom of Line.
19. Provide (1) 18 IN Man way for easy inner tank accessibility.
20. Tank to be UL 2085 Labeled and Listed.
21. Provide Step Ladder with Platform.
22. Tank to be constructed with a 3/16 IN steel Shell and a 1/4 IN thick steel Head (minimum).
23. Provide mounting brackets to allow mounting of fuel conditioner and transfer pump panels.

## 2.2 TANK DESIGN AND CONSTRUCTION

A. Type: Factory-fabricated all welded steel, horizontal cylindrical configuration, atmospheric pressure, internal and external corrosion protection as specified. In addition to specified requirements, tanks shall be fabricated in accordance with Steel Tank Institute (STI) design standards by manufacturer that participates in STI Quality Assurance Program.

B. Construction:
   1. Conform to NFPA 30 or NFPA 31 as applicable.
   2. Double-wall, insulation between walls, conforming to STI F941 "Fireguard" construction, and to UL 2085. Provide label of conformance.
   3. Design tanks for saddle supports furnished by tank manufacturer.
   4. Leaks and abrasions are prohibited. Maximum permissible out of roundness of cylindrical shells is one percent of the diameter.
   5. Provide lifting lugs for rigging tanks.
   6. Make provisions for leak detectors to be installed at lowest part of interstitial space between walls of double-wall tanks.

C. Platforms, Stairs, Ladders and Handrails: Provide welded steel assemblies as shown, conforming to OSHA requirements. Provide welded steel tank attachments designed to support platform framing, stairs, ladders and live and dead loadings. Clean and coat all surfaces as specified for tank.

D. Factory Cleaning: Clean interior and exterior of tanks. Remove mill scale, dirt, rust, oil, welding debris, loose coatings and coatings incompatible with fuel stored or protective coating. Sandblast exterior in accordance with NACE 3.

E. Factory Coating: As indicated previously

F. Pipe Connections to Tanks:
   1. Conform to UL 142.
   2. Pipe sizes 2 IN and smaller, threaded. Pipe sizes 2 1/2 IN and larger, flanged, 150 psig ASME rating.
   3. Welded joints required on steel piping located inside tanks.
   4. Provide valved drain of interstitial space.

G. Tank Manholes: Bolted cover type, gasketed.

H. Wear (Striker) Plates: Provide 12 IN square, 1/4 IN thick steel plates welded to tank bottom directly under the sounding opening, the fuel return discharge, and the fill discharge.

I. Lifting Lugs: Provide for rigging tanks.

J. Emergency Relief Vents for Fire Exposure: Venting capacity shall conform to NFPA 30 or NFPA 31 as applicable. Standard product of a manufacturer, designed to automatically open at

tank pressure of 2.5 psig gauge. Aluminum or cast-iron construction with Teflon seating surface. Provide separate vents for primary and secondary tanks.

K. Provide fittings for grounding per NFPA 70.

L. Seismic Design: design for seismic restraint in accordance with applicable codes.

## 2.3 TANK FLUID LEVEL MONITOR AND ALARM SYSTEMS

A. High and Low Fluid Level Alarm System:
   1. Visual and audible indicators combined with fluid level monitor. Identify the tank that is in alarm condition.
   2. Manual alarm test and silencing controls.
   3. Low level alarm actuation adjustable 0-25 percent of tank capacity. High level alarm actuation adjustable 75-100 percent of tank capacity.

B. Locate all indicators, selector switches, alarms on face of wall-mounted NEMA 250, Type 4 panel.

C. Remote Alarm Annunciator:
   1. Visual and audible high-level alarms adjacent to tank fill box locations. Locate in NEMA 250 Type 4X weatherproof exterior wall or pole-mounted panels.
   2. Alarm shall include flashing red light with 180-degree visibility for each tank and 95 dB horn or 4 IN diameter bell. Provide alarm silence control.
   3. Provide identification sign: "WHEN ALARM SOUNDS - FUEL TANK FILLED TO CAPACITY - DO NOT OVERFILL".

D. Sensors:
   1. Provide sensor types such as magnetostrictive, capacitance, float, hydrostatic and other types as necessary for the applications.
   2. Apply in accordance with manufacturer's instructions with provisions for easy future replacement without need for excavation.
   3. Provide for each hydrostatic sensor a constant flow differential pressure regulator and transmitter protected from fuel contamination. Air supply shall include filter and over-pressure protection. Provide desiccant-type dryer on air supply designed for removal of water vapor. Dryer rating, minimum 4.6 L/s (10 SCFM). Provide moisture indicator. Dryer may be deleted if air supply source has a refrigerated dryer.
   4. Float-type units shall be designed for installation and removal through a 4 IN diameter vertical pipe mounted in the top of the tank.

E. Code Conformance: NFPA 70.

## 2.4 FUEL TRANSFER PUMP ASSEMBLY

A. Transfer pump assembly shall be AXI FTS 1100 series or approved equivalent

B. Transfer Pump Assembly shall conform to the following specifications:
   1. Sized to a maximum generator fuel consumption of 72 gph
   2. Pump: Gear Pump, continuous duty
   3. Electrical: 120V/ Single phase, 1 HP max
   4. Provide external relief valve
   5. Pump Controller: Fully automated UL508A compliant
   6. Piping: Stainless Steel
   7. Provide Pump Strainer
   8. NEMA 4X Enclosure, suitable for outdoor installation
   9. Provide leak detector and alarm for enclosure

## 2.5 FUEL CONDITIONER

A. Fuel conditioner assembly shall be AXI STS series or approved equivalent

B. Fuel conditioner assembly shall conform to the following specifications:

1. Flow: 4 gpm
2. Pump: Gear Pump, continuous duty
3. Electrical: 120V/ Single phase, 1/3 HP max
4. Pump Controller: Fully automated UL508A compliant
5. Piping: Stainless Steel
6. Filter: 30 micron filter with water separator
7. Provide Inline fuel conditioner (AXI, LGX 1500 nor approved equal)
8. NEMA 4X Enclosure, suitable for outdoor installation
9. Provide leak detector and alarm for enclosure

## PART 3 - EXECUTION

### 3.1 UNLOADING AND STORAGE

A. Unload tanks on site after inspection and acceptance.

B. Store an in an acceptable manner that will protect from damage and corrosion prior to installation.

### 3.2 DESIGN COORDINATION

A. The fuel transfer pump system and fuel conditioner system shall be coordinated with the design of the generator fuel day tank system (Section 26-32-14) to provide fully automated controls and alarms.

### 3.3 INSTALLATION AND TESTING, ABOVEGROUND TANKS

A. Install in accordance with manufacturer's written instructions.

B. Conform to NFPA 30 or NFPA 31 as applicable.

C. C. Support tanks on steel saddles welded to the tanks. Anchor to concrete foundations. Provide molded neoprene isolation pads between the steel supports and the concrete foundation.

D. After tanks are installed, test steel tanks with air pressure of 3 to 5 psig, using soapsuds to locate leaks. Repair leaks by chipping to bare metal and rewelding. Retest until all leaks are repaired. Repair all damaged areas of prime coat on tanks and steel dikes (if furnished). Test interstitial area between steel tank walls with air at pressure recommended by tank manufacturer.

E. Provide electrical grounding in accordance with NFPA 70.

### 3.4 TANK CLEANING AFTER INSTALLATION

A. Prior to placing the tank into service, rinse the interior surfaces with water, including nozzle interiors and man way covers.

### 3.5 STARTUP AND TESTING

A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.

## END OF SECTION

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# SECTION 43 41 43
## POLYETHYLENE CHEMICAL TANKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes upright, cylindrical, polyethylene tanks, molded in one- piece seamless construction by rotational molding, and associated fittings and accessories. The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. Also included are a secondary containment basin and mixers for neat polymer.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 33 00 - Submittals.
   3. Section 10 14 00 - Identification Devices.
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
   5. Section 40 05 31 - Pipe - Plastic.
   6. Section 40 41 13 - Heat Tracing Cable
   7. Section 40 42 00 - Pipe, Duct, and Equipment Insulation
   8. Section 40 72 00 - Level Instrumentation.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Society of Testing Materials (ASTM).
      a. D638, Standard Test Method for Tensile Properties of Plastics.
      b. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
      c. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      d. D1525, Standard Test Method for Vicat Softening Temperature of Plastics.
      e. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
      f. D1998, Standard Specification for Polyethylene Upright Storage Tank.
   2. National Sanitation Foundation (NSF):
      a. 61, Drinking Water System Components.

A. Tank Manufacturer Requirements:
   1. Tank manufacturer shall have manufactured at least 50 tanks of similar size and design within five years. Fabricator's quality assurance supervisor shall have a minimum of 10 years' experience in the fabrication of fiberglass structures.
   2. Designer shall be a registered professional engineer in the State of Oregon.
   3. Provide services of an engineer, registered in the State of Oregon, for anchor bolt design and calculations. Engineer shall sign and seal all calculations and construction Drawings for tank anchors. Engineer shall be on manufacturer's permanent staff or retained for qualified outside source.
   4. See Contract Drawings for structural design requirements.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including the following.
      a. Tank manufacturer's catalog data.

b. Complete shop drawings with dimensions and mounting details, including locations and dimensions of all fittings and penetrations.
c. Details of inlet/outlet fittings, vents, mountings for level elements, sight glass level gage, and manway, with bolt and gasket material.
d. Wall thickness calculations per ASTM D1998 using 600 PSI design hoop stress at 100 DegF.
e. Weight of tanks.
f. Statement of fabrication is in accordance with test specifications.
g. Certificate of Compliance from the tank manufacturer stating:
    1) All fittings, heat tracing, insulation, etc. have been installed by the tank manufacturer.
    2) Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
h. Complete anchor bolt, wind load, and seismic calculations stamped by a Profession Engineer in Oregon.
i. Equipment mounting plans with tolerances for anchor bolts.
j. Anchoring system details.
k. Tank expansion (at discharge nozzle) measured as dimensional difference between empty and full dimensions (radius).
l. Details on packaging.
m. Instructions for handling, storage, and installation of tanks.
n. Resin used and a complete manufacturer specification of the resin used.
o. Samples of a representative tank wall.
p. Statement that materials and resin used are suitable for intended service.
q. Certificate of Compliance from the tank manufacturer stating:
    1) All fittings, heat tracing, insulation, etc. have been installed by the tank manufacturer.
    2) Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.

### 1.4 PROJECT / SITE CONDITIONS

A. The tanks will be located inside a semi-heated building and outdoors.
    1. Temperatures: Between 0 DEGF and 100 DEGF.
    2. Relative humidity: Between 60 and 80%.

### 1.5 WARRANTY

A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, for a period of five years from start-up.

B. The severity of the defect will determine the requirement of a site visit.

C. All travel expenses, accommodation, etc., for a service visit due to a defect deemed severe by the manufacturer shall be included in the warranty.

D. Travel expenses for procedures classified as routine maintenance are not included under this warranty.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Poly Processing Company.
    2. Snyder Industries, Inc.
    3. Assmann Corporation of America

## 2.2 MATERIALS

A. Materials used shall be virgin polyethylene resin as compounded and certified by the manufacturer.

B. The interior of the HDXLPE tank shall have an anti-oxidant resistant LLDPE liner for sodium hypochlorite.

C. The plastic shall not contain any fillers.

D. All plastic shall contain a minimum of 0.25 PCT U.V. stabilizer and a maximum of 0.60 PCT.

E. Tanks shall be manufactured from materials certified to NSF/ANSI Standard 61 for chemical storage.

F. HDXLPE material shall meet or exceed the following test properties, based on molded parts.
   1. Density (ASTM D1505): 0.938 - 0.946 g/mL.
   2. Tensile strength, ultimate, 2 IN minimum (ASTM D638): 2,830 PSI.
   3. Elongation at break, 2 IN minimum (ASTM D638): 700%.
   4. ESCR, 100% Igepal, Cond. A, F50 (ASTM D1693): >1,000 HRS.
   5. ESCR, 10% Igepal, Cond. A, F50 (ASTM D1693): >1,000 HRS.
   6. Vicat softening point (ASTM D1525): 250 DEGF.
   7. Flexural Modulus (ASTM D790): 86,780 PSI.
   8. Impact resistance at -40 DEGF (Phillips SSL-193): >120 FT/LB.

G. HDLPE material shall meet or exceed the following test properties, based on molded parts.
   1. Density (ASTM D1505): 0.942 - 0.947 g/mL.
   2. Tensile strength at Yield, 2 IN minimum (ASTM D638): 2,700 PSI.
   3. Elongation at break, percent, 2 IN minimum (ASTM D638): 350%.
   4. ESCR, 100% Igepal, Cond. A, F50 (ASTM D1693): 400 - 1000 HRS.
   5. ESCR, 10% Igepal, Cond. A, F50 (ASTM D1693): 200 - 500 HRS.
   6. Vicat softening point (ASTM D1525): 235 DEGF.
   7. Flexural Modulus (ASTM D790): 97,000-103,000 PSI.
   8. Impact resistance at -40 DEGF (Phillips SSL-193): >120 FT/LB.

H. Fitting, gasket, and bolt materials shall be compatible with intended chemical service of each individual tank.
   1. All wetted parts shall be NSF 61 certified

## 2.3 FABRICATION

A. The polyethylene tanks shall be constructed by the rotational molding process.

B. The tank diameter shall be measured externally.
   1. Tolerance on the outside diameter including out of roundness shall be plus or minus two percent.
   2. Measurement shall be taken in a horizontal position.
   3. The knuckle radius at bottom of wall shall be a minimum of 1 IN.

C. All edges cut out, such as entrance to manway, shall be trimmed to have smooth edges.

D. Tank wall thickness shall be per ASTM D1998.

E. Neat polymer mixers MX-7201and MX-7301:
   1. Impellers:
      a. Axial flow basic design.
      b. Dynamically and hydraulically stable.
      c. Impeller bolted to impeller shaft with set screws.
   2. Speed reducer:
      a. Designed and rated per AGMA standards.
      b. Totally enclosed.
      c. Service factor: 2.0 of nameplate on motor.

d. Gear drive ratio: 5:1.
e. Bearing design:
1) Antifriction type, ball or roller, grease lubricated.
2) Double grease seal at impeller shaft.
f. Grease lubricated at factory for life.
g. Food grade lubricants only.
3. Coupling:
a. Rigid flange on output shaft located for ease of access.
b. Welded or interference fit hub type.
c. Mated coupling faces provided with rabbeted male and female piloted connection.

F. Neat Polymer Mixing Motor:
a. 460 V, 3 PH, 60 HZ.
b. TEFC, chemical duty, 1,750 rpm, 1.15 SF.
c. Energy-efficient type.
d. Integral mount.

G. Mixer mount:
1. Mixer mount to be integrated with tank.
2. Mount provided by tank manufacturer.

## 2.4 DESIGN REQUIREMENTS

A. Aluminum Sulfate – T-7101, T-7102.
1. Shell Style: Upright.
2. Top Style: Domed top.
3. Bottom Style: Flat bottom.
4. Exposure: Outdoors.
5. Heat tracing and Insulation: Yes
6. Color: Natural.
7. Approximate Capacity: 6,100 GAL.
8. Approximate Diameter: 10 FT
9. Approximate Height: 12 FT.
10. Chemical design specific gravity: 1.33.
11. Maximum fluid temp: 100 DEGF.
12. Minimum fluid temp: 40 DEGF.
13. Minimum ambient air temp: 0 DEGF.

B. Settling Aid Polymer – T-7201.
1. Shell Style: Upright.
2. Top Style: Domed top.
3. Bottom Style: Coned bottom.
4. Exposure: Indoors, heated.
5. Color: Natural.
6. Approximate Capacity: 370 GAL.
7. Approximate Diameter: 4 FT
8. Approximate Height: 6 FT with stand.
9. Chemical design specific gravity: 1.2.
10. Maximum fluid temp: 80 DEGF.
11. Minimum fluid temp: 40 DEGF.
12. Minimum ambient air temp: 40 DEGF.

C. Filter Aid Polymer – T-7301.
1. Shell Style: Upright.
2. Top Style: Domed top.
3. Bottom Style: Coned bottom.
4. Exposure: Indoors, heated.
5. Color: Natural.

6. Approximate Capacity: 100 GAL.
7. Approximate Diameter: 3 FT
8. Approximate Height: 4.5 FT with stand.
9. Chemical design specific gravity: 1.2.
10. Maximum fluid temp: 80 DEGF.
11. Minimum fluid temp: 40 DEGF.
12. Minimum ambient air temp: 40 DEGF.

D. Sodium hypochlorite tank – T-7401
1. Shell Style: Upright.
2. Top Style: Domed top.
3. Bottom Style: Flat bottom.
4. Exposure: Outdoors.
5. Color: Black.
6. Approximate Capacity: 6,100 GAL.
7. Approximate Diameter: 10 FT
8. Approximate Height: 12 FT.
9. Chemical design specific gravity: 1.21.
10. Maximum fluid temp: 100 DEGF.
11. Minimum fluid temp: 0 DEGF.
12. Minimum ambient air temp: 0 DEGF.

E. Sodium Hydroxide – T-7501.
1. Shell Style: Upright, double-walled.
2. Top Style: Domed top.
3. Bottom Style: Flat bottom.
4. Exposure: Indoors, heated.
5. Color: Natural.
6. Approximate Capacity: 1,100 GAL.
7. Approximate Diameter: 6.5 FT, includes secondary containment.
8. Approximate Height: 7 FT, includes secondary containment.
9. Chemical design specific gravity: 1.278.
10. Maximum fluid temp: 80 DEGF.
11. Minimum fluid temp: 40 DEGF.
12. Minimum ambient air temp: 40 DEGF.

F. Secondary Containment Basin – SCB-7200
1. Shape: Rectangular
2. Bottom Style: Flat
3. Exposure: Indoors
4. Color: Natural
5. Approximate Capacity: 700 GAL
6. Approximate Width: 8 FT
7. Approximate Length: 6 FT
8. Approximate Height: 2 FT
9. Flange Width: 3 IN
10. Chemical Exposure: Settling Aid Polymer and Filtering Aid Polymer

## 2.5 FITTINGS

A. All sidewall fittings shall keep the storage solution from contacting the tank wall cross section.

B. Fittings terminate in socket or flanged connections.
1. Flanges: 150 LB ANSI/ASME B16.5.

C. Tanks provided under this section shall be provided with the following fittings. See the Drawings for more detail on the height and orientation of each fitting.
1. Outlet Port:

a. T-7101, 7102, 7401, 7501 & 7701
   1) 3 IN IMF on side.
   2) 2 IN IMF on side.
b. T 7201 & 7301
   1) 2 IN on side.
   2) 2 IN on bottom.

2. Fill Port:
   a. T-7101, 7102, & 7401
      1) 3 IN SABFF on top.
   b. T-7201, 7501, & 7701
      1) 2 IN SABFF on top.
   c. T-7301
      1) 1 IN SABFF on top.
3. Vent Line Port:
   a. T-7101, 7102, 7401, 7501 & 7701
      1) 6 IN SABFF on top.
   b. T-7201 & 7301
      1) 2 IN SABFF on top.
         a) Connection for desiccant module.
4. Overflow Protection:
   a. T-7101, 7102, & 7701
      1) 6 IN BFBF port on side.
   b. T-7201 & 7301
      1) 2 IN BFBF port on side.
   c. T-7401
      1) 4 IN BFBF port on side.
   d. T-7501
      1) 4 IN BFBF port on side.
   e. Overflow Check Valves:
      1) Tideflex Series TF-1 check valve, or approved equal.
      2) Wetted materials to be chemically compatible for the application.
      3) Provided by tank Supplier, installed by Contractor.
5. Level Sensor Port: 4 IN flanged nozzle on top.
   a. See drawings for details

D. Bolted Flange Bulkhead Fittings (BFBF):
   1. Constructed with one 150 LB flange installed inside the tank and one flange ring installed outside the tank.
   2. Flange shall be socket or threaded according to specific connection requirements.
   3. There shall be a minimum of four 1/2 IN DIA all thread bolts with bolt heads encapsulated in polyethylene preventing fluid contact with the metal material.
   4. Polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head.
   5. Encapsulated heads shall have a gasket to provide a sealing surface against the flange.
   6. Bolt holes shall straddle the principal centerline of the tank.

E. Bolted Flanged Fitting (BFF):
   1. Flange shall be 150 LB socket or threaded according to specific connection requirements.
   2. There shall be a minimum of four 1/2 IN DIA all thread bolts with bolt heads encapsulated in polyethylene preventing fluid contact with the metal material.
   3. Polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head.
   4. Encapsulated heads shall have a gasket to provide a sealing surface against the flange.
   5. Bolt holes shall straddle the principal centerline of the tank.

F. Integrally Molded Flange (IMF):

1. Located at the bottom of the sidewall and allows the tank to be fully drained.
2. Integrally molded into the tank during the rotational molding process.
3. Seamless, flanged, and manufactured from the same material as the tank.
4. Inserts are not acceptable.
5. A companion flange assembly with a split backing ring, bolts, and gasket shall be provided.

G. Self-Aligning Bolted Flange Fittings (SABFF):
1. Consists of a precision machined threaded swivel ball sealed inside a Bolted Flanged Fitting (BFF).
2. No self-aligning bolted flange fittings permitted on sidewall.

H. Self-Aligning Threaded Bulkhead Fittings (SATBF):
1. Consists of a precision machined threaded swivel ball sealed inside a Threaded Bulkhead Fitting (TBF).
2. No self-aligning threaded bulkhead fittings permitted on sidewall.

I. Threaded Bulkhead Fittings (TBF):
1. Consists of double compression nuts threaded over a Schedule 80 long shank tube which penetrates the tank wall.
2. An integrally molded backing flange shall be provided at one end of the tube.
3. A closed cell, polyethylene gasket shall be installed on the tube between the backing flange and the inner wall of the tank.
4. High-torque design and shall provide a minimum of 85 PCT thread contact.
5. Provide an NPT pipe coupling on the exterior of the tank otherwise indicated.
6. No threaded bulkhead fittings permitted on wetted sidewall.

J. Unitized Molded Outlet (UMO):
1. A molded-in encapsulated stainless steel insert located at the bottom of the sidewall that allows the tank to be fully drained.
2. The insert shall be sealed off from the liquid contents of the tank by two O-rings installed on a specially machined schedule 80 CPVC male pipe adapter.

## 2.6 TANK APPURTENANCES

A. Expansion Joints:
1. Provide an expansion joint for each tank nozzle.
2. Service: Chemical Systems.
   a. Manufacturers:
      1) PROCO Products, Inc.
      2) Or equal.
   b. Material:
      1) Bellows: PTFE-62.
      2) Flanges: PVC or CPVC.
      3) Limit Belts and Nuts: Carbon steel epoxy coated.
      4) Reinforcing Rings: Stainless Steel.
   c. Pressure rating at 70 DEGF: 70 PSIG.
   d. Minimum axial movement: 3/8 IN.

B. Lifting Lugs:
1. Tanks with 3,000 GAL capacity or larger shall have a minimum of three lifting lugs integrally molded into the top head.
2. Lugs shall be designed for lifting the tank when empty.

C. Manways and Access Caps:
1. Closed top tanks over 500 GAL shall have a manway opening with a minimum inner diameter of 24 IN.
2. Closed top tanks less than 500 GAL shall have an access cap with a minimum inner diameter of 7 IN.

3. Manways and access caps shall be constructed of polyethylene material integrally molded with the tank.
4. Manways and access caps shall be sealable.

D. Pipe Supports:
1. Provide pipe supports for the drop pipes attached to the tank.
2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 FT OC.
3. Pipe supports shall allow removal of supported pipes.
4. The pipe support shall be a bolted fitting at the tank sidewall and shall include a bolt with a polyethylene encapsulated head installed on the interior of the tank wall. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head. Pipe supports with exposed metal are not acceptable for use inside tanks.

E. Hazard and Safety Signs:
1. Caution Signs:
   a. Each tank shall be provided with a minimum of one Chemical Caution Sign.
   b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
   c. Size: 5 IN x 7 IN.
   d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.
   e. Schedule for T-7101 through 7701, except 7601; required for each:
      1) Quantity: 1.
      2) Location: Place in a visible location on each tank.
      3) Text/Symbol: WEAR EYE PROTECTION, RUBBER GLOVES, AND APRONS WHEN HANDLING CHEMICALS.
2. Danger Signs:
   a. Each tank shall be provided with a minimum of one Confined Space Danger Sign.
   b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
   c. Size: 5 IN x 7 IN.
   d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.
   e. Schedule for T-7101, 7102, 7401, 7501, and 7701; required for each:
      1) Quantity: 1.
      2) Location: On tank near the manway.
      3) Text/Symbol: DANGER / CONFINED SPACE.
3. NFPA Fire Hazards Material Signs:
   a. Each tank shall be provided with a minimum of one NFPA fire Hazards Material Sign.
   b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
   c. Size: 7-1/2 IN x 7-1/2 IN.
   d. Characteristics:
      1) 4 color background, blue, red, yellow, white.
      2) Diamond shape conform to NFPA No. 704, System for identifying fire hazards of materials.
   e. Legend letter height: 3 IN-high black hazard numerals.
   a. TSchedule for T-7101 & 7102:
      1) Quantity: 1.
      2) Location: Place in a visible location on tank.
      3) Text/Symbol:
         a) Material: ALUMINUM SULFATE.
         b) Health: 1.
         c) Fire: 0.
         d) Reactivity: 0.
   b. Schedule for T-7201:
      1) Quantity: 1.
      2) Location: Place in a visible location on tank.
      3) Text/Symbol:
         a) Material: SETTLING AID POLYMER.

b) Health: 0.
c) Reactivity: 0.
d) Specific Hazard: 0.

c. Schedule for T-7301:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Material: FILTER AID POLYMER.
b) Health: 0.
c) Fire: 1.
d) Reactivity: 0.

d. Schedule for T-7401:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Hazardous Material: SODIUM HYPOCHLORITE.
b) Health: 3.
c) Fire: 0.
d) Reactivity: 1.
e) Specific Hazard: OXIDIZER.

e. Schedule for T-7501:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Hazardous Material: SODIUM HYDROXIDE.
b) Health: 3.
c) Fire: 0.
d) Reactivity: 1.
e) Specific Hazard: CORROSIVE.

f. Schedule for T-7701:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Material: SODIUM CARBONATE.
b) Health: 1.
c) Fire: 0.
d) Reactivity: 0.

F. Seismic Restraint:
1. Tanks shall be provided with seismic restraint systems suitable to resist seismic loads. Restraint cable shall be Type 316 stainless steel. Base plates shall be enamel coated steel.
2. The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading situations without tank damage.
3. Anchor calculations for tanks shall be prepared and stamped by a registered structural engineer licensed in the State where the project is being constructed. Anchor bolt calculations shall be in accordance with the IBC 2009. Seismic restraints shall be designed for IBC $S_s = 1.1769g$; $S_1 = 0.427g$.

G. Tank Vents:
1. T-7201 & 7301 shall utilize a desiccant breather to prevent excess moisture buildup inside of tanks.
2. All closed top tanks shall be supplied with a U-vent that vents the tank outside of the building.
3. All vents shall have a 1/4 IN PVC or polyethylene mesh bug screen at the terminal end of the vent.

## 2.7 APPURTENANCES

A. Tanks provided under this section shall be provided with the following appurtenances. See the Drawings for more detail on the height and orientation of appurtenances.

B. Tank Appurtenance Schedule:
   1. T-7101, T-7102, & T-7701:
      a. Drop Pipe, External on:
         1) Fill line.
         2) Overflow line.
      b. Drop Pipe, Internal on:
         1) Fill line.
         2) Overflow line.
      c. Heat Tracing and Insulation.
      d. Level Gauges:
         1) Reverse Acting Sight Level Gauge.
   2. T-7201 & T-7301:
      a. Drop Pipe, External on:
         1) Overflow line.
      b. Drop Pipe, Internal on:
         1) Fill line.
         2) Overflow line.
            a) Overflow line to be sealed with check valve or P-trap filled with mineral oil to prevent bypass of desiccant breather.
      c. Desiccant Breather
      d. Agitator Bracket
         1) Clamp-on style
         2) Provide fitting for air-tight seal around agitator shaft, see Neat Polymer Mixers section below.
   3. T-7401
      a. Drop Pipe, External on:
         1) Fill Line.
         2) Overflow Line.
      b. Drop Pipe, Internal on:
         1) Fill Line.
         2) Overflow line.
      c. Level Gauges:
         1) Reverse Acting Sight Level Gauge
   4. T-7501
      a. Drop Pipe, Internal on:
         1) Fill line.
      b. Overflow prevention device integrated into fill line.
         1) Installation contractor to install drain to safe area or return chemical to delivery container in case of activation of overfill protection device.
      c. Level Gauges:
         1) Reverse Acting Sight Level Gauge.

C. Drop Pipe, External:
   1. Provide a pipe drop leg outside the tank.
   2. The drop leg shall be supported externally by pipe supports at 5 FT maximum intervals.
   3. The drop pipe supports shall be bolted fittings at the tank sidewall and shall include a bolt with a polyethylene encapsulated head installed on the interior of the tank wall. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head. Pipe supports with exposed metal are not acceptable for use inside tanks.

D. Drop Pipe, Internal:

1. Provide a pipe drop leg inside the tank. The pipe drop leg shall extend down into the tank interior within 1 FT of the bottom of the tank.
2. The drop leg shall be supported internally by pipe supports at 5 FT maximum intervals.
3. The drop pipe supports shall be bolted fittings at the tank sidewall and shall include a bolt with a polyethylene encapsulated head installed on the interior of the tank wall. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head. Pipe supports with exposed metal are not acceptable for use inside tanks.
4. Drop pipe shall have siphon-breaking capability inside the tank.

E. Heat Tracing and Insulation, T-7101, 7102, and 7701:
1. See Section 40 41 13 – Heat Tracing Cable & Section 40 42 00 – Pipe, Duct and Equipment Insulation

F. TReverse Acting Float Gauge:
1. Float, pulley, and cable type: Full-scale.
2. Locate as indicated by Engineer.
3. Gauge board mounted to outside of tank, calibrated in specified volume units:
   a. T-7101, 7102, 7401 & 7701
      1) 500 GAL
   b. T-7501
      1) 100 GAL
4. Minimum two exterior mounting brackets by tank manufacturer.
5. Cable and float runs in 2 IN clear PVC pipe.

## 2.8 DOUBLE WALLED TANK (T-7501)

A. A leak detection system is required to notify operators if the primary tank structure has failed.
1. The leak sensor shall be ultrasonic.

B. Secondary containment tank should allow for 110% containment of primary tank volume.

C. Tank construction should prevent contamination of containment when possible.

D. Only fitting on sidewall allowed is the outlet port.

E. The fill line should have an integrated overfill protection device. A connection will be provided by the owner to safely drain the fill line in-case of accidental an overfill

## 2.9 SECONDARY CONTAINMENT BASIN (SCB-7200)

A. No appurtenances required.

## 2.10 NEAT POLYMER MIXERS (MX-7201 AND MX-7301)

A. Number of units: Two (2).

B. Shaft: 1 IN DIA. Length as required for tank and mixer mounting assembly for tank mounting.
1. Impeller should be located in cone bottom to prevent interference with level measurement.

C. Number of impellers per mixer: One (1).

D. Impeller: Hydrofoil design. Diameter:
1. MX-7201: 6 IN
2. MX-7301: 3 IN

E. Maximum impeller speed: 350 rpm.

F. Horsepower:
1. As needed to ensure at least three turnovers of material in one 15 MIN mixing cycle.

G. Drive type: Constant speed.

H. Material mixed: Polymer at 1,000 to 2,000 cp viscosity.

I. Mixing vessels: 350 GAL tank (MX-7201) and 100 GAL tank (MX-7301).

J. On/off switch.

K. 10 FOOT electrical cord with three prong plug.

L. Bearing life at full nameplate horsepower: Minimum ABMA L-10 of 100,000 HRS.

M. Speed reducer:
   1. Designed and rated per AGMA standards.
   2. Totally enclosed.
   3. Service factor: 2.0 of nameplate on motor.
   4. Gear drive ratio: 5:1.
   5. Bearing design:
      a. Antifriction type, ball or roller, grease lubricated.
      b. Double grease seal at impeller shaft.
   6. Grease lubricated at factory for life.
   7. Food grade lubricants only.

N. Coupling:
   1. Rigid flange on output shaft located for ease of access.
   2. Welded or interference fit hub type.
   3. Mated coupling faces provided with rabbeted male and female piloted connection.

O. Neat Polymer Mixing Motor:
   1. 460 V, 3 PH, 60 HZ.
   2. TEFC, chemical duty, 1,750 rpm, 1.15 SF.
   3. Energy-efficient type.
   4. Integral mount.

P. Mixer mount:
   1. Mixer mount to be integrated with tank.
   2. Mount provided by tank manufacturer.

## PART 3 - EXECUTION:

### 3.1 DELIVERY AND INSPECTION

A. Inspect tanks for gouges, pinholes, and other obvious defects, immediately following delivery of the tanks to the project site.

B. Defects in the tanks will be cause for rejection of the tanks.

### 3.2 INSTALLATION

A. Tanks shall be installed as shown and in accordance with the manufacturer's written instructions.

B. Each tank shall rest on a level, even base of concrete so that the entire bottom of the tank is supported.

### 3.3 FIELD TESTING

A. T-7101, 7102, 7401, 7501, & 7701
   1. Tanks shall be field tested by filling the entire tank with water and monitoring the tanks and fitting connections for at least 24 HRS.

B. T-7201 & 7301
   1. Tanks shall be field tested with low pressure, compressed air (pressure as specified by manufacturer) and leak detection fluid used on fittings.
   2. If water is used, tank and fittings must be COMPLETELY dry prior to initial chemical fill. ANY AMOUNT OF LIQUID WATER will cause an adverse reaction with neat polymer.

C. Any leaks shall be corrected by the manufacturer's representative prior to acceptance.

D. Following successful field tank testing, the tanks shall be completely emptied and dried.

## 3.4 FIELD REPAIR

A. If, after filling with chemical, a leak is detected, the Contractor shall be responsible for all expenses associated with removing the tank contents, repairing the tank, and replacing the tank contents.

## 3.5 TRAINING

A. A minimum of 4 HRS of training, in the use and maintenance of tanks, shall be provided.

**END OF SECTION**

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# SECTION 43 41 45
## FIBERGLASS REINFORCED PLASTIC TANKS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Bulk chemical storage tanks (T-7101, T-7201, T-301-, T-7401, and T-7501).
   2. Secondary Containment Basin (SCB-7200)
   3. Neat Polymer Mixers (MX-7201 and MX-7301)

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements
   4. Section 40 41 13 – Heat Tracing Cable
   5. Section 40 42 00 – Pipe, Duct, and Equipment InsulationDivision 26 - Electrical

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. B16.5, Pipe Flanges and Flanged Fittings.
   2. ASTM International (ASTM):
      a. C582, Standard Specification for Reinforced Plastic Laminates for Self-Supporting Structures for Use in a Chemical Environment.
      b. D3299, Specification for Filament-Wound-Glass Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
      c. D4097, Specification for Contact Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
   3. American Bearing Manufacturers Association (ABMA).
   4. American Gear Manufacturers Association (AGMA):
      a. 390.03a, Gear Handbook - Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears.
   5. American Iron and Steel Institute (AISI).
   6. NSF International (NSF), formerly National Sanitation Foundation:.
      a. NSF/ANSI 61, Drinking Water System Components – Health Effects.

B. Tank Manufacturer Requirements:
   1. Tank manufacturer shall have manufactured at least 50 tanks of similar size and design within five years. Fabricator's quality assurance supervisor shall have a minimum of 10 years' experience in the fabrication of fiberglass structures.
   2. Designer shall be a registered professional engineer in the State of Oregon.
   3. Provide services of an engineer, registered in the State of Oregon, for anchor bolt design and calculations. Engineer shall sign and seal all calculations and construction Drawings for tank anchors. Engineer shall be on manufacturer's permanent staff or retained for qualified outside source.
   4. See Contract Drawings for structural design requirements.

### 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Tank and Secondary Containment Basin technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.
c. Complete information on basic materials including chemical resistance charts.
d. Sizes of all major tank components.
e. Details on nozzle and other openings lay-up.
f. Details on field assembly and installation.
g. Fitting locations.
h. Approved chemical storage.
i. Manufacturer's available gel coat colors.
j. Details of heat tracing and insulation.
k. Equipment mounting plans with tolerances for anchor bolts.
l. Anchoring system details.
m. Complete anchor bolt, wind load, and seismic calculations stamped by a Professional Engineer in the State of Oregon.
n. Certificate of Compliance from the tank manufacturer stating:
    1) All fittings, heat tracing, insulation, etc. have been installed by the tank manufacturer.
    2) Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.

3. Neat Polymer Mixers:
    a. Manufacturer.
    b. Type and model.
    c. Design rotative speeds.
    d. Bearing types and life calculations.
    e. Dimensions and net weight.
    f. Materials of construction.
    g. Mounting requirements and design forces: Torque and bending load.
    h. Disassembly procedure for impeller access.
    i. Calculations supporting all shaft and impeller design criteria (stress and critical speed).
4. Neat Polymer Mixer Drive units:
    a. Manufacturer.
    b. Type and model.
    c. Rated size.
    d. Temp rating and service factor.
    e. Dimensions and weight.
    f. Lubrication systems.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Fiberglass reinforced plastic tanks:
        a. Raven.
        b. Red Ewald, Inc.
        c. Tankinetics.
    2. Neat Polymer Mixers
        a. Mixing Equipment Co., Inc. (Lightnin).
        b. Philadelphia Mixers.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 MATERIALS

A. General:
    1. Resins:
        a. Atlac 382.

b. Atlac 580.
c. Derakane 411-45.
d. Derakane 470-36.
e. Dion Cor-Res 6694.
f. Dion Cor-Res 7000.
g. Hetron 197.

2. Reinforcement:
   a. Surfacing veil: Type C glass with silane finish and styrene-soluble barrier at 20 mils thick and interior Nexus.
   b. Chopped strand mat: Type E glass with silane finish and styrene-soluble binder.
   c. Continuous roving: Type E glass with chrome finish or silane finish.
   d. Woven roving: Type E glass with silane finish.
   e. Woven cloth: Type E glass with silane finish.
3. Exposed metal: Stainless steel, ANSI Type 316.
4. Lifting lugs: Stainless steel, ANSI Type 304.

## 2.3 ACCESSORIES

A. Flanges Nozzles:
   1. Conically gusseted to tank, withstand 300 LBS bending, 300 FT/LBS torque.
   2. Flange diameter and drilling per ANSI B16.5, 150 LB.
   3. At least 4 IN from outside face.
   4. Same material as tank.
   5. Location and sizes as shown on Drawings.

B. Fill Port:
   1. T-7101 & 7401
      a. 3 IN on top.
   2. T-7201 & 7501
      a. 2 IN on top.
   3. T-7301
      a. 1 IN on top.

C. Vents:
   1. Tanks 7101, 7401, & 7501:
      a. 4 IN screened mushroom or gooseneck type.
   2. Tanks 7201 & 7301:
      a. 1 IN - Replaceable desiccant filter/breather module.

D. Overflow Protection:
   1. T-7101 & 7401
      a. 4 IN port on side.
   2. T-7201 & 7301
      a. 2 IN port on side.
   3. T-7501
      a. 2 IN overfill protection device integrated with fill piping.
      b. Installation contractor to install drain to safe area in case of activation of overfill protection device.
   4. Overflow Check Valves:
      a. Tideflex Series TF-1 check valve, or approved equal.
      b. Wetted materials to be chemically compatible for the application.
      c. Provided by tank Supplier, installed by Contractor.

E. Sensor Connection
   1. Provide 4 IN flanged nozzle connection for non-contact radar level sensor. See provided drawings for details.

F. Handling lugs.

G. Manway and access caps:
   1. Tanks greater than 500 GAL:
      a. One 24 IN DIA access manway in top of each tank.
      b. Flange diameter and drilling per ANSI B16.5, 150 LB.
      c. 40-50 durometer 1/8 IN thick full-faced gaskets.
   2. Tanks less than 500 GAL:
      a. Access cap with a minimum inner diameter of 7 IN.

H. Heat Tracing and Insulation, T-7101
   1. See Section 40 41 13 – Heat Tracing Cable and Section 40 42 00 – Pipe, Duct, and Equipment Insulation

I. Tank Appurtenance Schedule:
   1. T-7101:
      a. Drop Pipe, External on:
         1) Fill line.
         2) Overflow line.
      b. Drop Pipe, Internal on:
         1) Fill line.
         2) Overflow line.
      c. Heat Tracing and Insulation.
      d. Level Gauges:
         1) Reverse Acting Sight Level Gauge.
   2. T-7201 & T-7301:
      a. Drop Pipe, External on:
         1) Overflow line.
      b. Drop Pipe, Internal on:
         1) Fill line.
         2) Overflow line.
      c. Desiccant Breather
      d. Agitator Bracket
         1) Clamp-on style
         2) Provide fitting for air-tight seal around agitator shaft.
   3. T-7401
      a. Drop Pipe, External on:
         1) Fill Line
         2) Overflow Line
      b. Drop Pipe, Internal on:
         1) Fill Line
         2) Overflow line
      c. Level Gauges:
         1) Reverse Acting Sight Level Gauge
   4. T-7501
      a. Drop Pipe, Internal on:
         1) Fill line
      b. Overfill prevention valve integrated into fill line.
      c. Level Gauges:
         1) Reverse Acting Sight Level Gauge

J. Drop Pipe, External:
   1. Provide a pipe drop leg outside the tank.
   2. The drop leg shall be supported externally by pipe supports at 5 FT maximum intervals.
   3. The drop pipe supports shall be bolted fittings at the tank sidewall and shall include a bolt with a polyethylene encapsulated head installed on the interior of the tank wall. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the

threads closest to the bolt head. Pipe supports with exposed metal are not acceptable for use inside tanks.

K. Drop Pipe, Internal:
   1. Provide a pipe drop leg inside the tank. The pipe drop leg shall extend down into the tank interior within 1 FT of the bottom of the tank.
   2. The drop leg shall be supported internally by pipe supports at 5 FT maximum intervals.
   3. The drop pipe supports shall be bolted fittings at the tank sidewall and shall include a bolt with a polyethylene encapsulated head installed on the interior of the tank wall. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 IN of the threads closest to the bolt head. Pipe supports with exposed metal are not acceptable for use inside tanks.
   4. Drop pipe shall have siphon-breaking capability inside the tank.

L. Reverse Acting Float Gauge:
   1. Float, pulley, and cable type: Full-scale.
   2. Locate as indicated by Engineer.
   3. Gauge board mounted to outside of tank, calibrated in specified volume units:
      a. T-7101 & 7401
         1) 500 GAL
      b. T-7501
         1) 100 GAL
   4. Minimum two exterior mounting brackets by tank manufacturer.
   5. Cable and float runs in 2 IN clear PVC pipe.

M. Hazard and Safety Signs:
   1. Caution Signs:
      a. Each tank shall be provided with a minimum of one Chemical Caution Sign.
      b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
      c. Size: 5 IN x 7 IN.
      d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.
      e. Schedule for all tanks; required for each:
         1) Quantity: 1.
         2) Location: Place in a visible location on each tank.
         3) Text/Symbol: WEAR EYE PROTECTION, RUBBER GLOVES, AND APRONS WHEN HANDLING CHEMICALS.
   2. Danger Signs:
      a. Each tank shall be provided with a minimum of one Confined Space Danger Sign.
      b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
      c. Size: 5 IN x 7 IN.
      d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.
      e. Schedule for T-7101, 7401, and 7501; required for each:
         1) Quantity: 1.
         2) Location: On tank near the manway.
         3) Text/Symbol: DANGER / CONFINED SPACE.
   3. NFPA Fire Hazards Material Signs:
      a. Each tank shall be provided with a minimum of one NFPA fire Hazards Material Sign.
      b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
      c. Size: 7-1/2 IN x 7-1/2 IN.
      d. Characteristics:
         1) 4 color background, blue, red, yellow, white.
         2) Diamond shape conform to NFPA No. 704, System for identifying fire hazards of materials.
      e. Legend letter height: 3 IN-high black hazard numerals.
      f. Schedule for T-7101:
         1) Quantity: 1.

2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Material: ALUMINUM SULFATE.
b) Health: 1.
c) Fire: 0.
d) Reactivity: 0.

g. Schedule for T-7201:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Material: SETTLING AID POLYMER.
b) Health: 0.
c) Fire: 0.
d) Reactivity: 0.

h. Schedule for T-7301:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Material: FILTER AID POLYMER.
b) Health: 0.
c) Fire: 1.
d) Reactivity: 0.

i. Schedule for T-7401:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Hazardous Material: SODIUM HYPOCHLORITE.
b) Health: 3.
c) Fire: 0.
d) Reactivity: 1.
e) Specific Hazard: OXIDIZER.

j. Schedule for T-7501:
1) Quantity: 1.
2) Location: Place in a visible location on tank.
3) Text/Symbol:
a) Hazardous Material: SODIUM HYDROXIDE.
b) Health: 3.
c) Fire: 0.
d) Reactivity: 1.
e) Specific Hazard: CORROSIVE.

## 2.4 FABRICATION

A. Tank and Secondary Containment Basin Size and Dimensions:
1. Aluminum Sulfate tank _T-7101, T-7102:
a. Approximate capacity: 6,100 GAL.
b. Approximate diameter: 10 FT.
c. Approximate height: 102IN.

2. Settling Aid polymer tank _T-7201:
a. Approximate capacity: 370 GAL.
b. Approximate diameter: 4 FT.
c. Approximate height: 6 FT with stand.

3. Filter Aid polymer tank _T-7301:
a. Approximate capacity: 100 GAL.

b. Approximate diameter: 3 FT.
c. Approximate height: 4.5 FT with stand.

4. Sodium Hypochlorite tank _T-7401:
   a. Approximate capacity: 6,100 GAL.
   b. Approximate diameter: 10 FT.
   c. Approximate height: 10FT.

5. Sodium Hydroxide tank _T-7501:
   a. Approximate capacity: 1,100 GAL.
   b. Approximate diameter: 7 FT.
   c. Approximate height: 7 FT.

6. Secondary Containment Basin SCB-7200:
   a. Approximate capacity: 700 GA:.
   b. Approximate Width: 6 FT.
   c. Approximate Length: 8 FT.
   d. Approximate Height: 2 FT.
   e. Flange Width: 3 IN.

B. Tank and Secondary Containment Basin Shape:
   1. T-7101 & 7401
      a. Cylindrical with flat bottom and closed domed top.
   2. T-7201 & 7301
      a. Cylindrical with cone bottom and closed domed top.
      b. Stand either integrated or separate.
   3. T-7501
      a. Cylindrical, double walled with flat bottom and closed domed top.
   4. SCB-7200
      a. Rectangular with flat bottom.

C. Service Conditions:
   1. T-7101
      a. Fluid: Aluminum Sulfate.
      b. Exposure: Outdoors, heat traced and insulated.
      c. Pressure: Atmospheric.
      d. Concentration by weight: 40 PCT.
      e. Specific gravity: 1.33.
      f. Minimum ambient temp.: 0 DEGF.
      g. Minimum fluid temp.: 40 DEGF.
      h. Maximum fluid temp.: 100 DEGF.
   2. T-7201
      a. Fluid: Settling Aid polymer.
      b. Pressure: Atmospheric.
      c. Exposure: Indoors, heated.
      d. Specific gravity: 1.2.
      e. Minimum ambient temp.: 40 DEGF.
      f. Minimum fluid temp: 40 DEGF.
      g. Maximum fluid temp.: 100 DEGF.
   3. T-7301
      a. Fluid: Filter Aid polymer.
      b. Pressure: Atmospheric.
      c. Exposure: Indoors, heated.
      d. Specific gravity: 1.2
      e. Minimum ambient temp.: 40 DEGF.
      f. Minimum fluid temp: 40 DEGF.

g. Maximum fluid temp.: 100 DEGF.

4. T-7401
   a. Fluid: Sodium Hypochlorite.
   b. Pressure: Atmospheric.
   c. Exposure: Outdoors
   d. Concentration by weight: 12.5 PCT.
   e. Specific gravity: 1.21.
   f. Minimum ambient temp.: 0 DEGF.
   g. Minimum fluid temp.: 0 DEGF.
   h. Maximum fluid temp.: 100 DEGF.
5. T-7501
   a. Fluid: Sodium Hydroxide.
   b. Pressure: Atmospheric.
   c. Exposure: Indoors, heated.
   d. Concentration by weight: 25 PCT.
   e. Specific gravity: 1.28.
   f. Minimum ambient temp.: 40 DEGF.
   g. Minimum fluid temp.: 40 DEGF.
   h. Maximum fluid temp.: 100 DEGF.

D. Design Loads:
   1. Seismic requirements: Zone II, UBC.
   2. Concentrated top load: 30 PSF plus dead load.

E. Design: Per ASTM D3299, PS-15, and as specified herein, the more stringent requirement to govern.

F. Tanks:
   1. Filament-wound or contact molded construction.
   2. Design safety factor and minimum wall thickness per governing standards.
   3. Sufficient resin on all surfaces to prevent fiber show.
   4. Ends fabricated integrally with shell or separately and laminated to shell.
   5. Joints made with heavy reinforced lay-ups for structural stability and to prevent leakage.
   6. Inner surface layer:
      a. 10-20 mils thick.
      b. Inner layer followed by laminate 80-90 mils thick, reinforced with noncontinuous chopped strand fiberglass.
      c. Laminate layer resin content: 70-80 PCT.
      d. Total thickness of two layers at least 100 mils.
   7. Walls structurally reinforced with fiberglass mat or woven roving or with filament winding of continuous strands.
      a. Outer layer resin content: 40 to 45 PCT.
      b. Thickness and glass content of outer wall per tensile and flexural requirements.
   8. Reinforcing ribs per manufacturer's recommendations.
   9. Lifting lugs provided on tank.
   10. Coated with protective gel, color as selected.
   11. Minimum wall thickness: 1/4 IN.

G. Minimum Laminate Fabrication Requirements:
   1. Ultimate tensile strength: 40,000 PSI.
   2. Modules of elasticity: 3 x 10(6) psi.
   3. Minimum glass content:
      a. 1/4 IN or less laminate thickness: 30 PCT.
      b. 5/16 IN laminate: 38 PCT.
      c. 3/8 IN and thicker laminate: 42 PCT.

H. Tie Down Lugs: Number and strength required per design loading.

I. Allowable Surface Tolerances:
   1. Cracks: None.
   2. Crazing (fine surface cracks): None.
   3. Blisters: None.
   4. Wrinkles: Maximum deviation: 10 PCT of wall thickness, but not exceeding 1/8 IN.
   5. Pits: Maximum dimension: 1/8 IN DIA x 1/32 IN deep, maximum number: 10/SQFT.
   6. Surface porosity: None.
   7. Chips: None.
   8. Dry spot: None.
   9. Entrapped air (bubbles or voids in the laminate):
      a. Maximum diameter: 1/16 IN.
      b. Maximum density: 10/SQ IN but none to a depth of 1/32 IN.
   10. Exposed glass: None.
   11. Burned areas: None.
   12. Exposure of cut edges: None.
   13. Scratches: None.
   14. Foreign matter: None.

J. Certification Label:
   1. Chemical contents, including:
      a. Concentration.
      b. Specific gravity.
      c. Maximum temperature.
   2. Exterior resin.
   3. Tank capacity.
   4. Date of manufacture.
   5. Seismic zone requirements.

K. Neat polymer mixers MX-7201and MX-7301:
   1. Impellers:
      a. Axial flow basic design.
      b. Dynamically and hydraulically stable.
      c. Impeller bolted to impeller shaft with set screws.
   2. Speed reducer:
      a. Designed and rated per AGMA standards.
      b. Totally enclosed.
      c. Service factor: 2.0 of nameplate on motor.
      d. Gear drive ratio: 5:1.
      e. Bearing design:
         1) Antifriction type, ball or roller, grease lubricated.
         2) Double grease seal at impeller shaft.
      f. Grease lubricated at factory for life.
      g. Food grade lubricants only.
   3. Coupling:
      a. Rigid flange on output shaft located for ease of access.
      b. Welded or interference fit hub type.
      c. Mated coupling faces provided with rabbeted male and female piloted connection.

L. Neat Polymer Mixing Motor:
      a. 460 V, 3 PH, 60 HZ.
      b. TEFC, chemical duty, 1,750 rpm, 1.15 SF.
      c. Energy-efficient type.
      d. Integral mount.

M. Mixer mount:
   1. Mixer mount to be integrated with tank.
   2. Mount provided by tank manufacturer.

## 2.5 DOUBLE WALLED TANK (T-7501)

A. A leak detection system is required to alert operators if the primary tank structure has failed.
   1. The leak sensor shall be ultrasonic.

B. Secondary containment tank should allow for 110% containment of primary tank volume.

C. Tank construction should prevent contamination of containment when possible.

D. Only fitting on sidewall allowed is the outlet port.

## 2.6 SECONDARY CONTAINMENT BASIN (SCB-7200)

A. No appurtenances required.

## 2.7 NEAT POLYMER MIXERS (MX-7201 AND MX-7301)

A. Number of units: Two (2).

B. Shaft: 1 IN DIA. Length as required for tank and mixer mounting assembly for tank mounting.
   1. Impeller should be located in cone bottom to prevent interference with level measurement.

C. Number of impellers per mixer: One (1).

D. Impeller: Hydrofoil design. Diameter:
   1. MX-7201: 6 IN
   2. MX-7301: 3 IN

E. Maximum impeller speed: 350 rpm.

F. Horsepower:
   1. As needed to ensure at least three turnovers of material in one 15 MIN mixing cycle.

G. Drive type: Constant speed.

H. Material mixed: Polymer at 1,000 to 2,000 cp viscosity.

I. Mixing vessels: 350 GAL tank (MX-7201) and 100 GAL tank (MX-7301).

J. On/off switch.

K. 10 FOOT electrical cord with three prong plug.

L. Bearing life at full nameplate horsepower: Minimum ABMA L-10 of 100,000 HRS.

M. Speed reducer:
   1. Designed and rated per AGMA standards.
   2. Totally enclosed.
   3. Service factor: 2.0 of nameplate on motor.
   4. Gear drive ratio: 5:1.
   5. Bearing design:
      a. Antifriction type, ball or roller, grease lubricated.
      b. Double grease seal at impeller shaft.
   6. Grease lubricated at factory for life.
   7. Food grade lubricants only.

N. Coupling:
   1. Rigid flange on output shaft located for ease of access.
   2. Welded or interference fit hub type.
   3. Mated coupling faces provided with rabbeted male and female piloted connection.

O. Neat Polymer Mixing Motor:
   1. 460 V, 3 PH, 60 HZ.
   2. TEFC, chemical duty, 1,750 rpm, 1.15 SF.
   3. Energy-efficient type.
   4. Integral mount.

P. Mixer mount:
   1. Mixer mount to be integrated with tank.
   2. Mount provided by tank manufacturer.

## PART 3 - EXECUTION

### 3.1 DELIVERY AND INSPECTION

A. Inspect tanks for gouges, pinholes, and other obvious defects, immediately following delivery of the tanks to the project site.

B. Defects in the tanks will be cause for rejection of the tanks.

### 3.2 INSTALLATION

A. Tanks shall be installed as shown and in accordance with the manufacturer's written instructions.

B. Each tank shall rest on a level, even base of concrete so that the entire bottom of the tank is supported.

### 3.3 FIELD TESTING

A. T-7101, 7401, & 7501
   1. Tanks shall be field tested by filling the entire tank with water and monitoring the tanks and fitting connections for at least 24 HRS.

B. T-7201 & 7301
   1. Tanks shall be field tested with compressed air (pressure as specified by manufacturer) and leak detection fluid used on fittings.
   2. If water is used, tank and fittings must be COMPLETELY dry prior to initial chemical fill. ANY AMOUNT OF LIQUID WATER will cause an adverse reaction with neat polymer.

C. Any leaks shall be corrected by the manufacturer's representative prior to acceptance.

D. Following successful field tank testing, the tanks shall be completely emptied and dried.

### 3.4 FIELD REPAIR

A. If, after filling with chemical, a leak is detected, the Contractor shall be responsible for all expenses associated with removing the tank contents, repairing the tank, and replacing the tank contents.

### 3.5 TRAINING

A. A minimum of 4 HRS of training, in the use and maintenance of tanks, shall be provided.

**END OF SECTION**

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# DIVISION 46

## WATER AND WASTEWATER EQUIPMENT

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# SECTION 46 31 54
## INSTALLATION OF OZONE GENERATING AND FEED EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:
   1. Ozone Generation System (System).

B. Related Specifications include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements
   4. Section 40 05 07 - Pipe Support Systems
   5. Section 40 05 19 - Pipe: Ductile
   6. Section 40 05 23 - Pipe - Stainless Steel
   7. Section 40 05 51 - Valves - Basic Requirements
   8. Section 40 05 52 - Miscellaneous Valves
   9. Section 40 05 63 - Ball Valves
   10. Section 40 05 64 - Butterfly Valves
   11. Section 40 05 66 - Check Valves
   12. Section 40 61 13 - Process Control Systems General Requirements
   13. Section 40 61 96 - Process Control Descriptions
   14. Section 40 63 43 - Programmable Logic Controller (PLC) Control System
   15. Section 40 62 16 - Computer Network and Human Machine Interface (HMI) Hardware
   16. Section 40 67 00 - Control System Panels and Racks
   17. Section 40 71 00 - Flow Instrumentation
   18. Section 40 72 00 - Level Instrumentation
   19. Section 40 73 00 - Pressure Instrumentation
   20. Section 40 74 00 - Temperature Instrumentation
   21. Section 46 31 59 – Cleaning Requirements for Oxygen Service

### 1.2 SCOPE OF WORK

A. This section covers the design, fabrication, delivery, installation, inspection and testing the ozone generation, side stream injection system, residual monitoring skid and destruction skids, including all items necessary for a complete System to provide ozonation to settled water for treatment.

B. The OSS shall supply the System under single source responsibility. The System equipment includes, but is not limited to, the items listed in Article 1.4 of this Section.

C. The Contractor shall unload, unpack, assemble, and install equipment items furnished by the Ozone System Supplier (OSS) as shown on the Drawings and as specified herein. In addition, the Contractor shall furnish and install additional equipment, interconnecting piping, valves, fasteners, pipe supports, instruments, power and control wiring, and all other appurtenances required to provide a complete and operable system.

D. This Specification and the Contract Documents outline expected performance requirements and design aspects for the system specific to its role in the overall project. These Contract Documents do not detail all process, mechanical, electrical, controls and related supporting System requirements. The OSS shall design and supply all components necessary for the successful automatic operation of the System to meet the performance requirements established herein. Should the OSS find it necessary or desirable to deviate from specific design aspects

detailed in the Contract Documents to meet the performance requirements, the OSS shall clearly state all deviations in the shop drawing with Contract Document references along with the reason for each deviation.

## 1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
   3. ASTM International (ASTM).
   4. American Water Works Association (AWWA).
   5. American Welding Society (AWS).
   6. Compressed Gas Association (CGA).
   7. Institute of Electrical and Electronic Engineers (IEEE): 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   8. Instrument Society of America (ISA).
   9. National Electrical Code (NEC).
   10. National Fire Protection Association CNFPA).
   11. International Building Code, 2003 (IBC).
   12. International Fire Code, 2003 (IFC).
   13. NSF/ANSI 61-2017 - Drinking Water System Components
      a. 61, Drinking Water System Components - Health Effects.
      b. 372, Drinking Water Components – Lead Content
      c. 600, Health Effects – Solvent
   14. Equipment shall be AIS/BABAA compliant.
   15. Where reference is made to one of the above standards, the revision in effect at the time of Bid opening shall apply unless otherwise noted.

B. OSS Qualifications:
   1. OSS shall demonstrate:
      a. A minimum of five (5) years' experience in the manufacture of the provided modular/cabinet-based ozone systems in the United States or Canada.
      b. Having supplied at least ten (10) systems of 100 pounds per day capacity or greater of the provided system, each supplied for potable water in the United States or Canada.
   2. OSS's onsite representatives during installation, testing, and training shall demonstrate experience with the installation and startup of a minimum of five (5) ozone systems in the United States or Canada.

C. All system components shall be designed for oxygen and ozone gas service, unless noted otherwise. Ozone off-gas and oxygen gas system components furnished shall be designed and installed in accordance with NFPA 50, 55 and industry standards as set forth by the Compressed Gas Association.

## 1.4 SYSTEM DESCRIPTION

A. The Ozone Generation System (System) includes the following components:
   1. Two (2) modular ozone generators (2 duty) in individual cabinets with internal power supply units.(GEN-2410 & GEN-2420)
      a. The OSS has the option to provide a factory assembled manifold to manifold services (ozone, oxygen, ozone purge, cooling water supply, and cooling water return) to the two generators to/from common headers.
   2. Two (2) ozone destruct units on independent skids. (OZD-2610 & OZD-2620)
   3. Two (2) chillers, one duty and one standby for both ozone generator cabinets, to provide closed loop cooling water. (CHL-2510 & CHL-2511)
   4. Sidestream injection (SKID-2001) equipment including:
      a. One (1) Mass Transfer Skid to inject and dissolve ozone gas (carried in a stream of oxygen gas) to the settled water sidestream by the use of an eductor/venturi.

b. One (1) 20-IN pipeline flash reactor for injection of the ozonated sidestream water into the process via opposing nozzles to dissolve the ozone at the required mass transfer efficiency.
c. One (1) inline 316 SST static mixer to provide additional mixing to satisfy the minimum transfer efficiency.

5. One (1) Nitrogen Boost System, if the ozone generators require the use of nitrogen boost. (CP-2301 & AC-2301)
6. Field Instrument/Equipment including:
   a. Two (2) Ambient Ozone Analyzers (AE/AIT-2401, AE/AIT-2402)
7. One (1) Master Ozone Control Panel (MOCP) (MOCP-2001)
8. Ozone Residual Monitoring System Skid including:
   a. Two (2) Dissolved Ozone (in water) Analyzers (AIT/AE-3002, AIT/AE-3003) with respective probes and flow through cells.
9. GOX Pressure Regulator Station . A pre-assembled set of pipe manifolds with valves, instruments, and filters to prepare the GOX for feed into the ozone generators, including:
   a. Two (2) Pressure Regulator (PRV-2202, PRV-2203)
   b. Two (2) Fine Coalescing Filters (LT-2201, LT-2202)
   c. Two (2) Pressure Transmitters (PIT-2201, PIT-2203)

One (1) Shutoff Valve (BV-2201)

10. All piping, valves, instrumentation, control panels, and appurtenances and accessories required for proper operation of the System.
    a. OSS can provide pneumatic valves if the air compressor system required is included in the price.

B. Gas Supply:
1. The ozone generator shall be designed by the OSS to produce ozone from a pure gaseous oxygen (GOX) feed gas with nitrogen boost gas (if required). GOX will be supplied from onsite liquid oxygen storage tanks and vaporizers. The LOX storage tanks and vaporizers are being provided by a service contractor. The Contractor shall coordinate onsite to provide a complete system, including controls/interlocks. Gaseous nitrogen (if required) will be supplied using a Nitrogen Boost System with air compressors supplied by the OSS.

## 1.5 SUBMITTALS

A. Product Data Submittals:
1. Submit in accordance with the requirements of Section 01 33 00, Submittals.
2. Qualification per Article 1.3 B and 2.11 B
3. Piping and instrumentation drawings (P&IDs).
4. Certified dimensional drawings of each piece of equipment to be furnished including installation drawings and details, shipping weights, flooded weights, and clearances on all sides of individual equipment as well as ground skids, frame mounted items, etc.
   a. Provide dimensional drawings that show that all system components fit the spaces, including piping, and with necessary clearance around for proper access and maintenance.
   b. Provide in PDF and digital (native format).
   c. Digital: Provide 3D model of each distinct piece of equipment and assembly in one of the following file formats:
      1) DWG
      2) STP (STEP)
      3) RFA
5. Detailed electrical and control wiring diagrams for all electrical power and controls equipment
6. Cut sheets and product data on all equipment and components, including but not limited to the following:
   a. Ozone Generators, including electrical power supply system.
   b. Ozone Generator Chillers, including piping and appurtenances.

c. Ozone Destruct Units.
d. LOX Boost System
e. Mass Transfer System, including the flash reactor, static mixer, etc.
f. Ozone Residual Monitors
g. GOX Pressure Regulator Station
h. Ozone Contactor Pressure/Vacuum Relief Valve.
i. Valves, Instruments, and ancillary appurtenances.

7. Factory Test Procedures, Test Results and Report.
   a. Test Plan/Procedures
   b. Test Results
   c. Certifications
8. Ozone generator and control panel front elevation drawing showing all face-mounted instruments
9. Ozone generator and control panel interior layout drawing showing location of major components and other data as required for a complete installation, including external connectors, wire and terminal numbers.
10. Ozone System Calculations
    a. Conduct at production equal to 10%, 25%, 50%, 75%, 90%, and 100% of firm ozone capacity.
    b. OSS to select optimal %wt and note it.
    c. For each production capacity, provide the following:
       1) Pounds ozone per day generated.
       2) Ozone mass transfer efficiency %.
       3) Ozone-in-oxygen gas volumetric flow rate.
       4) Gas temperature increase.
       5) Hydraulic losses through the complete sidestream system.
       6) Hydraulic losses through the mainstream dissolution system (flash reactor, static mixer)
       7) Hydraulic losses in the cooling water system.
       8) Cooling water temperature increase.
       9) Ozone production unit power consumption curves (kWh/lb), per ozone generator.
          a) Unit power consumption curves shall vary by cooling water temperature, ozone generator production, and %wt ozone.
11. Other product data and calculations.
    a. Load list including maximum and minimum working voltage, current, power, and frequency for all connected loads.
    b. Electrical submittals including wires, cables, control panels, transformers, circuit breakers, etc. Harmonic analysis to prove that the ozone generator power complies with IEEE latest applicable standards.
    c. Allowable feed gas control and pressure range that demonstrates turndown capacity.
    d. Maximum allowable gas feed pressure and pressure drop through the ozone generator.
    e. Required minimum closed-loop cooling water flow rate and maximum temperature.
    f. Closed-loop cooling water system test and working pressures.
    g. Complete system bill of materials.
    h. Anchorage design.
       1) Size, number, embedment, complete construction details.
       2) Submit all loads and reactions necessary for anchorage design, including operating and seismic base reactions.
    i. All valves and instruments:
       1) Manufacturer and model number, size, type, materials of construction, pressure rating and location.
    j. Dimensions of area required for servicing equipment.
    k. OSS's Certificate of Compliance that the factory finish coat system is equal to or better than the requirements specified herein.

l. Special shipping, truck unloading, on-site storage and protection, and other handling instructions.
m. OSS's installation instructions.
n. Routine maintenance requirements prior to plant startup.
o. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
p. Provide a letter detailing all systems and parts that will be cleaned for use with oxygen/ozone gas per Section 46 31 59 prior to shipping and/or onsite.

12. Controls Submittal
    a. A comprehensive control description of the operation and automation of the complete ozone system.
    b. Include a Functional Description (Control Writeup) and I/O tables.
    c. Control panel drawings
        1) Include wiring diagram, door detail layout (including nameplates with tag numbers), back panel layout
    d. Copy of control program with annotations.
        1) Include all calculation formulas
    e. HMI software user interface screen print outs.
        1) Include main screen, menus, popups, alarms, etc.
    f. Factory acceptance testing procedure.
    g. Checkout and start-up procedures. Refer to Section 01 75 00.
    h. Demonstration period procedure.
13. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

B. Operation and Maintenance Manuals:
    1. Refer to Specification Section 01 79 23.
    2. Operation and maintenance data shall be furnished and shall also describe safety procedures and precautions.

C. Closeout Submittals
    1. Field test reports, including:
        a. Checkout and Startup per Section 01 75 00
        b. Performance
        c. Oxygen cleaning results per Section 46 31 59
    2. Manufacturer's Certificate of Proper Installation.
    3. Warranty

D. Compliance with the Reduction of Lead in Drinking Water Act (2014) is required, and all applicable products must meet the lead-free requirements and conform to NSF 372.

E. All pipes, fittings, valves, gaskets, coating, lubricants, adhesives, pumps and other appurtenances and materials in contact with raw, partially treated or treated potable water must be NSF 61 product certified as applicable.

## 1.6 PROJECT CONDITIONS

A. Site Location:
    1. Ashland, Oregon.

B. All components of the System shall be located indoors, except the following equipment that is located outdoors: Chillers

C. Site Elevation (feet)
    1. +/- 1,950

D. Outside ambient conditions:
    1. Maximum outdoor ambient temperature: 100 DEGF

2. 5-year minimum outdoor ambient temperature: 23 DEGF

E. Raw water conditions:
   1. Maximum water temperature: 68 DEGF
   2. Minimum water temperature: 37 DEGF

F. Indoor ambient conditions:
   1. Maximum indoor ambient temperature: 80 DEGF
   2. Minimum indoor ambient temperature: 45 DEGF

### 1.7 WARRANTY

A. See Section 01 78 36.

B. Provide all necessary parts replacement and maintenance service necessary due to failure of the system to meet specified performance.

C. OSS shall provide written warranty against defects in materials and workmanship. OSS shall warrant the goods to be free from defects in materials and workmanship for a period of three (3) year from Substantial Completion..

D. In the event of malfunctions to the system which result in a failure to meet the firm capacity requirements, OSS shall provide a temporary system if the failure can't be corrected in (2) weeks. A temporary system to satisfy ongoing demands shall be provided and installed at no cost to the Owner. The temporary system will remain until the permanent system is repaired and can achieve firm capacity again.

E. Field services shall be provided during the warranty period and include two plant visits per year of a minimum duration of one day each by an OSS factory representative who is familiar with the project to inspect the system, check performance and assess operations.

F. Guarantee:
   1. Manufacturer shall demonstrate that the System meets the Guaranteed Operating Conditions (as defined herein) through performance testing as described in this Section.
   2. If the performance test does not demonstrate that the System meets the Guaranteed Operating Conditions, OSS shall provide any and all modifications and replacements, up to the full replacement of ozone generators, chillers, destruct units, and sidestream equipment necessary to ensure the System meets the Guaranteed Operating Conditions, as demonstrated through additional performance testing.
   3. System shall meet the Guaranteed Operating Conditions through the full term of the warranty. If the System is found to not meet the Guaranteed Operating Conditions at any time during the term of the warranty, the OSS shall provide any and all modifications and replacements, up to the full replacement of ozone generators, PSUs, cooling water skids, and destruct units, necessary to ensure the System meets the Guaranteed Operating Conditions
   4. License fees or claims for any patented invention, article or arrangement that may be used upon or in any manner connected with the furnishing, installing and operation of the ozone generation and application system or any part thereof shall be included in the price.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. OSS shall be the Manufacturer of the ozone generators, destruct units, and MOCP, at a minimum.

B. Acceptable OSS:
   1. Primozone
      a. GM-Series Ozone Generators

2. Pinnacle
   a. Summit Ozone Generators
3. Or approved equal.

C. Ozone Sidestream Injection Equipment:
1. Mazzei Injector Company
2. Or approved equal.

D. Valves, instruments, and other components:
1. Refer to referenced individual Specification Sections.

E. Submit requests for substitution in accordance with Section 01 25 13.

## 2.2 DESIGN CRITERIA AND GUARANTEED OPERATING CONDITIONS

A. The following table provides design criteria for the System.

| Overall System Criteria | Value | Comments |
|---|---|---|
| Minimum Raw Water Flow Rate (mgd) | 1.7 | |
| Maximum Raw Water Flow Rate (mgd) | 7.0 | Maximum flow for design of proposed system |
| Minimum Raw Water Temperature (°F) | 37 | |
| Maximum Raw Water Temperature (°F) | 68 | |
| Minimum Transferred Dose (mg/L) | 1.25 | Transferred dose is the ozone transferred to the water, not including losses. |
| Maximum Transferred Dose (mg/L) | 2.5 | |

B. The following table provides the Guaranteed Operating Conditions of the System that shall be met under the full range ozone production and plant flow rates, as defined herein. The OSS is permitted to select the optimal ozone weight percentage for production from the range specified in Article 2.4 at which to achieve the Guaranteed Operating Conditions.
1. Guaranteed Operating Conditions assuming the downstream dissolved ozone residual is 0.1 mg/l or less, as measured at the mainline entrance into the contactor.

| Guaranteed Operating Conditions | Value | Comments |
|---|---|---|
| Maximum Ozone Production | 152 ppd | 1 ozone generator running |
| Minimum Ozone Production | 26 ppd | 1 ozone generator running |
| Maximum Power Consumption at Full Load | 11 kW/lb O3 | |
| Maximum Power Consumption at Minimum Load | 36 kW/lb O3 | |
| Minimum Gas Flow | 1 SCFM | |
| Ozone Transfer Efficiency | 95%wt | Transfer efficiency is defined below in Article 2.2.B.2. |

2. Definition of Transfer Efficiency (TE)
   a. TE = 100*(WG – WO)/WG
   b. Where:
      1) WG = weight of ozone generated over a 1 hour period (in units of pounds)
      2) WO = weight of ozone in the contactor off gas over the same 1 hour period. WO is calculated by multiplying the following together:
         a) The average concentration of ozone in the off gas measured at the inlet of the Ozone Destruct Units (in units of %wt).

b) The average flow rate of gas through the Destruct units (in units of standard cubic feet per hour, SCFH).
c) 1 hour.
d) 0.0828 lbs oxygen gas per standard cubic foot of oxygen gas.

## 2.3 GENERAL REQUIREMENTS

A. Skidded and Factory Assembled Equipment:
1. Factory install all wiring, including power, control, and signal, and conduit for all equipment preassembled on a common skid.
2. Provide local panel or termination box, as required, to provide a common location for wiring connections on each skid.
3. Construct skid frames of the following materials
   a. Type 304 Stainless Steel
   b. Type 316 Stainless Steel
   c. Provide list of all devices shipped loose (not part of preassembled skid. Provide wiring diagrams for all applicable devices on the list.

B. General Requirements for OSS Provided Valves
1. Meet the requirements of the associated individual Specification Sections listed herein and suitable for the application.

## 2.4 OZONE GENERATORS

A. Design and Performance Criteria

| System Design and performance Criteria | Value | Comments |
|---|---|---|
| Ozone Generating Concentration Range (% by weight) | 10 to 14 | OSS is permitted to define the optimal concentration within this range to meet the Guaranteed Operating Conditions. |
| Minimum Turndown Available with Power and/or Gas Flow Modulated (mass percent) per ozone generator | 10:1 | |
| Number of LOX (Nitrogen) Boost Systems (if required) | 1 | Compressors: one duty and one standby |
| Oxygen Gas Source | LOX | LOX system is provided by others. |
| Number of Ozone Destruct Units | 2 | One duty, one standby |
| Number of Ozone Master Control Panels | 1 | |
| Minimum Ozone Generator GOX Inlet Pressure (psig) | 20 | |
| Maximum Ozone Generator GOX Inlet Pressure (psig) | 50 | OSS to confirm/coordinate GOX pressure regulator settings and pressure relief valves. |
| Maximum Ozone Generator OZG Discharge Pressure (psig) | 50 | OSS to confirm/coordinate GOX pressure regulator settings and pressure relief valves. |
| Maximum Gas Pressure Drop through Ozone Generator (psi) | 5 | |

B. Other Design Criteria
1. Power Requirements:
2. 480 VAC, 3-phase, 60 Hz to the ozone generator.
3. Power supply shall be external transformers (only one (1) per ozone generator cabinet).
4. Each ozone generator cabinet shall include:
   a. Internal power distribution system

b. GOX inlet connection
c. OZG outlet connection
d. CWS inlet connection
e. CWR outlet connection

5. Each ozone generator shall be supplied with all necessary valves and instruments to manifold the GOX inlet and OZG outlet services. CWS and CWR share a common manifold for one duty, one standby operation of chillers to serve both generators.
6. In the event of a modular reactor or a power supply failure, all remaining reactors and power supplies within the ozone generator cabinet shall continue producing ozone. In the event of such failure, the reduction in maximum ozone output capacity shall not exceed 10%.
7. The ozone generator shall operate with a power factor of 0.99 or higher at full ozone generator power.
8. Each ozone generator shall consist of a single assembly mounted on a rigid base with all accessories rigidly and permanently attached.

C. Materials of Construction:
1. Refer to requirements in Section 40 05 23.
2. Construct all parts of the ozone generator in contact with ozone gas with ozone-resistant materials including:
a. Type 316L stainless steel (or approved higher corrosion resistant grade of stainless steel)
b. Borosilicate glass
c. PTFE
d. Ceramic
e. Equal ozone- and oxidizer-resistant materials as approved by the Engineer.
f. All materials exposed to ozone and oxygen gas shall be certified resistant to the respective gas source and ozone production gas for a period of at least 5 years under the project specific design operating conditions.
3. Construct all cooling water and gas flange connections of Type 316 stainless steel.
4. All hold down lugs, bolts, nuts, washers, flange hardware, screws and miscellaneous hardware not in contact with oxygen or ozone gas shall be Type 304 or 316 stainless steel.
5. Use FKM, or PTFE where no other material options are available. However, provide full replacement written warranty for use of such materials ensuring that the grades of FKM, PTFE or other such material utilized are actually ozone resistant, up to 14 wt% in gas or 6% in water, for at least a 5-year life period. (Some grades of FKM are not ozone resistant.)
6. PVC, UPVC, EPDM, and any grade of polyethylene or polyester material are not considered ozone-resistant.
7. All materials of construction will be submitted to the Engineer for review prior to manufacturing of the equipment.
8. All equipment, pipes, and valves used with oxygen or ozone shall be cleaned and sealed in accordance with CGA publication G-4.1.

D. Ozone Generator Enclosure
1. The ozone generator shall be comprised of an enclosure with an internal platform that will accommodate ozone generation modules.
2. The ozone generator, in its standard configuration, shall operate at a maximum sound level of 55 dBA at 3 feet. This shall be achieved without the addition of any form of sound mitigating device (muffler, sound attenuating enclosure, etc.).
3. The enclosure shall have access panels or doors to access the internal components without moving the ozone generator.

E. Controls and Communication
1. Refer to Article 2.10 for additional requirements.
2. Each ozone generator shall be equipped with an integral local control panel with PLC and network capability.
a. A Human Machine Interface (HMI) shall be provided for status monitoring and control.

b. The ozone generator local control panels shall be capable of sending and receiving signals and commands to/from the master ozone control panel (MOCP).
3. The ozone generator control panel shall incorporate an elapsed run-time counter.
4. Each individual power supply shall be a self-regulating, circuit monitoring system which measures frequency, current, voltage and power. The measurements shall be locally communicated through the ozone control panel screen (HMI).

F. Backflow Protection Device
1. The OSS shall provide a system protecting the backflow of process water from the sidestream/mass transfer system from entering the ozone generators.
2. One (1) dedicated backflow protection device shall be provided on the common ozone line between the ozone generators and the mass transfer skid.
3. The backflow protection device shall be rated for the full design capacity of the ozone generators.
4. The device shall include automatic control of both a water detecting sensor and a shut-off valve or check valve. The device shall be connected to the MOCP to provide a software interlock to the ozone generators.
5. Construct of materials listed in Article 2.4.C

G. Gas Service Valves
1. For GOX and OZG services, provide valves as specified in Specification Sections 40 05 63 and 40 05 64.

H. All pressure relief safety valves shall be provided and sized by the OSS.

I. Provide closed loop cooling water pressure relief valve on inlet side of ozone generator. Route to floor drain.

## 2.5 GOX PRESSURE REGULATING STATION

A. Provide one GOX Pressure Regulating Manifold
1. Provide as one or more pre-fabricated assemblies with the valves, instruments and appurtenances for a complete system as required by the OSS design and in conformance with the Drawings.
2. GOX assembly piping shall be 316L Sch 40S stainless steel.
3. Include two parallel filter trains as shown on the Drawings
a. Each filter shall be housed in a type 316 SS shell with ASNI flange connections and ASME code design shell appropriate for the application.
b. Each filter train set shall be provided with a dedicated inlet isolation ball valve and outlet isolation ball valve.
c. The redundant filters shall be supplied pre-piped and pre-assembled together with individual differential pressure transmitter.
d. Filter cartridges shall be replaceable and of borosilicate microglass media capable of retaining particles greater than 1.0 micron in size with 99.9 percent efficiency and particles greater than 0.4 micron in size with 98 percent efficiency.
e. The pressure through the air filter at maximum flow shall not exceed 0.5 psig when clean. Each filter shall be fitted with a differential pressure indicator to monitor pressure loss across the cartridge.
4. Materials shall be 316L stainless steel pipe fittings or tubing.
5. Include two parallel pressure regulators
a. Pressure regulating valves shall be furnished to reduce gaseous oxygen pressure to that required for the ozone generator.
b. The valves shall be sized by the OSS, self-regulating, ANSI Flanged connections, and pressure rated for intended use.
6. Also include:
a. Temperature transmitters
b. Fail closed motorized ball valve to shut off GOX supply to building

c. Pressure transmitters upstream of the filters and downstream of the pressure regulators, and a pressure gauge between the filters and regulators
d. Dewpoint monitor
e. Pressure safety valves between any two isolation valves.

## 2.6 LOX BOOSTER SYSTEM (IF REQUIRED)

A. General
1. If required for operation, the OSS shall provide a nitrogen boost system to supply compressed dry air to the ozone generator gaseous oxygen supply.
2. The nitrogen boost system shall consist of:
   a. One oil-less air compressor with pressure regulator and one air receiver.
   b. One plate-mounted, factory wired and piped, suitable for wall-mount system, consisting of the following components:
      1) One desiccant dryer with internal dew point control.
      2) One particulate pre-filter, 1μm.
      3) One coalescing filter to prevent presence of any particles in the outlet air, 0.01μm.
      4) One MFC (Mass Flow Controller), with regulating valve for keeping a constant 1% compressed dry air content in the varying oxygen flow stream.
      5) One pressure switch.
      6) All other necessary accessories, mounts, fittings, valves, wires, connections, etc. for the Nitrogen Boost System operation.
3. Power shall be supplied to the plate-mounted system via a 120V, 1-Phase, 60-Hertz AC feed and a 24V DC feed to local junction box.

B. Design Criteria:

| Parameter | Value |
|---|---|
| Output (scfm) | Per OSS |
| Design Dew point (°F) | -94 |
| Required Duty Cycle (hrs) | 24 |
| Max air inlet Temp. (°F) | Ambient conditions specified herein |
| Max Inlet Humidity (%) | 100 |
| Max Noise Rating (dBA) | 67 |
| Design Operation Pressure (psig) | 100 |

C. Oil-less Air Compressor(s):
1. Duplex compressor shall be rotary scroll or piston type, air-cooled, oil-less construction with no oil needed for operation.
2. The air compressors shall be securely mounted on a skid or on the air receiver, with rubber vibration isolating machine feet.
3. Drive shall be close-coupled type with heavy-duty electric motor suitable for 120VAC, 1-Phase, 60-Hz supply.
4. Description of operations: the compressors shall alternate operation based on pressure settings for high pressure and low pressure. During normal operation the nitrogen boost system will continuously supply compressed dry air to the ozone generation system, while the compressor will alternate the duty cycles to keep the pressure in the air receiver between the high and low pressure setpoints.
5. Manufacturer:
   a. Kaeser
   b. Gardner Denver
   c. Atlas Copco
   d. Engineer-approved equal.

D. Air Receiver:
   1. The compressor shall discharge to an ASME approved welded steel tank with integral legs.
   2. Receiver shall be equipped with the following components:
      a. Automatic condensate drain valve, with electronic timer
      b. Pressure relief valve
      c. Control Devices, to keep the pressure in the air receiver between the high and low pressure setpoints.
      d. Pressure gauge
   3. The steel receiver tank shall conform to ASME, Section VIII – Division 1, Pressure Vessels and shall be national board registered.

E. Heatless Desiccant Dryer:
   1. The OSS shall furnish one (1) air dryer unit (with two drying trains), complete and operable, for the purpose of drying compressed air.
   2. Type: desiccant compressed air dryer with internal dew point control.
   3. Power supply: 120V, single phase, 60 Hz from local junction box.
   4. Components (all components below shall be supplied by the manufacturer of the dryer system):
      a. Two identical drying columns, each containing a hygroscopic desiccant bed.
      b. Solenoid valves for controlling cycling of air flow to the dryer unit
      c. NEMA 13 or IP44 enclosure

F. Control: the Nitrogen Boost System shall be controlled from the MOCP.

## 2.7 CLOSED-LOOP COOLING WATER SYSTEM

A. Manufacturers
   1. Thermal Care
   2. TAEevo
   3. or engineer pre-approved equal.

B. General:
   1. The OSS shall provide a cooling water system to supply the ozone generators with the necessary cooling water for proper heat dissipation.
   2. Provide one chiller per ozone generator. Each chiller shall be capable of being a swing spare to the other ozone generator it is not dedicated to.
   3. The chiller shall be air-cooled, closed-loop type.
   4. The chillers shall be located outdoors and rated for operation through the full range of outdoor ambient temperatures.
      a. Chiller shall be designed for outdoor winter operation with an enclosure rating of NEMA 4X or IP55.
      b. Insulate water lines as needed with appropriate insulation type and jacket for the application.
      c. Heat trace water lines if exposed to freezing conditions, if needed.
   5. The chiller shall monitor supply and return temperature of the process cooling water.
   6. The water used for ozone generator cooling shall be a chemically treated closed-loop cooling water.
      a. Provide chemical pot feeder to monitor closed loop water quality and adjust chemistry.
      b. Cooling water supplied to the ozone generator shall be in compliance with OSS's cooling water specification.
      c. Water shall be treated to lower freezing temperature as needed.

C. Provide packaged process chiller systems with the following components.
   1. Direct drive scroll compressors.
   2. Stainless steel evaporator.
   3. Nonferrous reservoir and water lines.
   4. Air-cooled condenser.

5. Internal tank.
    a. Designed and sized for the closed loop cooling water flow rate requirements provided by OSS and to account for headloss due to piping between process chiller and tank, fittings, valves and control valves, as shown on the Drawings.
6. System Pump
    a. Stainless steel construction.
    b. Designed and sized for the closed loop cooling water flow rate requirements provided by Ozone System Supplier and to account for headloss due to piping between internal tank and ozone generators, fittings, valves and control valves, as shown on the Drawings.
        1) OSS is responsible to confirm headloss based on pipe and fittings shown on Drawings.
    c. The rated capacity of the pump shall be equal to 110 percent of the maximum cooling water flow required for each ozone generator

D. Electrical requirements:
1. 480 VAC, 3-phase, 60 Hz

E. Local Control Panels
1. Provide local control panel for each chiller.
2. All components on packaged process chiller skid to be powered through the local control panel.
3. The cooling water system control panel shall be capable of sending and receiving signals and commands from the MOCP.

F. Refrigerant:
1. R454B.

G. Miscellaneous valves and instruments:
1. Low flow bypass valve, isolation valves and pressure gauges.

H. Globe valves: Water 2-1/2 IN and smaller
1. Class 150 bronze globe valve.
2. Comply with MSS SP-80.
3. Manufacturers:
    a. Nibco T235Y.
    b. Stockham B22.
4. Materials:
    a. Body, bonnet, disc holder and nut: Bronze.
    b. Stem: Copper silicon alloy.
    c. Packing: Teflon impregnated fiber.
    d. Disc: Teflon.
5. Design Requirements:
    a. 150 PSI steam at 400 DEGF, 300 PSI non-shock WOG.
    b. Union bonnet, rising stem, renewable disc.

I. The initial water fill for the system is the responsibility of the Contractor.

## 2.8 DESTRUCT UNITS - PRIMARY

A. General:
1. Provide ozone destruct system skids to destroy ozone in gas from the following sources:
    a. Gas purged from the ozone generators during startup or shutdown.
    b. Gas captured by the contactor vents (offgas) and conveyed to the destruct units.
2. The destruct units will be located indoors. Destruct units shall be designed for operation at the specified ambient air temperatures.

B. Design and Performance Criteria

| System Design and performance Criteria | Value |
|---|---|
| Inlet gas temperature range (deg F) | 40 to 90 |
| Inlet gas relative humidity (%) | 100 |
| Inlet gas flow rate range for each destruct unit (SCFM) | 0 to 50 |
| Minimum vacuum pressure at ozone contactors (in H2O) | -3 |
| Maximum vacuum pressure at blower intake (in H2O) | -5 |
| Design inlet ozone concentration (%wt) | To be determined by the OSS. |
| Maximum outlet ozone concentration (ppmv) | 0.1 |

C. Provide ozone destruct systems with the following components.
   1. In-line preheater.
   2. Destruct catalyst inside a stainless steel vessel.
   3. Blower
      a. Provide one (1) exhaust blower per destruct treatment train rated for the design conditions (flow and pressure) stated above for each ozone destruct skid unit.
      b. All components of blower in contact with Ozone shall be 316L stainless steel and shall be manufactured by New York Blower, Cincinnati Fan, or equal.
   4. All associated instrumentation required for a complete and operable system.
   5. Provide ozone destruct units capable of discharging off-gas at concentrations less than 0.1 ppm of ozone by volume at the discharge stack with a design life expectancy for the catalyst of at least three (3) years based on an average ozone gas concentration of 1.5% by weight.

D. Materials
   1. Type 316 stainless steel piping (Schedule 40S).
   2. All fastening hardware, nuts, bolts, washers, clamps, etc. shall be Type 316 stainless steel.
   3. All instrument and conduit supports shall be of Type 304 or 316 stainless steel.

E. Power
   1. 480 VAC/3ph/60Hz power
      a. If an external transformer is required, it shall be provided by OSS at no additional cost.

F. Controls
   1. Provide skid-mounted local control panel for each destruct system.
   2. The operation of the blower shall be controlled by a Hand-Off-Remote switch and shall be controlled by use of a makeup valve on the suction of the blower as recommended by OSS.
   3. The ozone destruct system control panel shall be capable of sending and receiving signals and commands from the MOCP.
   4. Preheater:
      a. Preheater shall not "fail" upon loss of power. Upon return of power, preheater shall automatically restart.
      b. The preheater shall be controlled by temperature element/transmitter located at the system inlet and the outlet of the preheater.
      c. The power controller shall be provided with protective over-current and over-temperature devices as recommended by the OSS.
      d. Preheater shall not experience over-temperature for flows equal to or greater than 10% of the rated capacity flow rate.
      e. Provide Low temperature heater alarm setpoint (DegF) setpoint (adjustable between 50 and 80 DegF).
   5. Provide differential pressure indicator across catalyst bed.

G. Demisters

1. Shall be provided as a loose item.
2. Provide demister pads on off-gas lines connected to ozone contactor to retain water droplets from gas in the gas line flowing to the destruct units
3. Mount in 3" flanged pipe spool.
   a. Maximum lay length: 24 inches long.
4. Maximum Pressure Loss through pad: 0.5 inch water column at design maximum flow.
5. Max face velocity: 5.0 feet per second.
6. Moisture removed by demister shall drain back into contactor through 316L stainless steel piping.
7. Manufacturers: Koch, York, or equal.

## 2.9 DESTRUCT UNIT – GENERATOR PURGE

A. Provide if ozone generator requires a standalone destruct unit for purge.

B. Design Criteria:
   1. Device shall be wall mounted.
   2. Design inlet ozone concentration and mass flow shall match or exceed the maximum ozone generation capacity of the generators.
   3. Maximum ozone concentration in outlet gas: 0.1ppmv.
   4. Controls:
      a. Device shall be controlled completely by MOCP and shall be used in fully automatic mode without any operator actions.
      b. If the purge of two ozone generators at the same time is required, the destruct unit shall be sized to match this ozone destruction capacity.
   5. Device shall not exceed the size show in the Drawings without Engineer approval

## 2.10 MASS TRANSFER SYSTEM TAG NO. SKID-2001

A. General:
   1. The Ozone Gas Dispersion System (GDS) shall be furnished from a single manufacturer as an integral component of the Ozone System and shall meet the overall system requirements and performance requirements specified.
   2. Local control panel to be provided.

B. Conditions of Service:
   1. The GDS shall be capable of treating plant flows of 1.7 to 7 MGD at an applied ozone dose of 1.5 – 2.5 mg/L. The sidestream(s) shall operate at a maximum Gas to Liquid ratio of 1:1.
   2. High efficiency eductor(s) shall be provided to mix 0.07 to 6.4 lb/hr ozone-in-oxygen gas at 10 wt% concentration at a minimum gas inlet pressure of 25 psig into a sidestream of motive water. The sidestream flow rate shall not exceed 180 gpm.
   3. The GDS shall be capable of providing a guaranteed minimum of 95% ozone mass transfer efficiency.
   4. Pipeline static mixer shall have a maximum pressure drop of 0.5 psi. See process drawings for installation requirements for the reactor. The unit shall be installed within a piping trench as shown. Systems utilizing de-gas separation upstream of the main contactor shall not be allowed.

C. Eductors
   1. Eductors shall be designed to use a sidestream of high pressure motive water to create a vacuum to draw the ozone gas into water.
   2. Design Conditions:

| | | |
|---|---|---|
| a. | Sidestream Liquid: | Raw Water free of solids and particulate |
| b. | Sidestream Liquid Pressure: | 50 psig |
| c. | Sidestream Liquid Temperature: | 37 to 68°F |
| d. | Sidestream Liquid Flow: | Less than 300 gpm (at each Eductor) |
| e. | Ozone Gas Pressure: | 25 psig (minimum) |
| f. | Ozone Gas Temperature: | 50 to 80°F |

g. Ozone Gas Flow: 64 lb/hr Total Gas Flow (at each Eductor)

3. Materials of Construction:
   a. Eductors shall be fabricated of Type 316L stainless steel.
   b. Welds shall be fully passivated per industry standards.
4. Connections: All connections shall be ANSI 150# Flanges
   a. Water Inlet: 3 inch
   b. Ozone Gas Inlet: ½" or ¾" inch based on best practices for gas velocity.
   c. Ozonated Water Outlet: 2.5 or 3 inch
5. Manufacturers:
   a. Transvac Systems Ltd. For Statiflo Corp.
   b. Mazzei Injector Company.

D. Pre-Dispersion Static Mixers
1. Pre-dispersion static mixers shall be required based on CFD modelling.
2. The pre-dispersion static mixer(s) shall be motionless mixer type with four (4) fixed mixing elements. Each mixing element shall provide at least two independent flow channels to ensure maximum efficiency. Pre-dispersers shall utilize high velocity flow to shear down the gas bubbles.
3. Design Conditions: Pre-dispersion mixer(s) shall be designed for conditions associated with outlet ozonated water stream from the Eductor(s). Pre-dispersers shall be installed as close to the contactor as possible, and at least ten (10) pipe diameters downstream of the eductor outlet flange.
4. Materials of Construction: Pre-dispersion mixer(s) shall be fabricated of Type 316L stainless steel. The mixing elements shall be solid, all-welded construction, permanently affixed in a schedule 10S housing. Internal fasteners, retaining bars, or pins shall not be permitted. Welds shall be fully passivated per industry standards.
5. Connections: Inlet and outlet connections shall be 2 1/2 inch ANSI 150# Flanges.
6. Manufacturers:
   a. Series 100 by Statiflo Corp.
   b. Mazzei Injector Company.
   c. Or Engineer approved equal.

E. Pipeline Static Mixer
1. The pipeline static mixer shall provide mixing and contact for ozone transfer into the mainstream water. The mixer shall be sized for 100% of the plant flow.
2. Computational Fluid Dynamics (CFD) 2-phase modeling shall be used to determine internal design of the PFR and shall demonstrate a mixture quality of Uniformity Index.
3. The mixer shall achieve theoretical mixture quality CoV of 0.05 at the outlet of the mixer. Mixers utilizing baffles and back-mixing shall not be acceptable.
4. The pipeline contactor mixer shall be 66 inches and shall not exceed 80 inches. Refer to drawings for installation requirements. The mixer will be installed within a piping trench with a fixed width and depth.
5. Design Conditions:
   a. Mainstream Flow Liquid: Raw Water free of solids
   b. Mainstream Liquid Pressure: 22 to 27 psig
   c. Mainstream Liquid Temperature: 37 to 68°F
   d. Mainstream Liquid Flow: 1.7 to 7 MGD
   e. Maximum ozone residual: <0.1 mg/L
6. Materials of Construction: Static mixer(s) shall be fabricated of Type 316L stainless steel. The mixing elements shall be solid, all-welded construction, permanently affixed in a schedule 10S housing. Internal fasteners, retaining bars, or pins shall not be permitted.
7. Connections:
   a. Plant Flow Water Inlet & Outlet: 20-inch 316 SS angle-face rings and epoxy-coated flanges
   b. Ozonated Sidestream Inlet: 2 1/2 or 3 inch 150# ANSI Flanges

8. Manufacturers:
    a. Series 600/ 650 by Statiflo Corp.
    b. Mazzei Injector Company.

F. Materials:
1. Mass Transfer Skid:
    a. Piping/fittings: Type 316L stainless steel.
    b. Gaskets: TFE or PTFE.
    c. Skid base and frame: galvanized steel
    d. Anchor bolts: Type 316L stainless steel
    e. Valves: Type 316L stainless steel
2. All equipment, valves, valve seats, analyzers, seals, gaskets, welds and all associated appurtenances to be used with oxygen, must be resistant to degradation and gas losses due to the use of this gas.
    a. Greases and lubricants shall be oxidation resistant, Dupont "Krytox," or equal.

G. Components
1. Mass Transfer Skids:
    a. Provide one (1) Mass Transfer Skid, factory assembled, tested, and wired.
    b. Skid shall monitor and regulate ozone gas injection into the sidestream for injection into the raw water at the indicated dosage range.
2. Valves:
    a. Mass transfer skid to use motorized butterfly valves to control sidestream flowrate through the eductors to 180 gpm.
    b. Motorized ball valves shall be used for isolation of ozone and water.
3. Remote I/O panel
    a. The mass transfer skid will be located with the Pretreament Room. System to come with a PLC remote I/O panel for PLC wiring connections and monitoring.

## 2.11 INSTRUMENTATION AND CONTROL

A. Controls shall be provided to remotely monitor and adjust ozone production rate and ozone concentration. Power consumption and oxygen feed gas flow shall be automatically regulated to achieve the set ozone production rate and ozone concentration.

B. General requirements for OSS supplied control panels:
1. Fabrication and components of control panels shall conform to the requirements of Section 40 67 00.
2. NEMA 4X enclosure
3. Interface with Plant SCADA.
    a. Control panels containing Allen Bradley PLCs shall support EtherNet/IP for communications to the Plant SCADA system. Non-Allen Bradley PLCs shall support Modbus TCP communications.
4. Provide 20% spare I/O points for each I/O type used.
5. Network equipment such as Ethernet switches shall conform to the requirements of section 40 66 05.
6. Factory assembled, wired, and tested.
7. UL 508A Listed.
    a. Affix entire assembly with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to delivery.
8. Panel-mounted Operator Interface Terminal (OIT).
9. Provide a Uninterruptible Power Supply (UPS) for the control system components
10. Provide all 24 VDC power supplies in control panel as required.

C. Master Ozone Control Panel (MOCP):
1. In addition to the general control panel requirements above, provide a master control panel to coordinate all individual sub-components of the system.

2. Provide a master control panel with PLC and software to control all components of the ozone generation system.
    a. MOCP shall meet all requirements of the general control panel section above.
    b. MOCP shall be a stand-alone control panel not integral to any other piece of equipment (e.g., ozone generator).
3. MOCP shall be designed, engineered, programmed, and commissioned by the OSS. MOCP shall not be subcontracted to a 3rd party.

D. Remote I/O control panel:
1. For equipment located in other buildings of the facility than the Master Ozone Control Panel (MOCP), provide a remote I/O panel to aggregate I/O for transmitting over network connection between the structures to the MOCP.

E. Instruments
1. Provide instruments for process control, monitoring, and safety as described in this Specification Section. The instruments Specified herein constitute the minimum requirements. OSS shall provide any additional instruments required for a fully functional System meeting the requirements specified.
2. See individual division 40 instrumentation specifications for instrument requirements.
3. Ozone Gas Analyzers
    a. Manufacturer: BMT Messtechnik GMBH, or approved equal.
    b. Refer to Section 40 76 00 - Process Gas Analytical Measurement for additional requirements.
    c. Provide high concentration analyzers for process control at the locations indicated in the Drawings.
    d. Provide ambient (low-concentration) meters at the locations indicated in the Drawings.
4. Oxygen Gas Analyzers
    a. Refer to Section 40 76 00 - Process Gas Analytical Measurement for additional requirements.
    b. Provide ambient oxygen analyzers at the locations indicated in the Drawings.
5. Dissolved Ozone Analyzers
    a. Provide one (1) dissolved ozone analyzer monitoring downstream of the contact pipeline (location indicated in the Drawings).
        1) The dissolved ozone analyzer shall be panel mounted and pre-assembled with an isolation ball valve, y-strainer, pressure reducing valve, solenoid valve, flow control needle valve, tube fittings, and pipe fittings. All materials shall be 316 stainless steel.
        2) The dissolved ozone analyzer shall meet the following requirements:
        3) Detection Range: 0 – 20 ppm
        4) Power: 120 VAC / 1pH / 60Hz
        5) Enclosure Rating: NEMA 4X
        6) Output: 4 – 20mA
    b. The dissolved ozone analyzer shall communicate directly with the Ozone System Master Control Panel.
    c. Refer to Section 40 75 00 - Process Liquid Analytical Measurement for additional requirements.
    d. Manufacturer: ATI Model Q45H/64, or approved equal.
    e. Provide dissolved ozone analyzers at the locations indicated in the Drawings.
    f. Provide flow-through tee or flow cell for sensor mounting.
6. Dewpoint Analyzer
    a. Manufacturer: GE Series 35 Panametrics Analyzer, or approved equal.
    b. Refer to Section 40 76 00 - Process Gas Analytical Measurement for additional requirements.

F. Control Loop Description:
1. PLC-based Process Monitoring and Control:

a. MOCP Manual:
   1) If Local and Manual modes of control are selected, control is from the Operator Interface Terminal (OIT) mounted on the MOCP.
   2) The operator can control components of the Ozone Generation System (valves, pumps, etc.) on an individual basis from the OIT.
   3) This mode of operation is used for troubleshooting purposes; normal control shall be automated. No safety interlocks shall be bypassed in manual control mode.

b. MOCP Automatic:
   1) If Local and Automatic modes of control are selected, the operator can only start/stop the Ozone Generation System and enter setpoints from the OIT mounted on the MOCP.
      a) Operator enters the desired Applied Ozone dosage rate on the OIT mounted on MOCP.
         (1) Applied Dose is the dose the system delivers to the water stream after accounting (internally) for mass transfer efficiency, etc.
         (2) The operator shall be able to adjust the Applied Ozone Dose setpoint within the range of 1.5 to 6.0 mg/L, by 0.1 mg/L increments.
   2) Then the MOCP's PLC starts and stops the Ozone Generation System in a pre-defined sequence, continuously controls and monitors the availability of all dependent subsystems to ensure that the Ozone Generation System can continue operation, and monitors and displays all alarms for both advisory purposes and shutdown.
      a) The system starts up in standby mode and waits for a run signal from the plant scada system. See Section 40 61 13 for additional details.
      b) The ozone generators shall shut down automatically and report an error message communicating such an event, if any of the following alarm conditions are met:
         (1) Internal temperature sensors indicate a temperature above the operating limit.
         (2) High ozone gas level detected at any of the ozone gas detectors.
         (3) Major equipment component failure, such as no/low cooling water flow, pump failure or other condition that could damage the gas feed, ozone equipment
         (4) Plant emergency shutdown event and/or treatment non-compliance.
      c) Ozone Generation Control Algorithms - Either of the two gas generation flow control methods described below shall be acceptable:
         (1) Feed Forward-Flow Pace Control - The control scheme shall be supplied with the system for selection by the operator through the MOCP operator interface. Scheme shall be a PID control loop utilizing a feed/forward type control which uses the raw water flow rate with an operator input desired applied ozone dosage (mg/L). These values shall allow for PID computation of the setpoint variable (SV) in terms of pounds per day (ppd) of ozone required. The process variable (PV) shall be computed by means of utilizing inputs from the oxygen gas flow signal input from the ozone generator oxygen gas flow meter along with the signal input from the high concentration gas monitor. The PV shall then be compared to the SV for automated computation and manipulation of the PID output control variable (CV). Provide a programmed maximum allowable operator setpoint applied ozone dosage equal to the design maximum value specified herein for this control loop.
         (2) Oxygen Gas Flow/Ozone Gas Concentration Control - In the gas flow control mode option the gas flow will directly correlate to the desired ozone gas concentration. The control loop shall be a single loop PID control that will have an Operator input of desired ozone gas concentration. The PLC shall use this Operator input to compute a

setpoint variable of the oxygen gas flow required to the ozone generator (scfm) to achieve the desired ozone concentration. This computed setpoint variable will be compared to the actual process oxygen gas flow as determined by the thermal mass oxygen flow meters. The control loop will then send a 4-20 mA output signal to a modulating valve to adjust until the proper oxygen gas flow is achieved. A dead-band of no greater than ±5% shall be applied to this control loop.

(3) Calculation of Transfer Efficiency and Transferred Dose
(a) Provide algorithm to calculate transfer efficiency (%) as shown in Article 2.2.B.
(b) Provide algorithm to calculate transferred ozone dose by multiplying transfer efficiency by applied ozone dose.
(c) Display both transfer efficiency and transferred dose on the HMI.

d) Provide manufacturer's standard controls for the following sub-systems:
(1) Ozone Contactor dissolved ozone sample system controls
(2) LOX gas pressure regulation controls
(3) Chiller controls
(4) Mass transfer controls
(5) Destruct unit controls
(6) LOX booster system (if needed)
(7) Ambient ozone gas detection

3) SCADA Automatic:
a) If Remote and Automatic modes of control are selected, the operator can start/stop the entire Ozone Generator System from SCADA. In the mode, the MOCP PLC shall accept the following from the Plant SCADA HMI:
(1) Master start/stop command for Ozone Generation
(2) System.
(3) All operator-entered setpoints.
(4) Then the MOCP PLC controls the entire Ozone Generation System as described for MOCP Automatic mode.

4) SCADA Manual:
a) Manual mode is not permitted via SCADA system.
(1) MOCP Automatic or SCADA Automatic modes of control shall be the preferred operation.
(2) All signals and data required by the Ozone System MOCP from systems outside of the MOCP control shall be provided. This shall include, at a minimum:
(a) Operational permissive from MASTER SCADA SYSTEM
(b) LOX switching manifold status (CP-2100).
(c) Vaporizer isolating ball valves statuses (BV-2111 and BV-2121).
(d) Raw water flowrate from raw water flow meter.

c. Hardwired Controls and Interlocks.
1) Alarms and interlocks shall be provided to ensure proper operation of the ozone generation equipment and its sequenced shutdown based on potentially unsafe or improper conditions that may exist.
2) The following section lists the minimum amount of alarm conditions and interlocks that will be monitored by the Local Control Panels and the Ozone System Master Control Panel.
a) Major equipment component failure such as no/low cooling water flow, pump failure or other condition that could damage the gas feed, ozone equipment or result in treatment non-compliance shall initiate ozone generator unit shutdown.
b) GOX Pressure Regulator Station
(1) High pressure alarm
c) Local Ozone Control System

(1) High cooling water temperature alarm
(2) Low cooling water flow alarm
(3) High inlet gas pressure alarm
(4) Low inlet gas flow alarm
(5) Backflow protection device triggered alarm
(6) Power supply status alarm
(7) Power supply communication error alarm
(8) External Modbus communication error alarm

d) Ozone System Master Control Panel
(1) General warning alarm
(2) Emergency stop status
(3) High dew point in inlet oxygen gas line to generator
(4) High and Low Dissolved Ozone Residual for each Ozone Treatment Train
(5) Low ambient oxygen system shut-down alarm
(6) High ambient oxygen system shut-down alarm
(7) High ambient ozone system shut-down alarm
(8) Ambient ozone monitor alarm
(9) LOX storage system alarms

e) LOX Booster System (if required)
(1) Air compressor general fault

f) Cooling Water System
(1) Cooling systems major fault
(2) High water temperature
(3) Low water pressure
(4) No / low cooling water flow
(5) Pump fail to start

g) Ozone Destruct System
(1) Inlet temperature monitor signal fault alarm
(2) Outlet temperature monitor signal fault alarm
(3) Fan VFD fault alarm
(4) Fan run status
(5) Fan VFD communication error alarm
(6) Heater run status
(7) Heater high-temperature limit alarm
(8) Main circuit breaker tripped alarm
(9) Flow or pressure monitor signal fault alarm

h) Ozone Contactor Residual Monitoring System
(1) Loss of Sample Alarm
(2) Loss of Sample Flow Alarm

i) Mass Transfer System
(1) Low Pretreatment water pressure
(2) Low Pretreatment water flow
(3) Low Ozone Gas Pressure

j) Miscellaneous
(1) Valve fail to open
(2) Valve fail to close

## 2.12 TOOLS AND SPARE PARTS

A. Provide one set of all manufacturer recommended spare parts needed for 2 years of routine equipment maintenance.

## 2.13 SOURCE QUALITY CONTROL

A. All equipment shall be factory tested by the OSS for compliance with the operational requirements specified herein, and a certification of the results of these tests shall be submitted

to the Engineer. Checkout and Startup Testing shall be conducted in accordance with Section 01 75 00, and as otherwise required in the Specifications.

1. Provide a Factory Test Plan that includes the systematic testing of all equipment, instruments, and controls to reduce troubleshooting delays in the field.
2. Provide option for Owner/Engineer to witness a system controls factory test to confirm functionality and conformance with the specifications/requirements.
3. Factory test reports on each ozone generator, including a test data sheet and ozone production computations, shall be submitted to the Engineer for approval at least 60 days prior to any startup activities.

B. Pneumatic and Hydrostatic Tests: In addition to testing required for ASME code compliance, each ozone generator skid shall be subjected to pneumatic and hydrostatic shop tests prior to shipment. Pneumatic tests shall be used for components designed for gas exposure and hydrostatic tests shall be used for components designed for exposure to water. Shop test pressure shall be 1.3 times the design pressure and held, without loss, for at least 2 hours or as required by the specified standard or code. Any leaks discovered during the test shall be repaired at the shop and the unit retested. Units shall be repaired and retested until there is no leakage. The gas used to perform the pneumatic tests on equipment shall be an inert gas such as nitrogen. The water used to perform the hydrostatic tests on equipment shall be of potable water quality, with a chlorine content of no more than 10 ppm. As soon as the hydrostatic tests have been completed on each item or component, the test water shall be drained immediately and the interior surfaces cleaned and/or drained.

C. Tests should include checks as electrical/signal continuity, verification of safety devices, software diagnostic and programming checks, and as much operational testing as possible. All deficiencies discovered during the factory tests shall be corrected and retested prior to shipment.

D. Mass Transfer Skids and Pipeline Flash Reactor
   1. Conduct factory hydrostatic leak test.
      a. Pressurize to 120% of maximum operating pressure.
      b. Hold for 2 hours
      c. Demonstrate no leaks by pressure decay - no pressure loss.
      d. Submit results per Article 1.3

# PART 3 - EXECUTION

## 3.1 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 01 65 50.

## 3.2 INSTALLATION

A. The OSS shall provide written instructions and installation manuals to the Contractor that detail the installation procedures for all supplied equipment.

B. Contractor shall install System in accordance with the OSS requirements.

C. Mount equipment on flat and level concrete bases where shown on the Drawings. Coat bolt thread projections with lubricant to facilitate future nut removal.

D. All strain from attached piping shall be eliminated and any evidence of misalignment, vibration, noisy operation, or other signs of improper setting shall be corrected by the Contractor. Care during storage, installation, and lubrication shall be in strict accordance with the manufacturer's recommendations.

## 3.3 CLEANING FOR OXYGEN SERVICE

A. All System components which come in contact with either pure oxygen gas or ozone gas, including but not limited to piping, valves, flanges, tubing, and gas instruments shall be cleaned according to Section 46 31 59.

B. Prior to testing, the ozone generators shall be verified as ready to operate by the OSS. Contractor shall assist OSS by providing any on-site cleaning or purging to ready the ozone generators for operation.

## 3.4 PRE-DEMONSTRATION PERIOD: SYSTEM CHECKOUT, START-UP, AND TESTING

A. Refer to 01 75 00 for additional requirements.

B. OSS representative shall be on-site during start-up and training.

C. Demonstrate functionality of the system with oxygen.

## 3.5 FUNCTIONAL DEMONSTRATION PERIOD

A. Refer to the requirements on Section 01 75 00

B. Functional Demonstration Testing may only commence once the operating training is complete and the System is online treating water.

C. Contractor to furnish all common materials, instruments, and incidental and expendable equipment required for the Demonstration Test, except otherwise specified.

D. OSS to furnish all tools specific to the startup and testing of OSS supplied equipment.

E. Functional Demonstration Test
   1. Operate the system as a part of the complete treatment process for the time required.
   2. OSS must be available during testing.
   3. Contractor or plant personnel must provide the OSS with daily reports for conformance.
   4. Collect data at no less than hourly intervals to demonstrate adherence to the Guaranteed Operating Conditions throughout the full test duration.
   5. If the Functional Demonstration Test is interrupted and cannot be completed, or if the data show that the Guaranteed Operating Conditions have not been met throughout the full test duration, repeat the Functional Demonstration Test as many times as necessary to pass.
   6. Start-up the ozone generation system initially with the ozone going to purge and destruct. Once proper operation has been established in the presence of the Engineer in this condition, the System can be operated to transfer ozone to sidestream.
   7. Conduct the following Functional Demonstration Tests to confirm the Guaranteed Operating Conditions
      a. Test at settings of 10, 50, and 100 percent of rated system production.
         1) At 100% utilize one ozone generator. Both generators shall be tested at 100%.
         2) Provide 30-day notice to schedule the test.
         3) Contractor to include cost for ozone quenching and additional quenching chemical feed temporary facilities to complete the test (if necessary).
         4) Each test shall be conducted for 2 hours, minimum. Operate for the initial 30 minutes to obtain steady-state conditions. Begin data collection once steady state is achieved. Collect data at 30-min intervals until the 2-hour test is complete.
         5) The following data shall be collected:
            a) Ozone generator power with certified, calibrated meter provided by the Contractor. The meter used shall be a certified portable kW meter provided by the OSS.
            b) Oxygen gas flow to the ozone generator.
            c) Ozone concentration using the ozone generator's high concentration ozone monitor.
            d) Ozone generator inlet and outlet water coolant temperature.

e) Cooling water flow rate.
f) Inlet and outlet gas temperature.
g) Ozone generator gas pressure.
h) Ozone destruct influent ozone concentration
i) Ozone destruct effluent ozone concentration
j) Dissolved oxygen (in Water) at all sampling locations

b. Provide test reports to the Engineer within 72 hours of the completion of the tests.
   1) Include kW/lb calculation
   2) Included transfer efficiency calculation
c. If the Guaranteed Operating Conditions are not met:
   1) Make any necessary system modifications.
   2) Retest the system.

8. Repeat System modifications and Functional Demonstration Tests as many times as necessary to demonstrate the system meets the Guaranteed Operating Conditions.

## 3.6 OPERATOR TRAINING

A. Refer to Specification Section 01 79 23 for additional requirements.

B. Operator training cannot begin until the System has been successfully started up and the Functional Demonstration Test has been passed.

C. The Contractor shall be responsible for coordination and scheduling of training.

D. OSS representatives shall conduct and lead the training. The Contractor shall assist the OSS with training and operation of the System.

E. Training session requirements
   1. Three (3) six hour sessions (one each for operations, maintenance, and controls staff).
   2. Split each session into classroom and field training.
   3. Record (video with audio) the training for the Owner's reference. Two copies shall be provided in DVD and Cloud Format.

F. Upon completion of the operator training, the Engineer shall submit a "Notice of Completed Training" to the Ozone System Supplier and the Contractor.

## 3.7 ACCEPTANCE TESTING

A. Upon receipt of the written "Notice of Completed Training", the Ozone System Supplier and the Contractor can perform an Acceptance Test for the facility.

B. The Acceptance Test is described in Section 01 75 00.
   1. The Ozone Supplier will provide on-site support and technical assistance for the entire duration of the Acceptance Test.

C. Acceptance by the Owner shall be contingent upon meeting the Performance Guarantee requirements and acceptance testing procedures as specified herein.

D. Contractor is responsible for the acceptance testing.

E. If Contractor activities do not allow acceptance testing to be completed within the Ozone System Supplier contracted days, the Contractor will be responsible for additional costs incurred by the Ozone System Supplier.

F. The Contractor shall provide personnel on-site during the Acceptance Test to fix any problems encountered with the equipment installation.

G. The purpose of the Acceptance Test is to demonstrate the following:
   1. The system was properly installed.
   2. The system is ready to be placed into service by the Owner.
   3. The system meets the requirements of the Ozone system Performance Guarantee.

4. The system is in compliance with the service conditions, performance requirements, material specifications, and other requirements specified by the Contract Documents.

H. The Contractor will furnish all materials, instruments, and incidental and expendable equipment required for the Acceptance Tests, except otherwise specified.

I. The Owner or authorized representative will be present to witness the Demonstration and Performance Period Testing.

J. If the Acceptance Test is interrupted at the request of the Ozone System Supplier or the Contractor, or due to the performance of the equipment, the test will be restarted as required in Section 01 75 00.

K. Successful completion of the Acceptance Testing and receipt of the revised operations and maintenance manuals for the Ozone system and the ancillary equipment provided by both the Ozone System Supplier and the Contractor shall be required for final acceptance of the equipment.

## 3.8 OPERATIONAL ASSISTANCE

A. The Ozone System Supplier will provide Operations Assistance to the Owner during the Acceptance Testing Period.

B. Operational Assistance shall be provided by the Ozone System Supplier to the Contractor to allow the Contractor to coordinate the Commissioning and Acceptance Testing of facilities not provided by the Ozone System Supplier for the Acceptance Test.

C. If Contractor activities do not allow completion of the activities completed within the Ozone System Supplier allocated time, the Contractor will be responsible for additional costs incurred by the Ozone System Supplier.

## 3.9 PERFORMANCE GUARANTEE

A. Determination of the Ozone System performance in relation to the Process Guarantee shall be evaluated per the requirements in this Specification Section.

**END OF SECTION**

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# SECTION 46 31 59
## CLEANING REQUIREMENTS FOR OXYGEN SERVICE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The Contractor and Ozone System Supplier shall ensure that all equipment and piping used with gaseous oxygen, ozone gas, and ozone off-gas is cleaned by the methods outlined in this section.
   1. This requirement shall include all equipment and piping installed and furnished by the Contractor.

B. This section specifies cleaning materials, methods, and inspections which shall be used by the Contractor during field cleaning, and which the Contractor and Ozone System Supplier shall require to be used by manufacturers of equipment and piping systems (including in-line components and instrumentation) to prepare the oxygen and ozone systems for safe operation.
   1. This Section also includes the requirements for post-cleaning protection, identification, and other functions related to cleaning.

C. Equipment and piping surfaces cleaned per this Specification shall be free of contaminants which can be seen with the naked eye under bright white light or black light, when inspected by methods given in Article Inspection and Tests of this section. The only exceptions shall be stains or lint.
   1. To meet this requirement, conventional greases, oils and thread lubricants, shop dirt, water, filings, scale, loose weld spatter, chips, fluxes, paints, varnishes, marking materials, rust (except for light film), excelsior, packing materials, labels and any other foreign materials must be removed. Many of these materials, especially hydrocarbon greases and oils, can react violently in the presence of ozone or oxygen, causing fires or explosions, while others can cause dangerous malfunctions of equipment.
   2. After an item is cleaned, it must be protected from recontamination until it is used. (See Article Piping System, Vessel, and Equipment Protection of this section).

D. The Contractor shall be fully and solely responsible for all damages resulting from inadequate cleaning of equipment and piping for ozone or oxygen service, and for any hazards which occurs as part of the cleaning process.

### 1.2 QUALITY ASSURANCE

A. Referenced Codes and Standards
   1. Structural Steel Painting Council, Pictorial Standard CSa2.
   2. Oxygen cleaning shall be in accordance with the latest edition of Compressed Gas Association Publication.
      a. No. G-4, Cleaning Equipment for Oxygen Service.

### 1.3 SUBMITTALS

A. The Ozone System Supplier shall furnish submittals in accordance with Section 01 33 03. The submittal shall contain information on the Ozone System Supplier's qualifications and experience, proposed cleaning chemical, and the proposed methodology for completely removing the chemical from the piping and equipment being cleaned, prior to testing and startup of that equipment.

B. The Contractor shall furnish submittals in accordance with Section 01 33 03. The submittal shall contain information on the Contractor's qualifications and experience, proposed cleaning chemical, and the proposed methodology for completely removing the chemical from the piping and equipment being cleaned, prior to testing and startup of that equipment.

## PART 2 - PRODUCTS

### 2.1 PRECLEANED EQUIPMENT SHIPPED TO THE FIELD BY THE OZONE SYSTEM SUPPLIER

A. The Contractor shall require that the following equipment be delivered to the site already pre-cleaned for oxygen and ozone service by the Contractor's equipment Sellers, by the Ozone System Supplier, and by the Ozone System Supplier's Sellers and manufacturers:
   1. Oxygen feed gas system components, including but not limited to, pressure regulator assembly and associated piping, low temperature shutdown assembly, valves, meters, and instrumentation.
   2. All ozone generation system components which come in contact with oxygen gas or ozone gas, including piping, valves, meters, instrumentation, flanges, etc. The ozone generator shells including all skid piping and accessories shall be shipped to the project site by the Ozone System Supplier already "Cleaned for Oxygen Service" from the factory.
   3. In-line components such as automatic and manually operated valves, check valves, pressure relief valves, and pressure reducing valves.
   4. Instrumentation such as pressure gauges and switches, temperature gauges and switches, analyzers including sample piping and tubing, pressure, temperature, and flow transmitters, instrumentation sensing line valves and appurtenances which come in contact with oxygen or ozone gas.
   5. Piping valves and equipment on the Mass Transfer Injection skids.
   6. Any other items specified in the Contract Documents as being used for oxygen or ozone gas service.

B. The Contractor shall require that each piece of pre-cleaned equipment be labeled "Cleaned for Oxygen Service" and be sealed in clear polyethylene wrapping by the Ozone System Supplier.

### 2.2 MATERIALS

A. The following equipment and piping systems shall require oxygen cleaning by the Contractor in the field:
   1. All liquid oxygen and gaseous oxygen piping around the LOX tank system.
   2. All gaseous oxygen piping and appurtenances from the LOX tank area to the ozone generators and inside the Ozone Equipment Building.
   3. All ozone gas piping from the ozone generators to the ozone sidestream injection system.
   4. All instrumentation piping and tubing from the ozone or oxygen gas process lines to the instruments and monitors, including all models of ozone gas monitors.
   5. All ozone contactor off-gas piping from the ozone contactors to the inlet flange connections on the new ozone destruct units.
   6. Any other equipment or piping specified in the Contract Documents as being used for oxygen or ozone gas service.

B. Any in-line components or assemblies for the above systems which were furnished uncleaned by a manufacturer shall either be returned to the manufacturer for cleaning or shall be cleaned by the Contractor in the field. If cleaned by the Contractor in the field, cleaning shall be performed in accordance with the manufacturer's printed instructions, and only under the direct supervision of a representative of the manufacturer. If any component recalibration is required, it shall be performed only by the manufacturer's representative.

C. Any equipment and in-line components which were furnished "Cleaned for Oxygen Service" to the Contractor by the Ozone System Supplier or another manufacturer and were later exposed to the environment or somehow contaminated, shall be re-cleaned in the field by the Contractor, at no added cost to the Owner.

## PART 3 - EXECUTION

### 3.1 CLEANING PROCEDURES

A. All equipment, valves, piping, instruments, and accessories in ozone or oxygen gas service shall be cleaned in compliance with the Compressed Gas Association (CGA) Pamphlet 4.1.

B. Systems shall be cleaned before and/or after installation as required for a completely cleaned system prior to putting oxygen or ozone gas in the system.

C. All cleaning for oxygen service must be performed by a qualified and experienced organization and individual.

### 3.2 INSPECTION AND TESTS

A. Items cleaned for oxygen or ozone service shall be inspected by the Contractor using black light where possible (as described in subparagraph Ultra-Violet or "Black Light" Inspection, below) and whichever other methods specified below apply to a particular situation. If any of the tests used reveal contaminants, the item must be re-cleaned. The Owner's field representative shall be notified and present at all inspections and tests.

1. Direct Visual Inspection: There shall be no observable residual oil, grease, paint, coating, varnish, or other films; no extensive adherent rust or mill scale, and no loose rust, scale, abrasive, dirt or other particulate matter. Sandblasted surfaces should correspond to Structural Steel Painting Council Pictorial Standard CSa2. A light film of rust is acceptable.
2. Ultra-Violet or "Black Light" Inspection: The surface shall be examined in darkness or subdued light using a 3,200 to 3,800 AU wavelength black light. Most common hydrocarbon oils or greases fluoresce, so that they become visible under black light even though they are invisible in normal light. However, not all organic oils fluoresce, so the Contractor shall back up this inspection by reviewing the manufacturing procedures involved, to make sure that no animal oils such as fish oil rust preventatives, or vegetable oils such as castor oil-based cutting emulsion, were used in its manufacture. If fluorescence shows up as a blotch, smear, smudge, or film, the item shall be re-cleaned.
3. Wipe Test: The item shall be wiped for at least 1 square foot of its surface with clean white paper or unbleached cloth, which shall be examined under normal and black light. If excessive discoloration or any fluorescence appears, the surface shall be re-cleaned.
4. Solvent Color Test: This method should be used to check the cleanliness of inaccessible metallic surfaces. A pint jar filled with used solvent wash shall be compared with a similar jar filled with new solvent. There should be few particles and little, if any, difference in light transmission between the two when they are both held up to the light and viewed simultaneously through the side.

### 3.3 SAFETY

A. Personnel: The Contractor shall ensure that all field-cleaning personnel are thoroughly trained in the proper oxygen cleaning techniques, and shall require them to wear apparel which is free of oil and grease and to work with clean gloves, appropriate eye protection, and appropriate breathing filters/masks and respiratory aid equipment.

B. Flammable Solvents: Flammable solvents such as gasoline, kerosene, naphtha, mineral spirits or acetone shall not be used for cleaning purposes.

C. Other Fluids: Fire extinguisher fluids shall not be used for cleaning purposes.

D. Liability: The Contractor shall have full responsibility and liability for ensuring safety with respect to oxygen cleaning in the field.

## 3.4 PIPING SYSTEM, VESSEL, AND EQUIPMENT PROTECTION

A. The Contractor shall ensure that piping systems, vessels, and equipment are protected from contamination from the time they are cleaned until they begin service, using the applicable methods given below.
   1. Short-Term Protection: For piping systems or equipment which are to be placed in service in 1 week or less, openings may be covered with metal or plastic caps or plugs, or a double layer of 6-mil polyethylene film, sealed to the pipe or nozzle with waterproof tape.
   2. Medium-Term Protection (1 week to 1 month until placed in service):
      a. Welding Ends: Ends shall be closed with clean Wedge Projects, or equivalent, galvanized steel caps sealed with two turns of Tuck No. 90, or equivalent, 2-inch waterproof tape.
      b. Flanged Ends: Flanged ends shall be closed with 10-gauge, or heavier, oxygen cleaned steel flange covers over solid Neoprene or Durabla gaskets, held in place with at least four hex -head bolts.
   3. Long-Term Protection: For piping systems or equipment which are not to be placed in service for 1 month or longer, the piping system or equipment shall be pressurized with dry nitrogen. Positive pressure up to 2 psig must be maintained. Pressurized lines should be identified at all significant flanges and valves.
   4. Protection of Small Parts: Small parts such as valves, expansion joints, pressure gauges, etc., should be kept in heavy gauge polyethylene bags or wrapped and sealed in polyethylene sheeting until installation.
   5. Equipment Protection: Manholes, inspection ports, nozzles and other openings shall be covered. Blind flanges, plastic protectors, hardboard covers, or polyethylene sheets securely taped in place shall be used.
      a. Larger pieces of equipment, after being cleaned or re-cleaned, should be completely covered with polyethylene sheeting.
   6. Identification: Any piping, equipment, or vessels cleaned in the field per this Section shall be identified.

**END OF SECTION**

# GAC FILTER MEDIA

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. Scope
   1. This Work includes furnishing and installing granular activated carbon (GAC) for use as a drinking water filtration media. The GAC shall be capable of removing organic carbon, color, tastes, odors and other organic contaminants from settled water effluent. Only the specific GAC types as specified herein will be acceptable.
   2. The GAC media vendor is herein referred to as "SUPPLIER". Unloading, storage and installation of GAC media in the filter basins shall be performed by the SUPPLIER under the guidance and responsibility of the General Contractor and herein referred to as "CONTRACTOR". The design engineer of record for the project is herein referred to as "ENGINEER". The City of Ashland is herein referred to as the "OWNER".
   3. SUPPLIER shall be the Manufacturer, provide, transport, deliver, unload, and install GAC filter media to a location within plant that shall be coordinated with OWNER and the CONTRACTOR.
   4. SUPPLIER shall be responsible for unloading and installing the GAC filter media. Use of the term CONTRACTOR and scope of CONTRACTOR's work are included herein for reference only and are not intended to be included in the SUPPLIER's scope of responsibility.
   5. Unit Responsibility: The Work requires that the GAC media be the end product of one responsible system SUPPLIER. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment. The SUPPLIER shall furnish and/ or coordinate all components and accessories as necessary to place GAC media in operation in conformance with the specified performance, features, and functions indicated without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.

B. GAC media shall consist of 48-inches of media depth after backwashing of fines. There are four total filters and each filter has a footprint of 13 feet by 25 feet. Requirements for backwashing of fines are discussed in Section 3.4 of this specification.

C. The GAC media shall be installed on top of silica sand as described in Section 46 61 13.

D. SUPPLIER shall clearly detail method of product delivery, storage, handling, and removal in the proposal package.

E. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but not necessarily limited to, work that is directly related to this Section.
   1. Division 01 – General Requirements.
   2. Section 46 61 00 - Filtration Equipment.
   3. Section 46 61 13 - Filter Media.
   4. Contract Drawings.

F. In evaluating selection of SUPPLIER, the OWNER may consider the qualifications and experience of the SUPPLIER in performing the Work. The OWNER may also consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work.

### 1.2 QUALITY ASSURANCE

A. SUPPLIER Qualifications:
   1. GAC provided under this Section shall be the product of a firm regularly engaged in supplying this type of material.

2. SUPPLIER shall have a minimum of 10 years of experience in producing GAC similar to that specified herein for use in municipal drinking water facilities and shall be able to provide documentation showing evidence of at least 5 separate installations in satisfactory operation for at least one year.

B. GAC Testing- General:
   1. All testing of filter media shall be performed by an OWNER-approved independent testing laboratory employed by the SUPPLIER.
   2. All sampling and testing shall be performed in accordance with the requirements of AWWA B100 and AWWA B604 except as modified and supplemented herein. Approved samples shall meet the requirements of AWWA B100, including all addenda, and AWWA B604, including all addenda.
   3. Conduct all specified testing and furnish all material, instrumentation, and personnel for conducting tests as specified herein. All costs of such testing shall be borne by the SUPPLIER. The costs of all work and materials to correct deficiencies revealed during testing, and the costs of retesting, shall be borne by the SUPPLIER. Give the ENGINEER sufficient advanced notice of the testing to enable the ENGINEER to witness the tests.
   4. SUPPLIER shall not place filter media in the basin before the ENGINEER has reviewed the media's test results and completed a visual inspection of the media. Any media placed in the filter without the ENGINEER's acceptance shall be subject to rejection and replacement by the SUPPLIER at no cost to the OWNER. The replacement media shall be provided by the SUPPLIER at no cost to the OWNER.
   5. Particle Size Distribution Analysis:
      a. The particle size distribution shall be determined by screening through standard sieves, Tyler square root of 2 series or equivalent U.S. series. The percent sizes shall be determined from a plot, on semi-log or probability paper, of the percentages of the material passing each sieve against the rated opening of the sieve or the equivalent diameter of the grains. Sieve dimensions shall conform to ASTM E11 and Table B.1 of the Appendix to AWWA B100.
      b. The percent size shall be defined as the size of the theoretical opening of a sieve through which that percentage of the media, by weight, will pass. For example, if the size distribution of the GAC particles is such that 10 percent of the sample is finer than 1.00 millimeter, the GAC shall be said to have a 10 percent size of 1.00 millimeter.
      c. The uniformity coefficient is the ratio of the 60 percent size to the 10 percent size of the filter media.

C. GAC Testing Prior to Shipment:
   1. Media SUPPLIER's Testing: Furnish for the ENGINEER's review and acceptance, certified laboratory test results from media that is typical of the GAC that is specified herein. These tests shall show the analysis of all specified chemical characteristics, physical characteristics, gradation, and size, including shape and particle size distribution.
   2. SUPPLIER shall sample and test GAC media from actual lots of material to be supplied to the OWNER before shipment.
      a. Certified laboratory performing analyses shall be selected by the OWNER.
      b. Test results from laboratory shall be submitted and approved before media shipment from the point of manufacture. After approval, all shipments shall meet the specifications.
      c. The certified test results shall cover all specified chemical characteristics, physical characteristics, gradation, and size, including shape and particle size distribution. All tests shall be made in accordance with Test Procedures as described in both AWWA B100 and AWWA B604.

D. GAC Testing Prior to Installation:
   1. At the OWNER'S discretion, random samples of dry GAC may be taken from each GAC media sack prior to installation for record purposes. Samples shall be collected by a qualified representative of a testing laboratory provided by the OWNER. Samples shall be

placed in two tight glass or clear plastic jars, each holding not less than two quarts, properly labeled. One of the two sample jars shall be furnished to the ENGINEER and the other shall be analyzed by the OWNER furnished testing laboratory.

E. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C127, Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
   2. ASTM C136, Test Method for Sieve Analysis of Fine and Coarse Aggregate.
   3. ASTM D3174 Test Method for Ash in the Analysis Sample of Coal and Coke from Coal.
   4. ASTM D4607, Test Method for Determination of Iodine Number of Activated Carbon.
   5. ASTM E11 Specification for Wire Cloth and Sieves for Testing Purposes.
   6. AWWA B100 Filtering Material, including any addenda.
   7. AWWA B604 Granular Activated Carbon, including any addenda.
   8. AWWA B605 Reactivation of Granular Activated Carbon, including any addenda
   9. Food Chemical Codex: Third Edition
   10. NSF International Standard 61 - Drinking Water System Components - Health Effects.

## 1.3 SUBMITTALS

A. See Specification 01 33 00.
   1. The Contractor is responsible to provide submittal information for both Sections 46 31 90 and 46 61 13 to the Engineer for review simultaneously.

B. See Specification Section 01 61 03 for further details. In addition to the requirements of this section, furnish the following:
   1. Submit qualifications of the independent testing laboratory for approval.
   2. Media SUPPLIER's testing submittal: Submit for the ENGINEER's review and acceptance, certified laboratory test results from media that is typical of the GAC that is specified herein.
   3. Submit test results and sample of GAC from actual lots of material to be supplied to the OWNER for approval by ENGINEER.
      a. Test results and sample shall be submitted to the ENGINEER not less than 14 days prior to shipment of the media from the point of manufacture.
      b. Submit additional samples and test results as required by the ENGINEER.
      c. Quantity of GAC Sample: 1/2 cubic foot sealed in a properly labeled container.
      d. Supplier shall certify that the GAC is in full compliance with this specification.
   4. Source location of coal.
   5. Carbon manufacturing location.
   6. Description of the reagglomeration/thermal process.
   7. Affidavit of Compliance stating that the GAC to be supplied is:
      a. 100% virgin, with no reactivated carbon content whatsoever, and
      b. 100% bituminous coal-based, reagglomerated material made in the United States of America.
   8. Certificates:
      a. NSF-61 certification of all filter media to be supplied.
      b. ISO 9001:2000 or later of facility where media will be manufactured.
   9. Submit documentation demonstrating five years of successful experience supplying specified GAC media for municipal potable water treatment plants used for organic contaminant removal. Provide list of five (5) installations and references.
   10. Submit media installation instructions from the media SUPPLIER including backwashing requirements and procedures.
   11. Submit detailed carbon exchange procedures.
   12. Submit a description of the Supplier's potable reactivation capabilities including disposal practices, cost of disposal and reactivation on a unit volume basis, and the estimated cost for a full media change out assuming todays dollars for both disposal and reactivation.
   13. Submit Safety Data Sheets (SDSs) for all GAC supplied.

### 1.4 PRODUCT DELIVERY, STORAGE, HANDLING, AND REMOVAL

A. SUPPLIER shall coordinate with the CONTRACTOR to deliver and install GAC to the Site to ensure uninterrupted progress of the work. GAC shall not be stored, transported, or delivered in such a manner that would annul NSF 61 certification of the GAC. Containers or trailers used to transport NSF/ANSI Standard 61-certified GAC to the drinking water treatment plants shall be dedicated to this service.

B. Deliveries shall be made on weekdays from 8:00 a.m. to 3:00 p.m. Weekend deliveries are allowable with approval of OWNER, ENGINEER, and CONTRACTOR. Approval of delivery times must be obtained at least 14 days before delivery.

C. Packaging:
   1. If GAC is delivered in super sacks, the GAC shall be packaged in 1/2-ton or 1-ton ultraviolet-resistant polyethylene bags (super sacks with bottom pour spout) on pallets. Each bag of material shall be clearly marked with the following information: Effective size, uniformity coefficient, source, date of bagging, and the lot or stockpile identification.

D. SUPPLIER shall place or store all filter media only in designated staging areas within the site and approved by the ENGINEER. Polyethylene bags shall be placed on pallets supplied by the media SUPPLIER.

E. All filter media at the jobsite shall be stored off the ground, protected from weather, and covered with a suitable membrane by the SUPPLIER to prevent contamination of the media from windblown debris and soil. All filter media is subject to gradation and retesting at the ENGINEER's direction if visual evidence of contamination is observed or suspected.

F. Removal of spent material shall conform with the AWWA B605 standard.

### 1.5 JOB CONDITIONS

A. Protection:
   1. Dust Control: CONTRACTOR shall provide adequate protection for surrounding areas at all times during the installation of GAC.
   2. Personnel Protection: SUPPLIER shall follow safe working practices and provide employees with the appropriate safety equipment during GAC delivery.
   3. SUPPLIER shall comply with CONTRACTOR's Site Specific Safety Plan at all times on site.

## PART 2 - PRODUCTS

### 2.1 GRANULAR ACTIVATED CARBON (GAC)

A. Quality:
   1. The GAC shall conform to AWWA B604 in addition to the modifications listed herein. GAC shall also conform to Food Chemical Codex when tested under the conditions outlined in the Food Chemical Codex, Third Edition.
   2. GAC for Initial Fill Contract shall be virgin or unused GAC.
   3. Carbon shall be thoroughly screened and free of clay, loam, dust, dirt, organic matter, and other foreign material, prior to delivery to site.
   4. Carbon shall be NSF/ANSI 61 certified for potable water applications. The GAC shall contain no substances in quantities capable of producing deleterious or injurious effects upon the health of those consuming the water treated using the GAC or cause the water so treated to fail to meet the requirements of county, state or federal drinking water regulations.
   5. Carbon shall be manufactured in an ISO 9001:2000 (or better) certified facility.
   6. Possess a unique product identifier.

## 2.2 ACCEPTABLE PRODUCTS

A. The filter media shall be manufactured and supplied by one of the SUPPLIERS listed below. Only previously tested products for this project shall be submitted.
   1. Calgon Carbon Corporation:
      a. Filtrasorb 820.
   2. Cabot Norit Activated Carbon:
      a. GAC 820.
   3. No substitution allowed.

## 2.3 MATERIAL

A. General:
   1. Material to conform to AWWA B604 as modified herin.
   2. Screen all material through standard sieves conforming to ASTM D2862.

B. Virgin GAC Media:
   1. Material Properties:
      a. 100% reagglomerated bituminous coal-based product, sized to a granular form prior to thermal activation.
      b. The following materials are not acceptable as substitutions or blend materials:
         1) Broken pellets, regardless of base material
         2) Direct activated GAC, regardless of base material
         3) Lignite-based GAC
         4) Peat-based GAC
         5) Wood-based GAC
         6) Coconut-based GAC
         7) Sub-bituminous-based GAC
         8) Anthracite-based GAC
      c. Shall be NSF-61 certified.
      d. Be capable of removing color, tastes, odors, and other organic contaminants from water.
      e. Shall be minded and manufactured in the United States.
      f. Product as packaged shall meet the following specifications:

| Product Specification: | Value | Test Method |
|---|---|---|
| Iodine Number (mg/g), min. | 900 | TM-4, ASTM D4607 |
| Moisture, weight %, max. | 2 | TM-1, ASTM D2867 |
| Effective size, mm | 1.0-1.2 | TM-47, ASTM D2862 |
| Uniformity Coefficient, max. | 1.5 | TM-47, ASTM D2862 |
| Abrasion No., min. | 75 | TM-9, AWWA B604 |
| Trace Capacity Number, (mg/cc), min. | 10 | TM-79, TM-85 (converted to TCN) |
| Screen Size (US Sieve), weight % | | |
| * Larger than No. 8, max. | 5 | TM-8, ASTM D2862 |
| * Smaller than No. 20, max. | 4 | TM-8, ASTM D2862 |
| Apparent Density, g/cc, typical | 0.56 | TM-7, ASTM D2854 |

C. Compatibility:
   1. Filter media shall be provided as a compatible system. The media provided by the manufacturer will meet the individual requirements identified in this specification as well as the following media system requirements.
      a. Dual media – For dual media filters, the manufacturer shall confirm prior to shipment that the following criteria is met as it relates to Section 46 31 90.
         1) GAC d90 size/Sand ES ratio of 2.8 to 3.2.
         2) L/d ratio > 1,000.

D. Silica Sand Media:

1. See Section 46 61 13.

### 2.4 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Supply at least 5 PCT of each type of filter media by volume to account for variations in filter box dimensions.
   2. Anticipate 5 PCT media loss for each type of filter media due to washing and scraping.
   3. All excess media to become property of Owner.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. SUPPLIER shall provide the services of a qualified technical representative throughout the entirety of filter bed preparation, GAC inspection, and backwashing for removal of GAC fines, installation to ensure proper compliance with the procedures described herein up to the point of placing the GAC filter basin in service. The duration of GAC placement in basins is approximately 5 days. SUPPLIER shall furnish a cost for adding or deducting startup and test services from this duration.

A. SUPPLIER shall inspect the placed filter sand prior to GAC placement to confirm the GAC media can be placed.

B. SUPPLIER shall inspect OWNER'S GAC receiving site and will ensure that their equipment is compatible with those sites. Modifications needed to safely transfer GAC to the filter basins shall be made by the CONTRACTOR.

C. Unless otherwise directed by the OWNER, one filter shall be filled at a time. OWNER will identify the sequence that the filters are to be filled.

### 3.2 INSPECTION

A. GAC shall be inspected on-site by the OWNER or OWNER's representative for organic matter and other contamination. All GAC that has been found to be contaminated will be rejected and replacement media shall be provided by the SUPPLIER at no additional cost to the OWNER if contamination occurred up to delivery of media. Contamination of media after media is delivered to the site will be the responsibility of the CONTRACTOR.

### 3.3 PREPARATION

A. CONTRACTOR shall place the filter media per 46 61 13, thoroughly clean each filter before any GAC is placed and shall keep each filter clean throughout placement operations. CONTRACTOR shall thoroughly clean and sweep the filter walls and underdrains and shall verify that all openings of the underdrain porous plates are open and free of obstructions. CONTRACTOR shall keep GAC unloading area external to each filter clean throughout the installation operations.

B. Disinfection:
   1. Before placing GAC, disinfect the filters per 46 61 13 – Filter Media.

C. Startup and performance testing of all filters and all GAC fill equipment must be completed by CONTRACTOR and approved by the OWNER and ENGINEER prior to Final Acceptance.

### 3.4 INSTALLATION

A. No GAC shall be shipped or installed until certified copies of the laboratory test reports have been approved by the ENGINEER and hydraulic structures have been successfully cleaned, tested, and disinfected by CONTRACTOR and all equipment started, performance tested and approved by the OWNER.

B. Do not place GAC media until filter sand in that cell has been skimmed and the final grain size distribution has been accepted by Engineer.

C. Do not disinfect filter after GAC installation.

D. Placing of GAC shall conform to AWWA B604-96 and the recommendations of the GAC SUPPLIER.

E. Conveying of the new filter media shall be hydraulically by slurry through an eductor system provided by CONTRACTOR. Water used for eduction shall be chlorine-free.

F. Transport, handle, store and place media carefully to prevent contamination of any sort. Any GAC media which becomes contaminated or dirty (i.e., contains more than 0.5 PCT of foreign material by weight), either before or after it has been placed, shall be removed and replaced with clean media at no cost to the Owner.

G. Prior to GAC placement, fill filter partially with water in a manner so as not to disturb the top layer of sand.

H. Filter media shall be placed in a minimum of three (3) lifts of roughly equal depths and made level over the entire filter bed area.

I. GAC shall be deposited by SUPPLIER in a uniform thickness corresponding to that shown on the Drawings and brought to a true level plane.

J. The filter may be flooded with water from the backwash system to use as a leveling gauge for each layer of material.

K. The elevation of the top surface of the GAC shall be as indicated by the GAC bed depth markers installed in the filters after the fines are removed. SUPPLIER is responsible for all costs associated with excessive fines that result in additional media being placed to achieve the minimum filter bed depth.

L. GAC Backwash Water:
   1. Backwash Water required for installation of the GAC shall be supplied by CONTRACTOR using the equipment installed under this contract.
   2. CONTRACTOR shall coordinate with OWNER prior to backwashing filters.

M. GAC depletes oxygen from air and can be hazardous in a confined situation. Contractor shall be responsible for worker's safety and follow all local, State, and Federal guidelines pertaining to confined space entry procedures. Obtain necessary permits for work in confined areas.

N. Do not permit workers to walk or stand directly on media. Use boards that will sustain workers' weight without displacing media or support sand if specified.

O. All equipment used in placing the GAC in the filter shall be cleaned and disinfected in accordance with AWWA C653. All workers shall wear boots and gloves which has been disinfected in accordance with AWWA C653.

P. Do not damage any equipment or piping in the filters units.

Q. After placing, the GAC shall be soaked overnight prior to backwashing.

R. GAC Washing:
   1. Plant staff shall operate all filter backwash controls when washing the new filter media installed in the filter basin.
   2. The CONTRACTOR is responsible for coordinating the scheduling of filter media washing through the ENGINEER with plant operations. Plant operations shall govern scheduling the use of the backwash system. The CONTRACTOR is responsible for this coordination to avoid delays to schedule.
   3. Media manufacturer shall submit a recommendation for backwashing that includes flow rate, duration of backwash, and number of backwashes per lift. Suggested backwash procedure for the media manufacturer's consideration is as follows:

a. After wetting the media, the bed shall be backwashed with water at a reduced rate (less than or equal to 5 GPM/SF) to remove carbon fines and level the media.
b. Air backwash, at a reduced rate, shall be used to facilitate fines removal.
c. As the fines are removed and the media is clearly visible, the backwash rate shall be increased to provide 30 PCT expansion of the total bed depth. The rate shall be adjusted based upon water temperature and GAC characteristics.
d. This rate shall be maintained for a minimum of 30 minutes at a rate of at least 10 GMP/SF, and then reduce backwash rate to 5 GMP/SF and hold for at least 30 seconds and then slowly close the backwash valve.
e. Add GAC media for subsequent lifts and repeat the backwash procedure outlined above.
f. Add GAC media to the full GAC volume to achieve the full depth of media and specified and including considerations for loss of fines and permanent expansion of the GAC.
g. Repeat the backwash procedure outlined above.

4. Coordinate initial backwash of GAC filter with ENGINEER to confirm that GAC fines have been sufficiently washed out of the filter.

S. Final depth of GAC media after washing shall be the specified depth plus or minus 1 IN.
1. If final media depth is below this minimum, Contractor shall install additional GAC and complete backwashing as required to reach the specified depth at their own expense.
2. If final media depth is above this maximum, Contractor may be required to remove additional GAC if directed by Engineer.

T. Filter Structure Cleaning:
1. SUPPLIER shall be responsible for the cleanup of any spills during delivery that are caused by the SUPPLIER'S equipment, off-loading technique, or packaging failure and shall provide technical support for spills of materials supplied by the SUPPLIER, including a 24-hour emergency phone number. CONTRACTOR shall be responsible for the cleanup of any spills during installation of media in the filter basins that are caused by the CONTRACTOR's equipment, or off-loading technique and shall provide technical support for spills of materials supplied by the CONTRACTOR, including a 24-hour emergency phone number.

U. Backwash Waste Basin Cleaning:
1. CONTRACTOR shall be responsible for disposal of any GAC fines that accumulate in the Filter Channel, Backwash Waste Basin, or other areas of the plant during backwashing.

V. SUPPLIER shall install the media no later than 60 days from the date that the particular media was received on-site.

## 3.5 WARRANTY

A. SUPPLIER shall provide a written warranty for the quality and performance of GAC media for a minimum of two years from the time of delivery or one year from the time of start-up of the GAC filters after commissioning.

**END OF SECTION**

# SECTION 46 33 33
## LIQUID POLYMER FEED EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Equipment for feeding, diluting, mixing, and distribution of liquid polymer.

B. Equipment Numbers:
   1. Provide polymer feed equipment for two (2) liquid polymer units:
      a. Settling Aid Polymer Blending and Feed System-1: PBU-7211.
      b. Filter Aid Polymer Blending and Feed System-1: PBU-7311.

   2. The liquid polymer preparation and feed modules shall include, but is not limited to, the following components:
      a. Neat Polymer pump.
      b. Activation chamber.
      c. Dispersion injector/mixer.
      d. Dilution water solenoid valve.
      e. Dilution water rotameter.
      f. Dilution water flow control valve.
      g. Static mixer.
      h. Pressure gages.
      i. Calibration columns.
      j. Control Panel.

C. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 40 05 31 - Pipe - Plastic.
   5. Section 40 61 96 – Process Control Descriptions.
   6. Section 46 33 46 – Pumping Equipment: Peristaltic Pumps

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

### 1.3 SYSTEM DESCRIPTION

A. Provide two polymer feeders, one for each type of polymer, as an integrated system to automatically meter, dilute, activate and feed liquid polymer and water to the treatment process.
   1. This process must activate 100 PCT of the available polymer with a single pass-through mixing chamber and minimize damage to the polymers' long molecular chain.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements specified.
      b. Manufacturer's installation instructions.

c. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.

3. For each system, submit schematic showing valves, piping chemical handling and feeding equipment, utilities and related work.
   a. Acknowledge assigned equipment, valve, piping, and instrumentation tag numbers when so designated.
   b. Information on schematic shall include but not necessarily be limited to itemization of components and equipment specified.
   c. Acknowledge and justify need for deviations from system included in Drawings and Specification Sections.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

## PART 2 - PRODUCTS

### 2.1 GENERAL

A. The entire liquid polymer preparation module shall be provided as a packaged system which shall include all equipment, instruments, controls and appurtenances listed in this Section or as deemed necessary by the manufacturer in order to meet the performance requirements and operate the system consistent with the Control Strategy.

B. Liquid Polymer Preparation Module:
   1. Liquid polymer preparation and feed system shall be provided to dilute, meter, and pump the liquid polymer to the water treatment process as shown on the drawings. Two liquid polymer preparation modules (PBU-7211 and PBU-7311) shall be provided. The units shall consist of polymer pump, activation chamber, dispersion chamber/mixer, solenoid valves, dilution water isolation and flow control valves, 0-160 psi pressure gages, and rotameter selected for the appropriate flow range, plus union fittings and isolation ball valves required for connection of water, polymer and solution piping. Valves, unions and piping shall be as shown on the drawings. Dilution water shall be potable water.

### 2.2 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Polymer blending unit:
      a. UGSI PolyBlend
      b. Fluid Dynamics – DynaBlend.
      c. Velodyne.
      d. Acrison Model 580-1.
   2. Neat Polymer Feed Pumps
      a. See Section 46 33 46 – Pumping Equipment: Peristaltic Pumps

B. Submit request for substitution in accordance with Section 01 25 13.

### 2.3 MATERIALS

A. Polymer Feeder (both units):
   1. Wetted materials: PVC, Buna-N, acrylic, stainless steel, Teflon, Kynar, TFE, cast iron unless otherwise specified.
   2. Base or support frame: Reinforced fiberglass, epoxy-coated steel, ABS structural foam, unless otherwise specified
   3. Support bracket: 304 stainless steel.

## 2.4 EQUIPMENT

A. Performance Requirements:
   1. Polymer feeder: PBM-7211:
      a. Neat polymer output: 0.05 – 1.05 GAL/HR.
      b. Stock solution output: 19-420 GAL/HR.
      c. Secondary dilution: 120-720 GAL/HR.
      d. Mixer body: Stainless Steel.
      e. Mixer impeller: 304 Stainless steel.
      f. Mechanical seal: Viton.
      g. Cover: clear polycarbonate or clear outlet pipe for hydrodynamic mixing chambers.
      h. Polymer activation: 100 PCT.
      i. Water supply pressure: 45 PSI.
   2. Polymer feeder: PBM-7311:
      a. Neat polymer output: 0.01 – 0.064 GAL/HR.
      b. Stock solution output: 0.4-25.6 GAL/HR.
      c. Secondary dilution: 30-180 GAL/HR.
      d. Mixer body: Stainless Steel.
      e. Mixer impeller: 304 Stainless steel.
      f. Mechanical seal: Viton.
      g. Cover: clear polycarbonate or clear outlet pipe for hydrodynamic mixing chambers
      h. Polymer activation: 100 PCT.
      i. Water supply pressure: 45 PSI.

## 2.5 ACCESSORIES

1. Provide the following for each blending unit:
   a. One (1) floor-mounted frame fabricated from minimum 12 GA 304 stainless steel and 1-1/2" x 1-1/2" x 1/8" wall minimum structural stainless steel framing as shown on Drawings. All components shall be mounted to the frame with final connection consisting of water inlet, polymer solution discharge, power inlet, and control signal inlet.
      1) Furnish with 304 stainless steel fastening hardware.
   b. One (1) graduated cylinder sized for one a minute draw-down minimum at maximum pump output type calibration kit with clamps, tubing, brackets and hardware necessary for mounting to the feeder. Supporting the calibration column by the neat polymer inlet piping shall not be allowed.
   c. One (1) control panel with all required electrical equipment pre-wired for auto control as described below.

## 2.6 FABRICATION

A. Description:
   1. Each blending system shall include but not necessarily be limited to:
      a. A peristaltic type polymer transfer pump with variable flow resulting in no less than 20:1 turn-down range.
         1) The pump shall be designed to deliver required capacity of liquid polymer to mixer at apparent viscosities up to 3,500 cps without drop in pump capacity.
         2) See Specification Section 46 33 46.
      b. A mixing chamber which uses a rotating impeller to uniformly mix and activate the polymer solution without excessive shear or a clear outlet pipe for hydrodynamic mixing chambers.
         1) Recycle of polymer solution through mixing chamber is not acceptable
         2) 6" Mixing chamber; S.S. body and head, 150 max. psi.
         3) ½" Pressure relief valve; 316 S.S.
         4) ¾" Polymer check valve.
      c. Dilution Water Piping Assembly including:
         1) Solenoid valve for on/off control of dilution water supply.

2) Both primary and secondary dilution piping shall have Sch 80 PVC needle-type control valve and rotameter type flow indicator.
3) Provide 1 IN FNPT dilution water connection and 1 IN FNPT polymer solution discharge connection.
4) 0-160 psi pressure gage, 304 S.S. case, glycerin filled.
5) Primary dilution water flow transmitter.

d. Polymer Piping Assembly
1) Calibration column assembly.
2) Provide 3/4 IN FNPT polymer inlet connection.

2. Controls: Provide each system with LOCAL-AUTO switch, interlocks and controls for either local or auto operation as specified in Specification Section 40 61 96 and as follows:
a. Local operation:
1) Manual speed adjustment.
2) Manual start/stop with interlocks for operating water supply solenoid valves.
b. Remote Control Interface:
1) Discrete Input: For start-stop of polymer system including water supply solenoid valves.
2) Analog Input: 4-20 mA signal for speed rate control of polymer metering pump.
3) Discrete Outputs: system running (discrete dry contact), system remote mode (discrete dry contact), common alarm (discrete dry contact)
4) Analog Output: polymer pumping rate (4-20 mA) speed feedback.

3. Polymer Blending System Control Panel:
a. Provide one local control panel for the control of the neat polymer metering pumps and the dilution water as required to makeup the desired polymer concentration and deliver to the process stream:
b. The control panel shall include the following functions and features:
1) Fiberglass enclosure with NEMA 4X rating.
2) Door mounted power disconnect switch.
3) Power supply: 120VAC, 1-PH.
4) DC drive for motor speed control.
5) Controls shall be via PLC and color-touch screen operator interface terminal (OIT).
a) System ON/OFF/REMOTE mode selection:
b) When in ON mode, the blending system shall automatically start and stop based on operator adjustable setpoints.
c) When in OFF mode, the blending system will remain off.
d) When in REMOTE mode, a contact closure from the Plant Control System shall enable the blending system to automatically start and stop based on the previously described operator adjustable setpoints.
6) The OIT shall display the following:
a) Dilution water flow rate.
b) Neat polymer pump running status and speed.
c) Polymer solution concentration.
d) Polymer totalizer.
e) Low water flow alarm.
7) Status/Alarm Indicators:
a) Main power ON indication.
b) Loss of dilution water
c) Run status

B. Electrical: Provide with three-prong grounded plug for 120 VAC, 60 Hz, 15 A, 1 PH service.
1. NEMA 4X rated glass fiber reinforced plastic enclosures.
2. Circuit breaker motor protection.
3. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes. See Section 01 61 03 for information on

how to determine the available fault current, such that, the SCCR rating meets or exceeds the available fault current.

### 2.7 SPARE PARTS

A. Include spare parts as recommended by manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. See Section 01 61 03.

B. Install products in accordance with manufacturer's written instructions.

### 3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise any adjustments and installation checks.
   3. Conduct start-up of equipment and perform operational checks.
   4. Provide Owner, through the Contractor, with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.
   5. Instruct Owner's personnel for one day at jobsite on operation and maintenance.

## END OF SECTION

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# SECTION 46 33 46
## PUMPING EQUIPMENT: PERISTALTIC PUMPS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes:
   1. Peristaltic metering pumps for sodium hypochlorite (SHC), sodium hydroxide (SHY), sodium carbonate (SCL), aluminum sulfate (ALM), filter aid polymer (FAP), settling aid polymer (SPC), and calcium thiosulfate (CTH).
      a. Chemical accessories including: valves, injection quills, calibration columns and other equipment and instrumentation required for a functional chemical system as shown on Drawings.
   2. Equipment Numbers
      1. P-7111
      2. P-7121
      3. P-7211
      4. P-7311
      5. P-7411
      6. P-7412
      7. P-7413
      8. P-7511
      9. P-7512
      10. P-7513
      11. P-7611
      12. P-7612
      13. P-7621
      14. P-7622
      15. P-7711
      16. P-7721

B. Related Sections include but are not necessarily limited to:
   1. Division 1 – General Requirements
   2. Section 01 33 00 – Submittals
   3. Section 01 33 04 – Operation and Maintenance Manuals.
   4. Section 11 00 00 – Equipment: Basic Requirements
   5. Section 43 21 00 – Pumping Equipment: Basic Requirements
   6. Section 40 05 00 – Piping and Pipe Fittings: Basic Requirements
   7. Section 40 05 31 – Pipe: Plastic
   8. Section 40 05 66 – Check Valves
   9. Section 40 05 52 – Miscellaneous Valves
   10. Division 13 – Special Construction
   11. Section 26 05 00 – Electrical: Basic Requirements

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   4. American National Standards Institute (ANSI).
   5. American Society for Testing Materials (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.

b. A536, Standard Specification for Ductile Iron Castings.
c. A666, Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar for Structural Applications.

6. National Sanitation Foundation (NSF) – NSF-61

B. Manufacturer's Experience:
1. All equipment described under this Section shall be supplied by a manufacturer who has been regularly engaged in the design, manufacture, and installation of the type of equipment specified herein for at least five years. All like equipment to be supplied in multiples units (i.e., metering pumps, valves, gauges, diaphragm seals, etc.) shall be of a single supplier.

C. Warranty
1. The chemical metering pump manufacturer shall provide a two-year warranty on the metering pump mechanical drive and two-year warranty on the liquid end.

D. System Responsibility:
1. Pump manufacturer must provide pumps, gear reducers, motors, drives, leak detection systems, diaphragm seals and pressure gauges and other accessories as specified herein, regardless of manufacturer, as a complete integrated package to ensure proper coordination and compatibility.

## 1.3 SUBMITTALS

A. Shop Drawings:
1. See Section 01 33 00.
2. Product Technical Data including acknowledgement that products submitted meet requirements of standards referenced and submittal includes manufacturers installation instructions.
3. Certifications and testing.

B. Operation and Maintenance Manuals:
1. See Section 01 33 04.

C. Catalog data and information including:
1. Type of liquid handled.
2. Capacity, gph; maximum and minimum gph.
3. Motor and adjustable speed drive type.

D. Materials of construction.

E. Net positive suction head required.

F. Manufacturer's catalog data on all accessories including pressure relief valves, pressure regulating valves, pulsation dampeners, flow calibration chambers, and suction assemblies. Data shall demonstrate sizing procedure for pulsation dampeners.

G. Certification:
1. The Contractor shall obtain written certification from the manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these specifications and as indicated on the drawings, that all the materials are best suited for the chemicals handled, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, variable speed drives, controls, and services required for proper installation and operation of the completely assembled and installed unit. The Contractor shall submit all such certificates to the Engineer.

H. Tools:
1. Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal toolboxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

I. Maintenance:
   1. Printed instructions related to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units. A recommended spare parts list shall be included.

J. Field Procedures:
   1. Instructions for field procedures for erection, adjustments, inspections, and testing shall be provided prior to installation of the equipment.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Peristaltic Metering Pumps.
      a. Masterflex.
      b. Blue-White M-Series.
      c. Verderflex.
      d. Or approved equal.
   2. Injection Quill
      a. Saf-t-Flo Model.
      b. Or approved equal.

### 2.2 MATERIALS

A. All metering pump equipment and accessories in contact with the pumped fluid shall be chemically and physically compatible.
   1. Drive: Polyester Powder Coated CRS
   2. Track: Thermoset polyester
   3. Guard: Stainless steel or polycarbonate.
   4. Rotor rollers: 316 Stainless Steel
   5. Hardware: Stainless Steel

### 2.3 EQUIPMENT

A. Provide peristaltic metering pumps meeting the following parameters:
   1. Suction Head:
      a. 25 ft maximum.
      b. 0 ft minimum.
   2. Pump speed: 200 rpm maximum at specified maximum delivery capability. Minimum speed must be 0.1 rpm or lower.
   3. Electric variable speed.
   4. Minimum Turndown: 200:1
   5. Wherever possible, pump capacity shall not exceed 125% of specified maximum delivery capability.
      a. This can be achieved through hose sizing and motor selection when needed.
      b. If desired maximum delivery capability is less than 75% of pump capacity, select smallest available pump.

| Equipment No. | P-7111, P-7121 | P-7211 | P-7311 | P-7411, P-7412, P-7413 | P-7511, P-7512, P-7513 | P-7611, P-7612 | P-7621, P-7622 | P-7711, P-7721 |
|---|---|---|---|---|---|---|---|---|
| Material Pumped | $Al_2(SO_4)_3$ (ALM) | SPC | FAP | NaOCl (SHC) | NaOH (SHY) | $CaS_2O_3$ (CTH) - BWS | $CaS_2O_3$ (CTH) - Ozone | $Na_2CO_3$ (SCL) |
| Concentration | 48.5% | 40% | 30% | 12.5% | 25% | 24% | 24% | 20% |
| Delivery Capability (gph) | | | | | | | | |
| Max | 11.9 | 1.05 | 0.064 | 7.2 | 4.8 | 0.035 | 0.13 | 19.9 |
| Min | 0.55 | 0.05 | 0.001 | 0.7 | 0.17 | 0.0028 | 0.0073 | 2.4 |
| Maximum Discharge Pressure (psi) | 75 | 45 | 45 | 45 | 75 | 45 | 75 | 45 |

## 2.4 ACCESSORIES

A. Provide the following for each peristaltic metering pump:
   1. Nameplate:
      a. Each piece of equipment shall be equipped with a nameplate, indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.
   2. Flow Calibration Column:
      a. Provide one calibration column per metering pump or as shown on Drawings.
      b. Metering pumps shall be provided with flow calibration columns on the pump suction lines. Calibration columns shall be chemically compatible with (i.e., rated "excellent" or "no effect, little noticeable change or action") with the chemical pumped, and shall be labeled in standard divisions and milliliters.
      c. Calibration columns shall have a volume such that chambers empty within 60 seconds when pumps are operated at rated capacity and shall have ½-inch female NPT connections at the top and bottom.
      d. Install valve on top for fill/drain.
   3. Feed Pump Skid and Equipment Supports:
      a. As shown on Drawings, pumps and ancillary components including valves, fittings, accessories, instruments and all components required shall be supplied factory assembled and tested prior to shipping.
      b. The metering pumps shall be firmly supported on spill containment pans as shown on the drawings and anchored down. Spill containment pans shall be fabricated of PVC, polypropylene, or FRP. Chemical feeding equipment and piping shall be firmly supported on PVC sheets above the spill containment pans. Fabricated supports exposed to chemical spills shall be fabricated of PVC, polypropylene, or FRP. All anchor bolts, nuts, and washers of such supports shall be of type 316 stainless steel, with an anti-seize compound on the threads.
   4. Safety Equipment:
      a. Where required by Code, all chemical uploading, storage, and feeding equipment shall be furnished with the necessary safety devices and warning signs, clearly visible.
   5. Wye Strainers:
      a. Provide wye strainers as indicated on drawings.
      b. Removable cover with external threads.
      c. In-line connection flanges.
      d. PVC or CPVC basket materials same materials as piping and must be compatible with material pumped.
      e. NSF/ANSI 6.

6. Valves:
    a. Diaphragm Valves:
    b. Degassing Valves and Vented Ball Valves:
        1) Provide Plast-o-matic degassing valves on all high points in chemical piping. Provide also on SHC systems anywhere there are two isolation valves in series.
        2) Vented ball valves shall be provided on SHC systems when ball valves are shown on drawings.
    c. Pressure Relief Valves:
        1) Pressure relief valves with ½-in FPT connections sized for the flow rate of the pump shall be provided with all metering pumps. Valves shall be suitable for the chemical solution service as specified. For sodium hypochlorite service: Viton shall be used for o-rings and seals or other wetted elastomers. Pressure relief valves shall be field adjustable between 25 and 100 psig.
7. Flow Glass:
    a. The discharge side of the pressure relief valve must provide a clear portion of pipe or a flow glass to visually indicate the relief valve is in operation.
    b. For P-7211 & P-7311, angle glass to allow polymer to gravity drain into calibration column.
8. Chemical Injection Quill: Provide as indicated on drawings.
    a. 1 ½ IN NPT chemical piping connection.
    b. 1 ½ IN NPT main connection.
    c. Stainless steel restrain hook and chain.
    d. Brass solution tube adapter and corporation stop.
    e. ½ IN Schedule 80 CPVC solution tube, extended a minimum of 3 IN into process piping.
    f. Standard tip configuration with spring loaded ball check valve.
    g. Rated to 150 PSIG.
    h. Included with hose section to allow removal of injector from injection port.
9. Provide compression couplings on suction and discharge of pumps and as shown on the drawings.
    a. For chemical drums, provide pump suction apparatus as follows:
        1) Drum Stick or equal.
        2) Integral check valve to prevent need to prime peristaltic pumps.
        3) Hastelloy strainer
        4) ¾-inch polypropylene construction.
10. Leak Detection System:
    a. Each metering pump shall be equipped with a leak detection system that shall render the drive inoperable in the event of a tubing failure.
11. Tubing:
    a. Tubing provided under this section shall be compatible (i.e., rated "excellent" or "no effect, little noticeable change or action") with the chemical pumped.
        1) In addition to other tubing required, Contractor shall include tubing as shown on drawings for connecting drums to permanent piping.
12. Pump discharge pressure gauge with diaphragm seal:
    a. Pressure Gauge:
        1) All components suitable for service at:
            a) 250 DEGF.
            b) The maximum process temperature to which the gauge is to be exposed.
        2) Provide viewer protection from element rupture.
        3) Calibrate gauges at jobsite for pressure and temperature in accordance with manufacturer's instructions.
        4) Dial size: 4-1/2 IN.
        5) Equip with white faces, black numerals and black pointers.

6) Gauge tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
   a) Gauge to be readable from an accessible standing position.
7) Gauge accuracy: 1 PCT of full range.
8) Select gauge range so that:
   a) The normal operating value is in the middle third of the dial.
   b) Maximum operating pressure does not exceed 75 PCT of the full scale range.
9) Install where specified or shown in the Drawings.

b. Diaphragm Seal:
1) Isolates instrument from process fluids which are corrosive or contain solids.
2) Upper housing with bleed screw.
3) Lower housing with flushing connection.
4) Fill fluid:
   a) Utilize halocarbon fill for process applications involving strong oxidizing agents.
      (1) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
   b) Utilize manufacturer's standard fill for other applications.
      (1) Ensure fill is suitable for application temperatures.
5) Connections:
   a) Instrument: 0.25 IN female NPT.
   b) Process: 0.5 IN female NPT.
   c) PVC pipe applications: Use a socket weld connection.
6) Install where specified or shown in the Drawings.

## 2.5 FABRICATION

A. Peristaltic Metering Pumps:
1. Pumps shall be 100% integral in design with the pumphead, motor, controls, and pump case. All controls, motor, and gear reduction shall be housed in a single chemically resistant pump case.
2. Drives:
   a. Drive shall be rated for continuous 24-hour operation at ambient temperature to 40°C (104°F).
   b. Pump drive shall be close coupled and self-aligning, requiring no flexible couplings.
   c. Supply voltage shall be 120 V, 60 Hz, Single Phase.
   d. Power cord with NEMA 5-15 type plug.
   e. Drive circuitry shall be microprocessor controlled.
   f. Drive motor shall be Brushless DC, HP as required.
   g. Systems are UL and CE approved.
   h. Dispense accuracy/resolution shall be ± 1 revolution.
   i. Washdown (IP66) rated enclosure. Operator panel shall have a FWD/OFF/REV Switch and a sealed potentiometer.
3. Integral Pumps Controls:
   a. Shall be provided for drive speed, pumping direction, tubing size, prime, flow rate calibration, keypad lockout, on/off control, and remote control.
   b. Drive shall be capable of accepting analog speed setpoint signal ranging between 4-20mA signals. Other remote control features shall be Switch Closure inputs for CW/CCW, Remote start/stop, and remote prime/purge.
   c. Operator panel shall have a sealed keypad to protect from spills and to allow easy cleaning. The controller keypad shall be externally accessible to avoid compromising the enclosure seal during operation.
   d. Drive shall be capable of returning analog speed feedback output signal of 4-20 mA.
   e. Drive includes a LED display readable from 12 ft. and shall be capable of displaying speed in RPM and flowrate.

f. TTL pulse and relay contacts to indicate pump operating (motor running) in NO and NC rated at 1A @ 28 VDC.
g. Washdown (IP66) rated enclosure. Operator panel has a sealed potentiometer and switch to protect from spills and to allow easy cleaning.
h. Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
    1) Display pump speed, running status, flow rate, and programming instructions
    2) Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
    3) Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.
    4) Programmable "Auto Restart" feature to resume pump status in the event of power outage interruption.
    5) Programmable "Keypad Lock" to allow operator lockout of all keys except emergency start/stop.
    6) Programmable "Maximum Speed" to allow operator to set the maximum speed of the pump.
i. Plant Control System interface:
    1) Status and Alarm dry relay contacts:
    2) Remote status.
    3) Running status.
    4) Fault status.
    5) Tube failure alarm.
    6) Remote Start/Stop dry contact.
    7) Analog, 4-20 mA speed command signal.
    8) Analog, 4-20 mA speed feedback signal.

4. Rollers:
    a. Two rollers shall at all times be fully engaged with the tubing providing complete compression to prevent back flow or siphoning. The pumping action shall be created by the occlusion (compression) of the pump hose and its subsequent restitution (return to original shape) causing a vacuum effect to draw the fluid into the suction side of the hose. The tubing shall be in contact with the inside diameter of the track (housing) through a minimum angle of 150 degrees and be held in place on the suction and discharge.
    b. Hose occlusion shall come factory set to provide optimal occlusion for the tubing supplied.
    c. Rotor: The rotor shall be made of all stainless steel components and shall be end mounted in two stainless steel sealed bearings, which in turn are mounted within a body bearing support. A rotor guard fits between the rollers preventing fingers from entering the deep internal rotor region. The occlusion bed shall be a molded polysulphone or polyphenylene sulfide held close in its operating position by means of a stainless steel latch. Tubing retention shall be by means of a formed stainless steel component in conjunction with slots in the thermoset polyester body. A stainless steel protective cover minimizes the potential for injury by blocking access to the rotor when closed, and shall be held in place by a tubing retainer clamp screw.
5. Pump Head:
    a. The pump head shall be secured to the drive and be self-locating.
6. Tubing:
    a. The process fluid shall only be in contact with the inside of the pump tubing. The pump tubing shall be extruded from a material compatible with the pumped chemical and shall be suitable for long life when pumping chemicals specified under Paragraph 1.1.A.1.
7. The pump shall use no check valves or diaphragms and not utilize any dynamic seals in contact with the fluid pumped.

### 2.6 MAINTENANCE MATERIALS

A. Peristaltic Metering Pumps:
   1. Tubing:
      a. One (1) 50-foot roll of each size and material of tubing used on the project, or
      b. Five (5) tubing elements of each size and material used on the project.

B. Chemical injection quill.
   1. Provide one spare chemical injection quill for each one installed.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as shown, unless otherwise approved.

### 3.2 FIELD QUALITY CONTROL

A. Comply with Section 43 21 00.

B. Install per manufacturer's installation instructions.

C. Coordinate manufacturer's field services.

### 3.3 SERVICES OF MANUFACTURER

A. See Section 01 75 00.

B. Inspection, Startup, and Field Adjustment:
   1. The service representative of the Manufacturer shall be present at each site for one (1) work day for field inspection and one (1) work day for startup and one (1) work day for field adjustment services.

C. Instruction of Owner's Personnel:
   1. After the equipment has been installed, tested, adjusted, placed in satisfactory operating condition, the pump manufacturer shall provide a minimum of one (1) actual working man-day to instruct the operating personnel in the use and maintenance of the equipment.

**END OF SECTION**

# SECTION 46 33 50
## CHEMICAL FEED: SODA ASH

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Soda ash storage bins, stair, grating, platform, handrails, and accessories.
   2. Soda ash feed pumps

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 – General Requirements.
   3. Section 00 43 33 – Proposed Major Equipment Form.
   4. Section 01 61 03 – Equipment: Basic Requirements.
   5. Section 05 50 00 – Metal Fabrications.
   6. Section 05 52 02 – Welded Aluminum Railings.
   7. Section 43 21 00 – Pumping Equipment – Basic Requirements.
   8. Section 46 33 46 – Pumping Equipment Peristaltic Pumps.

### 1.2 QUALITY ASSURANCE

1. Referenced Standards:
2. American Water Works Association (AWWA):
   a. B201-08, Standard for Soda Ash.
3. British Columbia Building Code.

### 1.3 SYSTEM DESCRIPTION

A. System shall be supplied through a single source and include all components specified herein to:
   1. Prepare and store 25% soda ash solution using 23-kg (50-lb) bags of dry soda ash crystal.
   2. Meters soda ash solution to Rapid Mix Chamber to aid in PACL coagulation.
   3. Meters soda ash solution to Finished Water for corrosion control.

### 1.4 SUBMITTALS

A. See Section 00 43 33 – Proposed Major Equipment Form.

### 1.5 PROJECT CONDITIONS

A. Material Handled:
   1. General:
      a. Soda ash to conform to AWWA B201-08.

## PART 2 - PRODUCTS

### 2.1 REQUIREMENTS

A. Soda ash usage:
   1. To Ozonated Water Pipeline:
      a. Estimated average: 5.0 mg/L as dry soda ash.
      b. Range:
         1) Minimum: 2.5 mg/L as dry soda ash using one pump at minimum duty flowrate in Section 46 33 46.
         2) Maximum: 10.0 mg/L as dry soda ash using one pump at maximum duty flowrate in Section 46 33 46.
      c. Discharge pressure: 45 psi max.
   2. Soda ash service conditions:

a. Fluid: Sodium Carbonate.
b. Pressure: Atmospheric.
c. Exposure: Indoors.
d. Concentration by weight: 20%.
e. Specific gravity: 1.19.
f. Minimum ambient temp.: 0 DEGF.
g. Minimum fluid temp.: 40 DEGF.

B. Maximum fluid temp.: 100 DEGF. Materials
1. Tank T-7701:
a. Capacity: 100 gal (min.) between top of outlet and bottom of overflow.
b. Inlets/outlets: As indicated in Drawings.
c. Drains: 2 IN with plastic ball valve.
d. Feed hopper: stainless steel.
e. Tank: Fiberglass reinforced plastic.
f. Fasteners: Galvanized steel.
2. Mixer MXR-7701:
a. Paddle: Stainless steel.
b. Motor: 0.5 HP fixed speed, 1750 RPM (max), 480V/3-Phase.
c. Attachments: Galvanized steel.
3. Sodium Carbonate Metering Pumps P-7711 and P-7721:
a. Number: One duty and one standby.
b. See Specification Section 46 33 46.

## 2.2 ACCESSORIES:

A. Tank:
1. See Specification Section 05 50 00 and 05 52 02.
2. Aluminum stairs and grating platform.
3. Aluminum handrail around stairs and platform.

B. Pumps:
1. Factory-assembled skid mounts with:
a. Tubing.
b. Injection check valves.
c. Back pressure valve, if required.
d. Pressure relief valve.
e. Pressure gauge.
f. Calibration column.
g. Inlet wye-strainer.
h. Junction box for power and control cabling attachment.
2. All materials compatible with pumped solution and installed environment.
3. One full maintenance repair kit for each supplied pump.

C. Mixer Control Panel (LCP-7701):
1. Stainless Steel enclosure with NEMA 4X rating.
2. NEMA combination motor starter.
3. 2-position, ON/OFF selector switch.
4. Running light.
5. Elapsed time meter.
6. UL508 labeled as an assembly.

D. Hazard and Safety Signs:
1. Caution Signs:
a. Tank shall be provided with a minimum of one Chemical Caution Sign.
b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
c. Size: 5 IN x 7 IN.
d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.

e. Schedule:
    1) Quantity: 1.
    2) Location: Place in a visible location on each tank.
    3) Text/Symbol: WEAR EYE PROTECTION, RUBBER GLOVES, AND APRONS WHEN HANDLING CHEMICALS.

2. Danger Signs:
    a. Tank shall be provided with a minimum of one Confined Space Danger Sign.
    b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
    c. Size: 5 IN x 7 IN.
    d. Legend: Conforming to OSHA 1910.145(d)(4), Specifications for Caution Signs.
    e. Schedule:
        1) Quantity: 1.
        2) Location: On tank near the manway.
        3) Text/Symbol: DANGER / CONFINED SPACE.
3. NFPA Fire Hazards Material Signs:
    a. Tank shall be provided with a minimum of one NFPA fire Hazards Material Sign.
    b. Tag type: Type D – Self-Adhesive Tape Tags and Signs.
    c. Size: 7-1/2 IN x 7-1/2 IN.
    d. Characteristics:
        1) 4 color background, blue, red, yellow, white.
        2) Diamond shape conform to NFPA No. 704, System for identifying fire hazards of materials.
    e. Legend letter height: 3 IN-high black hazard numerals.
    f. Schedule:
        1) Quantity: 1.
        2) Location: Place in a visible location on tank.
        3) Text/Symbol:
            a) Material: SODIUM CARBONATE.
            b) Health: 1.
            c) Fire: 0.
            d) Reactivity: 0.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install all equipment in accordance with Treatment Equipment Supplier's instructions.

B. Anchor equipment as required by Building Code.

### 3.2 FIELD TESTING

A. Tank shall be field tested by filling the entire tank with water and monitoring the tank and fitting connections for at least 24 HRS.

### 3.3 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
    1. Inspect equipment covered by this Specification Section.
    2. Supervise pre-start adjustments and installation checks.
    3. Conduct initial start-up of equipment and perform operational checks.
    4. Instruct Owner's personnel for 8 hours at jobsite on operation and maintenance of the full system and individual components.

B. See Specification Section 43 21 00.

### 3.4 FIELD REPAIR

A. If, after filling with chemical, a leak is detected, the Contractor shall be responsible for all expenses associated with removing the tank contents, repairing the tank, and replacing the tank contents.

**END OF SECTION**

# SECTION 46 43 62
## BALLASTED FLOCCULATION SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Seller shall supply all labor, materials, equipment, tank accessories, controls, appurtenances, testing, and startup services for the ballasted flocculation system complete and operable in accordance with the requirements specified herein. The Contractor is responsible for providing a complete installation of the equipment furnished by the Seller.
   1. The Contractor is responsible for all material and labor related to concrete and grout work for the Ballasted Flocculation System as required by the system selected by the Contractor. In addition, the Contractor shall furnish and install all additional equipment items, interconnecting piping, valves, fasteners, pipe supports, instruments, power and control wiring, and all other appurtenances required to provide a complete and operable system.
   2. Contractor shall note that all ballasted flocculation systems may have differing requirements and the basis of design depicted on the drawings are based on a single Seller's system. Contractor shall obtain approved shop drawings prior to placing concrete and will be responsible for any and all changes in the design required due to the system the Contractor has selected to provide.

B. Ballasted Flocculation system Performance Guarantee and Equipment Warranty requirements.

C. Some equipment associated with the Ballasted Flocculation system to be furnished by others is identified in this Section.

D. Related Specifications include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Division 40 – Process Interconnections.
   4. Section 43 21 00 – Pumping Equipment – Basic Requirements.

### 1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
   3. ASTM International (ASTM).
   4. American Water Works Association (AWWA).
   5. American Welding Society (AWS).
   6. Institute of Electrical and Electronic Engineers (IEEE): 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   7. Instrument Society of America (ISA).
   8. National Electrical Code (NEC).
   9. National Fire Protection Association CNFPA).
   10. International Building Code, 2015 (IBC).
   11. International Fire Code, 2018 (IFC).
   12. NSF/ANSI 61-2017 - Drinking Water System Components
   13. Where reference is made to one of the above standards, the revision in effect at the time of Bid opening shall apply unless otherwise noted.

B. Ballasted Flocculation System:
   1. Single Seller shall provide all materials, equipment, incidentals, and appurtenances and be responsible for designing, furnishing, coordination, proper sizing and performance of all systems components for a complete operating system.

a. The Seller shall also provide Special Services during the construction of the Project to include but not be limited to coordination with the Contractor, installation assistance, including written and verbal instructions, to the Contractor to assure proper installation, inspection of the completed installation, operator training (initially and any additional training specified), start-up assistance to the Contractor, commissioning, acceptance testing field services as specified, operation and maintenance manuals and any other services as specified further in these Documents.

2. It is the Seller's responsibility to provide all parts, equipment, materials, and components required for a complete and functional system to the specified limits. If the Seller's system must control a piece of equipment to ensure proper operation of the system and it is not included in the Seller's scope of supply, it shall become the Contractors responsibility to provide at no additional cost to the Owner.
3. The Seller shall be responsible for the design, supply, and installation of all wiring, including power, control, and signal, and conduit for all equipment preassembled on a common skid.
4. The Contractor shall be responsible for the supply and installation of all wiring, including power, control and signal, and conduit for all equipment not preassembled on a skid or supplied by the Seller. The Contractor will also be responsible to furnish and install all interconnecting control, signal and power cabling between the Seller supplied skids and the others.
5. The Contractor shall be responsible to furnish and install all interconnecting control, signal and power cabling to integrate the System into the Owner's plant wide control and SCADA system.

## 1.3 SUBMITTALS

A. Submit complete shop drawings in accordance with the requirements of Section 01 33 00, Submittals for Procurement Contracts. Submit complete design and manufacturing data for the System as follows:
   1. Process and instrumentation diagrams for complete Ballasted Flocculation system including all equipment and instrumentation to be controlled by the Seller's system.
   2. Installation drawings showing all important details of construction, dimensions, and anchor bolt locations.
   3. Descriptive literature, bulletins, and/or catalogs of the equipment.
   4. A complete total bill of materials for all equipment.
   5. Data on the characteristics, features, and performance of the equipment.
   6. Electrical Schematics, panel layouts, field wiring diagrams, instrumentation sheets, and product data sheets for all electrical equipment being supplied by the Ballasted Flocculation system Seller.
      a. Panel exterior layout drawings to scale and shall indicate the following:
         1) Panel materials of construction, dimensions, and total assembled weight.
         2) Panel access openings.
         3) Conduit access locations.
         4) Front panel device layout.
         5) Nameplate schedule:
            a) Nameplate location.
            b) Legend which indicates text, letter height and color, and background color.
            c) Short Circuit Current Rating (SCCR) marking per NFPA 70 or statement of exception. Include any required calculations.
         6) Layouts of graphic panels or mosaic displays.
      b. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
         1) Sub-panel or mounting pan dimensions.
         2) Interior device layouts.
         3) PLC general arrangement layouts.
         4) Wire-way locations, purpose, and dimensions.
         5) Terminal strip designations.

6) Location of external wiring and/or piping connections.
7) Location of lighting fixtures, switches and receptacles.

c. Wiring diagrams shall consist of the following:
1) Panel power distribution diagrams.
2) Control and instrumentation wiring diagrams.
3) PLC I/O information:
a) Model number of I/O module.
b) Description of I/O module type and function.
c) Rack and slot number.
d) Terminal number on module.
e) Point or channel number.
f) Programmed point addresses.
g) Signal function and type.
4) Wiring diagrams shall identify each wire as it is to be labeled.
5) OIT graphics.
6) Description of controls.

7. The total weight of the equipment including the weight of the single largest item.
8. Complete motor drive data.
9. Equipment anchoring calculations.
10. Complete data and drawings on control system.
11. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.
12. Electrical load calculations for each panel:
a. Total connected load.
b. Peak electrical demand for each panel.
13. Climate control calculations for each panel.
a. Verify that sufficient dissipation and/or generation of head is provided to maintain interior panel temperatures within the rate operating temperatures of panel components.
14. Signed warranty documents.

## 1.4 BALLASTED FLOCCULATION SYSTEM PERFORMANCE GUARANTEE

A. Seller guarantees that the Ballasted Flocculation process will perform as set out in these specifications when erected in accordance with the process design basis and detailed design approved by Seller, and if operated at conditions in accordance with Seller's process design basis, operating instructions (to include chemical type and dosage instructions), and any modifications or revisions thereof, all as furnished in writing by Seller, directly or indirectly, to the Contractor.

B. The Ballasted Flocculation system Performance Guarantee performance requirements are as follows:

**Ballasted Flocculation Performance Guarantee Performance Requirements**

| Parameter | Requirement |
|---|---|
| Design Influent flow per train | 5,000 gpm |
| Raw water turbidity less than or equal to 100 NTU | Effluent less than ***or equal to*** 2.0 NTU |
| Raw water turbidity 101 NTU up to 2000 NTU | Effluent not greater than 5 NTU not less than 95% of the time* |
| Raw water source, summer | Reeder Reservoir water blended with Talent Irrigation District water |
| Raw water source, winter | Reeder Reservoir water |

C. Performance Guarantee.

1. The period of the Performance Guarantee shall be limited to 1 year from the date of documented substantial completion based on the results of demonstration testing. If, within the 1-year Performance Guarantee Period, the Ballasted Flocculation system is operated under and meets the specified Performance Guarantee conditions listed in the table in Part 1.4.B, then the Ballasted Flocculation system shall be construed as sufficient with respect to the Performance Guarantee. Determination of Ballasted Flocculation system performance in relation to the Performance Guarantee shall be evaluated for each of the water quality conditions in Part 1.4.B and shall be based on a 1-hour rolling average over three days of the SCADA records of continuous on-line measurement. Seller's total liability under the Performance Guarantee will be discharged, and the Owner will have no further recourse against Seller or any claims for recovery hereunder with respect to such Performance Guarantee.
2. The Owner shall operate the Ballasted Flocculation system during the Performance Guarantee period in accordance with the design basis and within the range of operational control and monitoring requirements as detailed by the Seller in the Operations and Maintenance documentation or in subsequent Seller furnished operational modification guidelines and revisions. The Owner shall also be responsible for operating the Plant during the Performance Guarantee period, for collecting the turbidity data, influent and effluent data such as flow, turbidity in NTU, for recording chemical use and dosage data, for carrying out all laboratory tests, for maintaining any online instrumentation according to the manufacturer's specified intervals, and for keeping detailed testing records including the date and type of any action taken.
3. Sampling and analytical support during the demonstration testing period shall be the responsibility of the Contractor.
4. It is understood and agreed that any mechanical corrective work necessary to cause the Ballasted Flocculation system to meet the Performance Guarantee will be performed by Seller, the Owner, or their respective contractors at times mutually agreed upon by Seller and the Owner.
5. Costs associated with implementation of equipment or operational modifications required to bring the Ballasted Flocculation system into compliance with the Performance Guarantee, and those costs associated with training required to implement an equipment modification or operational change, shall be borne by the Seller.
6. Costs associated with re-training or additional training of Owner's personnel during the Performance Guarantee testing period shall be borne by the Owner.
7. Ballasted Flocculation system performance records will be retained by the Owner until the Performance Guarantee has been satisfied and will be comprised of all daily log sheets, operator notes, sample inspections, and instrument charts produced as part of plant operations. Upon Seller's request, Owner will furnish copies of such records to Seller for their review towards identification of potential process equipment or operational modifications as required to meet the Performance Guarantee requirements.
8. If the Owner chooses not to document or is unable to conduct adequate Performance Testing due to problems unrelated to the Seller's equipment after the plant has achieved stable operation during the 12-month Guarantee Period, the Performance Guarantee will be assumed to have been met.
9. If, during the Performance Guarantee period, it appears that the requirements of the Guarantee are not being met, Seller will have the right to have the Ballasted Flocculation system portion of the Treatment Plant operated at such conditions as it may deem necessary or advisable for purposes of determining the nature or cause of the failure of the plant to meet the Guarantee, provided such operating conditions are in accordance with good engineering practice and the Owner's safety rules enforced at the plant site, and thereafter will have the right to make or have made such adjustments as it deems necessary or advisable in order to meet such guarantee and the right to make or have made, at its own expense, such alterations or modifications to the Ballasted Flocculation system equipment as it deems necessary or advisable.

10. The Owner will promptly notify Seller when each guarantee parameter under the Performance Guarantee has been met and, if necessary, of the failure of the plant to meet any such guarantee, specifying the respect in which such guarantee has not been met.
11. The Seller will not be responsible in any way for non-fulfillment of the Performance Guarantee due to deficiencies in the plant with respect to materials, equipment (other than equipment furnished by Seller), workmanship, or services, including but not limited to:
    a. Defective materials or mechanical condition or deficient performance of equipment utilized in the Ballasted Flocculation system's auxiliary parts supplied by Contractor.
    b. Noncompliance with the Process Design Basis for the Ballasted Flocculation system and/or noncompliance with operating instructions to include system Seller's recommendations on proper chemical feed rates and types, or revisions of any of these, furnished or approved in writing by Seller to Contractor or defective conditions or performance of any materials, equipment (other than equipment furnished by Seller) or work supplied by or contracted for by anyone other than Seller.
    c. Failure of the Contractor to furnish adequate utilities, such as, but not limited to, electricity, air, water, etc. as well as an adequate operating force.
    d. Mechanical failure of any of the equipment or component parts thereof due to ordinary wear and tear or any other cause.
    e. Failure of Contractor to perform any of the responsibilities and obligations assumed by it in accordance with the provisions hereof.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Seller shall be responsible for designing, furnishing, coordination, proper sizing, and performance of all systems components for a complete operating system.

B. Acceptable Sellers
    1. Veolia Actiflo Turbo.
    2. WesTech RapiSand.
    3. Or approved equal.

C. Submit requests for substitution in accordance with Section 01 25 13.

## 2.2 GENERAL

A. This specification establishes specific requirements and features for the Ballasted Flocculation equipment, but do not purport to cover all details necessary for a complete and operable Ballasted Flocculation system. Ancillary and accessory devices, within the confines of the Ballasted Flocculation system Seller's scope, necessary for system performance shall be included by the Seller whether specified or not.

B. The equipment covered by these Specifications is intended to be standard process equipment of proven ability as manufactured by reputable manufacturers having experience in the production of such equipment.

C. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its piece of equipment is operating at any point on its characteristic curve.

D. The location, size, and type of all piping associated with the Ballasted Flocculation system shall be as shown on the Drawings, or as required by the supplied equipment.

## 2.3 DESCRIPTION OF THE SYSTEM

A. The Ballasted Flocculation system is a compact coagulation/clarification/sedimentation process that uses microsand for enhanced flocculation and settling. Raw water is passed through automated strainers before ozone contact and subsequent calcium thiosulfate addition to quench any remaining ozone. Alum coagulant, soda ash, polymer, and microsand are added to the raw water at various feed points. The Ballasted Flocculation system has tanks to mix chemicals and

then agglomerate and grow particles into high density flocs commonly called ballasted flocs, which are then separated from the process flow by the use of the inclined settling plates or tubes in a settling tank. The sludge/microsand mixture collected at the bottom of the settling tank is then pumped to hydrocyclones where the sludge is separated from the microsand by the centrifugal force of the vortex action. The recovered clean microsand is then returned to the Ballasted Flocculation system and the separated sludge is continuously discharged to sanitary drain. Overflow from the settling tank flows to the filter which is outside the Seller's scope.

B. The design criteria for the Ballasted Flocculation system are as follows:
   1. Number of process trains: 2 (1 duty, 1 standby).
   2. Process design flow (peak conditions): 5,000 gpm per train.
   3. Process design flow (minimum flow): 1,200 gpm.

C. As a minimum, the Ballasted Flocculation system Seller shall include the following equipment for each process train:
   1. One mixer for the coagulation tank.
   2. One mixer for the maturation tank.
   3. One draft tube or baffles for the maturation tank(s) (304 SS).
   4. One sludge scraper assembly for settling tank.
   5. One set of high impact polystyrene or polyvinyl chloride lamella settling tubes with supports (304 SS).
   6. One set of collection troughs with supports (both troughs and supports 304 SS).
   7. One electrically actuated blowdown plug valve.
   8. One microsand (recirculation) pump, each pump system to include: rubber lined sand/slurry pump, pump seal water stations, seal water flow switches, suction and discharge isolation valves, flush connections, and pressure indicators/transmitters and high and low pressure switches manifolded with diaphragm seals and isolation valves.
   9. One hydrocyclone each with underflow and overflow pipe, pressure gauge assembly, complete with diaphragm seals and isolation valves and 304 SS supports.
   10. Microsand delivery pipes, which includes the recirculation piping between the ballasted flocculation system, microsand pumps, and hydrocyclones, shall be designed and provided by the Seller. Seller shall ensure recirculation piping is constructed out of materials that are compatible with project requirements.
   11. Microsand and chemicals for start-up
       a. Microsand: minimum 8 tons.
       b. Polymer: minimum 400 gallons.

D. Conduit and Wire:
   1. All skid-mounted equipment, valves, and instruments shall be pre-wired to two NEMA 4X, stainless steel junction boxes mounted to the unit. One junction box shall be designated for signal wire and one junction box shall be designated for power wire.
   2. Equipment disconnects with NEMA 4X, stainless steel enclosures shall be provided for all motors.
   3. pH Probe and Turbidimeter shall be mounted to handrail and inserted into Settling Tank
   4. All motors to be run to a local disconnect mounted to the handrail. Then run conduit under the grating to each unit.
   5. Ability to remove the grating with conduit in place is required.
   6. Flexible conduit is to be run from the motor enclosure and terminate at the extents of the tank (At the top of side of the tank depending on the equipment location).

E. Ballasted Flocculation Control System:
   1. Shall include a Main Control Panel with NEMA 4X rated enclosure and Train Control Panels with NEMA 4X rated enclosures.
      a. The Main Control Panel shall include Programmable Logic Controller (PLC) hardware:
         1) Shall provide automatic controls and monitoring of each train.
         2) Shall receive 120 VAC, 1-phase power with through the door disconnect.

3) Shall include a UPS to keep PLC and OIT energized for 10 minutes upon loss of input power.
4) Managed ethernet switch.
5) Submittal shall clearly indicate required branch circuit size for the control panel.

b. A Train Control Panel shall be provided for each Ballasted Flocculation train.
1) The Train Control Panels shall include PLC Input/Output modules, pilot devices, indicator lights, motor starters, and VFDs for the associated train.
2) Shall include provisions for manual, local control of the equipment upon loss of communications or failure to the Main Control Panel.
3) Shall communicate with the Main Control Panel via Ethernet communications.
4) Shall receive 460 VAC, 3-phase power with through the door disconnect.
5) Motor starters shall be NEMA type.
6) Submittal shall clearly indicate required branch circuit size for the control panel.

c. The control panels shall be completely assembled, tested, and programmed for the required functionality.
d. Each control panel shall be UL508 listed.
e. Interconnections between control panels shall be provided by the Contractor.

2. Shall be controlled using a PLC based system with Operator Interface Terminals (OITs):
a. PLC hardware shall be Rockwell Automation, Allen-Bradley CompactLogix.
b. OIT hardware shall be Rockwell Automation, Allen-Bradley PanelView Plus7 15-in color with touch-screen and keypad.
c. Shall include provisions for EtherNet/IP communication with the WTP process control system.
d. PLC discrete input points shall be 24VDC type.
e. PLC shall include 20 percent spare I/O capacity, and minimum of 4 each analog input, 2 analog output, and 8 each discrete input, 4 discrete output.
f. Provide PLC and local operator interface programming, configuration, and graphics for control and monitoring of all functions in the ballasted flocculation system.
g. All information available on the Main Control Panel local operator interface shall be configured to be made available to the WTP process control system using PLC "produced and consumed tags" as follows:
1) Produced tags: Intended for transmission across the plant SCADA system's network such that it is available to be read by other controllers and/or the plant SCADA human machine interface (HMI) system.
2) Consumed tags: Configured to be read by the plant SCADA HMI system across the plant SCADA system's network.
3) Utilize explicit messaging (not write messages) and message reads

F. Instrumentation
1. Instrumentation required for control and monitoring of the Ballasted Flocculation system shall be provided by the Seller:
a. At a minimum the instruments shown on the attached PIDs shall be required.
b. Any and all other instruments required by Ballasted Flocculation Seller to meet Performance Guarantee shall be included in Sellers scope of supply.

G. Microsand:
1. Microsand shall meet the following requirements:
a. Material: Silica Sand, $SiO_2$
b. Greater than 99 percent.
c. Toxicity elements (As, Hg): None.
d. Particle density: 2.65 grams/cubic centimeter
e. Effective size: 100 to 120 μm
f. Uniformity coefficient: ≤ 1.77
2. Furnish ballasted flocculation train initial fill plus makeup equivalent to initial fill quantity (minimum 8 tons of microsand).

## 2.4 COAGULATION, INJECTION, AND MATURATION MIXERS

A. Each mixer assembly shall consist of a heavy-duty speed reducer, electric motor, baseplate, agitator shaft, and mixing impellers. Mechanical components of the mixers shall be as follows:
   1. See Section 01 61 03.
   2. The mixer gear drive manufactured to current AGMA Standards. The AGMA calculated drive HP rating shall be stamped on the drive nameplate. Drive housings shall be of high quality close grained cast iron, or fabricated steel, stress relieved and reinforced, and shall be provided with integral or separate baseplates suitable for mounting.
   3. Gearing shall be vertical parallel shaft all helical gears or helical spiral bevel to ensure the highest efficiency coupled with the convenience of mounting and maintenance (worn gearing is not acceptable). Gears shall be a minimum AGMA Quality 10 per AGMA standard 390.03. The gears shall be lubricated from a common food grade oil bath.
   4. The mixer gear drive shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The drive's minimum AGMA service factor shall be 1.5 and based upon motor nameplate horsepower. The service factor shall be based on AGMA Standards for 24 hour per day moderate shock application. Service factors based on uniform load and motor bhp will not be accepted.
   5. All drive bearings shall be of the antifriction type, ball bearings. All bearings within the drive, including output shaft bearings, shall have minimum AFBMA B-10 lives of 50,000 hours when operating at full motor nameplate horsepower at design speed.
   6. Each drive must have an effective lubrication of rotating elements without leakage down the output shaft. Output shaft bearings may be grease lubricated, including a high quality lip seal to retain grease.
   7. The electric motor drivers shall be suitable for operating in a humid outdoor environment with class F insulation, a 1.15 service factor and TEFC enclosure. The motors shall be squirrel cage induction motors for operation on 3-phase, 60 hertz, 230/460 volt current with synchronous speed of 1800 rpm or less. All motors shall be designed constructed and tested in accordance with applicable IEEE, NEA, and ANSI, standards. Motors for use with VFDs shall be inverter duty.
   8. The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged or integral coupling.
   9. The agitator shaft shall be of 304 SS. The shaft shall be designed such that the maximum stress shall not exceed 9,000 psi under maximum operating loads. It shall be of overhung design. The use of underwater steady bearings is not permitted. The mixer shaft shall have a maximum operating speed of 0.75 times the natural frequency of the shaft and impeller assembly without the use of stabilizing ring and lower shaft bearing.
   10. Mixing impellers shall be constructed of 304 SS or other approved material as recommended by the mixer manufacturer and shall be of bolted construction and shall be connected to the agitator shaft with a hook key for maximum security. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads. Mixer gear drive and motor shall be painted with a minimum of a 5 mil coat of epoxy primer. Primer to be equal to Amerlock 400 and a finish coat of Amershield urethane high gloss finish. Paint shall meet EPA and VOC requirements.
   11. Upon installation each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.
   12. The mixers shall be as manufactured by Philadelphia Mixers, Lightnin, Mixtec, or approved equal.

## 2.5 SLUDGE SCRAPER ASSEMBLY

A. The sludge scraper mechanism shall be suitable for installation in the settling tank. The total load of the scraper mechanism shall be supported from the top deck of the settler tank.

B. The overall mechanism shall be designed for a torque capacity determined when the full volume of sand in the system is collected at the bottom of the settler. Each scraper mechanism shall

consist of a drive unit with torque overload protection, center shaft, rake arms, and discharge cone scraper.

C. The drive unit shall be single shaft type rated with a cut-out torque determined when the full volume of sand in the system is collected at the bottom of the settler as provided by the Ballasted Flocculation Seller.

## 2.6 DRIVE MECHANISM FOR SLUDGE SCRAPER ASSEMBLY

A. The drive mechanism shall consist of an electric motor, a primary hydraulic reduction unit, a final gear reduction unit (as required), and an overload device (if applicable). All components are directly coupled, eliminating chains and V-belts. The primary reduction unit shall be a parallel-helical multistage gearbox and the final reduction unit shall be a parallel-helical shaft mounted gearbox.

B. Electric Motor
   1. Minimum service factor: 1.15
   2. Motor enclosure: TEFC with Class F insulation and Class B temperature rise above 40-deg C ambient.
   3. Motors shall be three phase, 60 Hz, 230/460 volts.
   4. Motors shall be rated for severe duty.
   5. Efficiency shall be determined in accordance with IEEE 112, Test Method B.
   6. All motors shall comply with manufacturer's standard design, construction and testing procedures as defined by applicable IEEE, NEMA, and ANSI standards.

C. The final gear reduction unit (as required) shall have bearings with a B-10 life in excess of 100,000 hours and be AGMA rated for 10,000,000 cycles when operating at the continuous operating torque. The final gear reduction unit shall be of the planetary/spur gear type and be permanently grease lubricated.

D. The drive motor shall be a "Severe Duty" motor for 3-phase, 60 Hertz, 480 volts service, compatible for use with a variable frequency drive, and have a stainless steel shaft.

E. An overload device shall be attached to the primary hydraulic reduction unit and shall be activated by the hydraulic pressure in the primary reduction unit. The device shall have two adjustable pressure switches so that an alarm circuit may be energized when the load on the mechanism approaches overload, and open the motor circuit when an overload occurs. The overload device shall also have a minimum 6-inch-diameter gage that will indicate the output torque of the drive in ft-lbs.

## 2.7 SHOP PAINT

A. All non-submerged steel surfaces shall be commercial blast cleaned (SSPC-SP6). All submerged steel surfaces shall be near white blast cleaned (SSPC-SP10). All surface preparation should be SSPC-SP5 White metal blast.
   1. Seller to provide equipment supplier standard coatings (interior and exterior) for steel tank.
   2. The center drive mechanism assembly shall be factory finish painted with a polyamide epoxy coating system unless constructed from stainless steel.
   3. All machined surfaces subject to corrosion shall be coated with an easily removable rust preventative compound prior to shipment.

## 2.8 LAMELLA TUBE EQUIPMENT

A. Tubes shall incline at 60 degrees from the horizontal.

B. Material shall be high impact polypropylene, polystyrene or polyvinyl chloride tubes with 304SS supports.

## 2.9 EFFLUENT COLLECTION SYSTEM

A. Clarified water shall be collected by means of either rectangular or V-notch weir collection troughs, 304 stainless steel. Each trough shall discharge to a common effluent launder.

B. Collection troughs shall be rectangular shaped and fabricated from 304 stainless steel. The troughs shall be sized by the ballasted sedimentation system Seller. Each trough shall be complete with weir plates sized for the maximum design flow.

## 2.10 MICROSAND PUMPS

A. General:
   1. See Sections 01 61 03 and 43 21 00.
   2. Microsand (recirculation) pumps shall be centrifugal rubber lines slurry pump with V-belt drives. The Ballasted Flocculation Seller shall design and size the microsand pumps to meet the system head requirements of their system configuration. Each pump shall be provided with a motor.
   3. Manufacturer:
      a. Flowserve
      b. McLanahan.
      c. Or approved equal
   4. The pumps shall be designed so that they:
      a. Operate at maximum possible efficiency throughout the duty range.
      b. Cause no overloading of motors under all operating conditions
      c. Are capable of continuous operation.
      d. If centrifugal, shall have a continuously falling head/capacity characteristic curve from no flow to maximum flow conditions to ensure satisfactory parallel operation.
   5. Submit all performance curves of the pumps showing head/flow rate, horsepower, efficiency, and net positive suction head requirements over the full operating range.
   6. A complete arrangement drawing of each pump shall be provided showing overall dimensions and the weight of the combined pump, motor, and base.
   7. The impellers, shafts and all other rotating parts of the pump shall, as a complete unit, be statically balanced to ensure freedom from vibration.
   8. Pumps shall be driven by V-belts and sheaves to obtain the required pump speed. Provision shall be made for adjusting belt tension. A fully enclosed, steel belt guard shall be provided in compliance with OSHA requirements.

B. Pump Arrangement/Construction (Centrifugal)
   1. Casings shall be cast iron radially split type, for easy maintenance, fitted with replaceable abrasion resistant rubber liners pressure molded to the backing plate and secured to the casing externally by heavy-duty studs and nuts. Rubber liners shall extend through casing nozzles to form natural gaskets between flanges and piping. Flanges shall be slotted for easy assembly and disassembly. For pumps 8 inch and larger, the casing shall be equipped with anti-rotation veins for smooth flow into pump.
   2. The impeller is to be balanced and fully enclosed to protect the veins. The impeller shall be abrasion resistant rubber, pressure molded to a ductile iron support skeleton. Impeller to be screwed to the shaft with heavy duty threads running in opposite direction to the shaft rotation for maximum security.
   3. Stuffing box shall be cast iron or SS with replaceable heavy duty protector plate. The shaft shall be enclosed within the stuffing box by coated stainless steel hook-type sleeve.
   4. The pump shall be fitted with a flushless mechanical gland. The mechanical gland shall be suitable for sand slurry service. An external seal water flush is not required but a drip, with suitable drain piping connection, is required.
   5. All bearings to be heavy duty anti-friction type completely enclosed in an oil-lubricated cast iron cartridge assembly.
   6. All pumps and motors shall be provided with necessary lugs, eye bolts, or other suitable attachments for lifting.
   7. The electric motor shall be sized to be non-overloading at all points on the pump performance curve. Motor enclosure shall be TEFC, and suitable for operation in a humid, outdoor environment. Motors shall be for operation on 3-phase, 60 Hertz, 230/460 volt

power. All motors shall comply with manufacturer's standard design, construction, and testing procedures as defined by applicable IEEE, NEMA, and ANSI standards.

a. Motors shall be Inverter duty rated complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.
    1) At a minimum, applied to motors connected to a VFD.
    2) Windings insulated for 1600 peak volts and voltage rise times of 0.1 microseconds.
    3) Nameplate identification of meeting NEMA MG 1 Part 31 requirements.
    4) Have the following minimum turndown ratio without the use of a blower to provide continuous supply of cooling air over the motor.
        a) Variable torque: 10:1.
        b) Constant torque: 6:1.
b. Insulated drive end bearing on all motors.
c. Shaft grounding ring on all motors:
    1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
    2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.

## 2.11 HYDROCYCLONES

A. The hydrocyclones shall be sized by the Ballasted Flocculation system Seller. The underflow of the hydrocyclones shall be gravity fed to the maturation tank for reuse of the cleaned microsand. The overflow of the hydrocyclone will be discharged and flow by gravity to the sanitary drain.

B. Manufacturer:
    1. Krebs
    2. Or approved equal

## 2.12 BLOWDOWN PLUG VALVES (PV-3216, PV-3226, AND MANUAL VALVES AS SHOWN ON DRAWINGS)

A. Manufacturers:
    1. DeZurik.
    2. Henry Pratt.
    3. Millikin.
    4. ValMatic.

B. Materials:
    1. Body: Cast-iron ASTM A126, Class B.
    2. Plug: One or two-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
    3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
    4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
    5. Valve seats: Welded-in overlay of 90% nickel, (minimum 1/8 IN thick).
    6. Stem seal: per AWWA C517, Section 4.4.7.
    7. Actuators per Section 40 05 51 – Valves Basic Requirements part 2.3.E. PV-3216 and PV-3226 only.

## 2.13 SPARE PARTS

1. One set of mixer seals and bearings and one mixer gear box for pre-coagulation/tank
2. One set of mixer seals and bearing and one mixer gear box for coagulation tank
3. One set of mixer seals and bearings and one mixer gear box for maturation tank
4. One pump impeller
5. Two pump drive belts
6. Two pump packing sets
7. Two hydrocyclone apex tips

8. One calibrated Imhoff cone for operators' use
9. One spare PLC module of each type used.
10. One spare Ethernet switch.

## PART 3 - EXECUTION

### 3.1 SERVICES OF SELLER

A. Subsequent to the complete testing and startup of all new process systems included in the Project and the Owner's acceptance of them in accordance with the Contract Documents, should the quality of the effluent (settled water) from the Ballasted Flocculation system cause performance problems for the filters as evidenced by filter runs shorter than 8 hours and/or earlier turbidity breakthrough as compared to the average filtration performance for similar facilities under similar raw water quality conditions, the Ballasted Flocculation Seller shall work with the Owner to investigate and test Ballasted Flocculation operational modifications.
   1. Such modifications may include changes in the types or dosages of coagulants, microsand concentration, recirculation rates, or other changes that can reasonably made to correct the filter performance problems. In such an event, the Ballasted Flocculation system Seller shall provide a technical representative on-site for up to 2 days at no added cost to the Owner.

### 3.2 SYSTEM STARTUP

A. The Seller shall provide field services necessary to start-up and test the system as follows required in Section 01 75 00.

B. Functional Demonstration Testing of the Ballasted Flocculation system shall be contingent upon meeting the requirements of the Ballasted Flocculation system Performance Guarantee listed in Part 1.4.B, as determined by Functional Demonstration testing that shall be conducted over a 3-day (72 hours continuous) period of operation where the raw water turbidity is within the range listed in the Guarantee and the associated chemical feed equipment has previously been fully tested and accepted by the Owner.
   1. For the Functional Demonstration Testing, the Ballasted Flocculation system shall be fully maintained and operated without interruption as described in Section 01 75 00.
   2. In order to create a feed water meeting criteria listed in Part 1.4.B., the Owner will provide the Contractor with soil harvested locally and the Contractor shall make provisions to slurry the soil into suspension creating a feed water suitable for performing the Functional Demonstration Testing.

C. Determination of Ballasted Flocculation system turbidity performance during the Functional Demonstration Testing shall be based on the rolling average of the Plant SCADA records of continuous on-line measurements of the flow rates through the Ballasted Flocculation system and turbidity in the raw water entering a Ballasted Flocculation train and the settled water (effluent) at the outlet of the same Ballasted Flocculation train.
   1. For verification of the accuracy of the on-line turbidity measurements within the Functional Demonstration Testing period, a minimum of eight pairs of grab samples of both raw and settled water from the Ballasted Flocculation train in operation shall be taken and measured for turbidity using a bench-top turbidimeter that has been calibrated to the manufacturer's standards.
   2. If the average difference between the measured turbidity readings of the on-line and the bench-top turbidimeters is not more than 3 percent for all grab samples taken in the testing period, the on-line turbidimeters will be used to determine raw and settled turbidity for determining compliance with the Guarantee requirements.
   3. If the average difference between the on-line and bench-top turbidity measurements is greater than 3% for all grab samples, the measurements averaged over the course of the 3-day period of operation from the calibrated bench-top turbidimeter shall be used to determine Guarantee compliance.

D. If the raw water turbidity exceeds the levels listed in the Performance Guarantee at any time during the Demonstration Testing period, the Seller shall have the right to omit the corresponding settled water turbidity data for that time.
   1. Once the raw water turbidity returns to within the guarantee levels, the performance testing will continue.

E. The Contractor shall operate the Ballasted Flocculation system during the Functional Demonstration Testing period in accordance with the design basis and within the range of operational control and monitoring requirements as detailed by the Seller in the Operations and Maintenance documentation or in subsequent Seller furnished operational modification guidelines and revisions.
   1. The Contractor shall also be responsible for operating the Plant during the Functional Demonstration Testing period, for collecting the turbidity data, influent and effluent data such as flow, turbidity in NTU, for recording chemical use and dosage data, for carrying out all laboratory tests, and for keeping detailed testing records.

F. The Seller, with Contractor approval, shall be granted sufficient time as required during the Performance Guarantee testing period to make equipment modifications and control or monitoring changes as necessary to bring the Ballasted Flocculation system into compliance, followed by appropriate training of Owner's personnel to facilitate its performance. Such time shall be added to the 72-hour testing period.

G. Upon completion of the Functional Demonstration Testing per 01 75 00, the Contractor shall perform the Acceptance Test. See 01 75 00.

**END OF SECTION**

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# SECTION 46 43 83
## GRAVITY FLOW FLOATING DECANTER

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Two Gravity Flow Floating Decanters DEC-4701 and -4702, support structure design and materials, ancillary equipment for an operational system, and spare parts

B. Related Sections include but are not necessarily limited to:
   1. Contract Drawings.
   2. Division 00 - Procurement and Contracting Requirements.
   3. Division 01 - General Requirements.
   4. Section 01 61 03 - Equipment - Basic Requirements.
   5. Section 09 96 00 - High Performance Industrial Coatings.

### 1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

B. Stipulated Price (Lump Sum). If Contract is a Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

### 1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. American Society for Testing and Materials (ASTM):
      a. A48, Standard Specification for Grey Iron Castings.
      b. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

### 1.4 SUBMITTALS

A. Shop Drawings.
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 01 61 03.
   3. Structural supports shall be designed to withstand seismic forces using criteria defined in the structural drawings. Structural calculations for the floating decanter supports shall be stamped and sealed by a professional engineer registered in the State of Oregon.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 65 50.

### 1.6 WARRANTY

A. Provide manufacturers standard one year warranty from the date of Substantial Completion as defined in Division 0.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Floatation Weir System:
      a. Aquaturbo Systems, Inc.
      b. Vulcan Industries.
      c. Or equal.

### 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Decanters:
   1. Number of units: 2
   2. Design decant flow rate per decanter: 1,000 gpm.
   3. Wall pipe connection: 8 IN, flange.

### 2.3 MATERIALS:

A. Overflow Weir: 304L Stainless Steel.

B. Intake Cone: 304L stainless steel.

C. Float: 304L stainless steel.

D. Mooring Hardware: 304 stainless steel

E. Discharge Hose: Flexible reinforced PVC impregnated with carbon black for UV protection.

F. Guide Posts: 304 stainless Steel.

### 2.4 ACCESSORIES

A. Discharge Hose:
   1. Provide discharge hose of length and quantity sufficient to operate without kinking.

B. Guide Posts
   1. Provide four (4) guide posts with U-bolts attached to the floating decanter.
      a. Wall mounted guide posts are acceptable.
   2. Secure guide posts to a concrete pad with a base plate and anchor bolts.
   3. Attach stop clamps to each guide post at the minimum decanter operating level as specified by the manufacturer.

### 2.5 FABRICATION

A. Floatation Weir:
   1. The float(s) shall adequately support the decanter and be filled with closed cell type polyurethane foam having a minimum density of no less than 2 lbs/sf.
   2. Overflow weir shall be cone-shaped, have an anti-vortex device, and be adequately attached to the float(s) with stainless steel hardware.
   3. The overflow weir shall be covered with a removable screen that prevents leaves from entering the weir. The screen shall be adequately framed and supported to prevent sagging when covered with leaves.
   4. The perimeter of the decanter shall have a baffle at the water surface to prevent matter floating in the basins from entering the weir. The floats may serve as a baffle if they completely surround the weir.
   5. Provide lifting eyes on the floatation weir.

B. Support Structure:

1. Shall be wall mounted or stand alone, designed to the loading requirements noted on Structural drawings.
2. Support Structure:
   a. Will be designed to be accessible from the top of structure walkway as shown on the Contract Drawings and from the top of concrete within the basin.

### 2.6 SOURCE QUALITY CONTROL

A. Decanters shall be given manufacturer's standard quality control inspections and tests to ensure the quality of materials used in the manufacture of the units and workmanship conform to the specified requirements and highest industry practice, the units operate properly, and the units have been correctly and adequately prepared for shipment, long term site storage and initial operation.

### 2.7 MAINTENANCE MATERIALS AND SPARE PARTS

A. Supplier to provide all non-typical maintenance materials and tools for operating and maintenance of the units.

B. Supplier to provide spare parts for continuous operation of both units for the first two years of operation.

### 2.8 FINISH PAINTING

A. Pumps shall be factory primed and manufacturer's standard red oxide epoxy primer. Final finish coating shall be applied by the Contractor in accordance with Section 09 96 00.

B. Stainless steel, aluminum, packing glands, flexible connectors, and mechanical mating and bearing surfaces shall not be primed or painted.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Locate decanters as shown on Drawings.

B. Attach decanter and equipment to the guide posts allow free movement with the water level.

C. Attach flexible decanter hose to decant collection catch basin piping with hose couplings as specified by the manufacturer. Support any rigid piping such that it remains stationary as the flexible hose moves up and down with the water level in the lagoons.

### 3.2 FIELD QUALITY CONTROL

A. Provide Manufacturer's Field Services as defined in Section 01 75 00 to provide the following services:
   1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
   2. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to provide written approval of installation.
   3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.
   4. Resolution of assembly or installation problems attributable to or associated with, respective manufacturer's products and systems.
   5. Assistance during Demonstration Period functional and performance testing, and until product acceptance by the OWNER.
   6. Completion of Manufacturer's Certificate of Proper Installation as include in Section 01 75 00 with applicable certificates for proper installation and initial, interim, and final test service.

7. Complete Certificate of Successful Start-up as defined in Section 01 75 00.

**END OF SECTION**

# SECTION 46 61 00
FILTRATION EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Furnishing and installing all of the equipment described in this section. All equipment shall be supplied by a single filter system manufacturer regularly engaged in that business. This section requires the furnishing and installation of four filters as shown on the contract drawings. Each filter is 13'-0" x 25'-0". The equipment to be supplied shall consist of:
      a. Filter underdrain.
      b. Filter media (See Section 46 61 13 and Section 46 31 90).
      c. FRP wash water troughs.
      d. Air header with riser tubes.

B. Equipment Numbers:
   1. Provide filter equipment for four (4) filter systems
      a. FIL-4111
      b. FIL-4121
      c. FIL-4131
      d. FIL-4141

C. Related Sections include but are not necessarily limited to:
   1. Division 00 – Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 – General Requirements.
   3. Section 01 61 03 – Equipment: Basic Requirements.
   4. Section 09 96 00 – High Performance Industrial Coatings.
   5. Section 10 14 00 – Identification Devices.
   6. Section 40 05 00 – Pipe and Pipe Fittings - Basic Requirements.
   7. Section 40 05 23 – Valves: Basic Requirements.
   8. Section 40 61 13 – Process Control Systems General Requirements.
   9. Section 43 11 33 – Rotary Lobe Blowers.
   10. Section 46 61 13 – Filter Media.
   11. Section 46 31 90 – GAC Filter Media.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Welding Society (AWS):
      a. D1.1 Welding in Building Construction
      b. A2.0 Standard Welding Symbols
   2. American Water Works Association (AWWA)
      a. B100 Water Treatment Filtering Material latest edition.
      b. B604 – Granular Activated Carbon.
   3. American National Standards Institute (ANSI)/AWWA
      a. F101 Contact-Molded, Fiberglass-Reinforced Plastic Washwater Troughs and Launders.
      b. F102 Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates Scum Baffles and Mounting Brackets.
   4. American Society for Testing and Materials (ASTM):
      a. A312, Standard specification for Seamless and Welded Stainless Steel Pipe.
      b. F593, Standard specification for Stainless Steel Bolts, Hex Cap Screws & Studs.

c. F594, Standard specification for Stainless Steel Bolts.

5. National Sanitation Foundation (NSF):
   a. Standard 61, Drinking Water System Components – Health Effects.

B. Manufacturer: The filter system shall be supplied by one manufacturer who shall assume total responsibility for the parts operating as a whole.

C. NSF Certification: All materials used in contact with the water and backwash air shall meet NSF Standard 61.

D. Underdrain: The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.

E. The filters will be controlled by the Water Treatment Plant control system per specification 40 61 13.

## 1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 61 03. In addition to the requirements of this section, furnish the following:
      a. Mathematical proof or test data to demonstrate maximum percentage of flow maldistribution within a contactor cell and the maximum percentage of flow maldistribution within a given underdrain lateral.
      b. Certification of compatibility of the underdrain systems with the filter and GAC media specified.
      c. Certification of compatibility of the media retainer and media as specified.
      d. Submit full and complete hydraulic test results and design calculations showing conformity with all flow design requirements to the Engineer for review and acceptance. Include the full range of flow conditions specified, and indicate pertinent physical relationships between the metering orifices, cross-sectional flow areas for water transport to the flow metering elements, relative magnitudes of entrance, transport, metering, and discharge losses; and such other data as may be required by the Engineer. All test setups, procedures, and instrumentation shall be capable of providing data accuracy of plus or minus five (5) percent.
      e. Proper documentation showing NSF-61 certification of all underdrain components.
      f. The manufacturer's proposed method of testing the installed underdrain flow distribution.
      g. All other data, which in the judgment of the Engineer is necessary to demonstrate conformance with all specification requirements.
      h. Plastic block units with integral flow metering elements and specialties required for installation, such as special anchorage, grout retaining strips, grout plates, closures, gaskets, and clips shall be furnished by the underdrain supplier.
      i. Submit a detailed report after installation, containing information on amount and type of desirable material removed, if necessary, and the final thickness of each layer of filter media.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Field Verification Testing
      a. Submit the independent laboratory to perform field verification tests.
      b. Submit all field verification test.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. The following manufacturers and products are acceptable:
   1. Leopold – low profile block underdrain only
   2. Roberts – low profile block underdrain only
   3. Severn Trent – low profile block underdrain only

B. Submit requests for substitution in accordance with Specification Section 01 25 13. In addition to the requirements of this section, the following shall be required:
   1. Experience:
      a. The underdrain system shall be a standard product of a contactor or filter manufacturer who has been actively providing air/water underdrain equipment for at least 10 years. The underdrain supplier shall provide the Engineer with a list of operating installations in the State of Oregon.
      b. Bonds or extended warranties are not acceptable in lieu of experience.
   2. NSF Certification:
      a. All materials used in contact with the water and backwash air shall meet NSF Standard 61 Drinking Water System Components – Health Effects.

### 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Criteria:

| | | |
|---|---|---|
| 1. | Number of Cells: | 4 |
| 2. | Area per Cell, SF: | 325 |
| 3. | Filter Depth, FT: | 5 |
| 4. | Max. Flow Rate, GPM: | 1,625 |
| 5. | Filter flow rate (max) GPM/SF: | 5.0 |
| 6. | Backwash rate, GPM/SF: | 12 – 22 |
| 7. | Air wash rate, CFM/SF: | 4 |
| 8. | Simultaneous air and water CFM/SF and GPM/SF: | 2 – 5 and 5 |

### 2.3 UNDERDRAINS:

A. The underdrain system for the contactors shall be a dual parallel lateral type whereby feeder and compensating chambers are provided within the cross section of a single block.

B. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located to provide uniform distribution of air and water.

C. The primary chamber should provide at least 43 SQ IN of cross sectional area per block to insure optimal flow velocity to achieve maximum efficiency of backwash and air flow distribution.

D. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks.

E. The underdrain shall have a horizontal flat top discharge surface, so that the finished contactor bottom is essentially flat, which direct flow vertically for effective penetration and cleaning of the media.

F. The underdrain must be capable of evenly distributing air throughout the contactor when installed ± ¼ inch out of level.

G. Air Header - Because the proper distribution of air into the underdrain has a significant effect upon operation, the filter manufacturer shall have the responsibility to design and provide the air distribution header for this underdrain.

H. Performance and Design Requirements:
   1. General Requirements
      a. The underdrain system is intended to allow for the uniform collection of water and uniform distribution of backwash water and air over the total area of the filter floor.
      b. The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.
      c. The system shall be designed to avoid localized areas of excessive flow (maldistribution), which may cause mounding, lateral displacement, or other deleterious disturbances in the contactor media.
      d. When subjected to a backwash flow rate of 20 gpm/sf of contactor area the headloss through an underdrain lateral with media retainer shall not exceed 41 inches water column when the water temperature is approximately 60°F.
      e. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through an individual underdrain block shall not be less than 15 inches water column at a backwash flow rate of 20 gpm/sf of contactor area when the water temperature is approximately 60°F.
      f. Design Flow Rates: The filter underdrain system shall be furnished and installed to perform satisfactorily when operated at 25% over the maximum design criteria point specified above.
      g. Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:
         1) Lateral Water MD: The maldistribution in a lateral shall not exceed +/– 3 percent of the average gpm/sf of filter for a backwash rate of 22 gpm/sf.
         2) System Air MD: Visually, the air should show a uniform pattern when operating at flow rates as low as 4 scfm per square foot of filter surface area.
      h. Structural Design Requirements
         1) General: The filter underdrain system, including anchorage supports, etc. shall be designed to safely withstand loadings for at least 25% over the specified conditions.
         2) Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 600 psf or 200 percent of the maximum pressure at maximum backwash. No credit shall be taken for the weight of the contactor media.
         3) Downward Load: During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200° F.
      i. Air Temperature: During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200°F.
   2. Materials and Construction:
      a. Underdrain:
         1) Material: The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces. All orifices shall be properly deburred. Underdrain systems that use clay are not acceptable.
         2) Dimensions: The block size and weight shall permit ease of handling and installation.
         3) HDPE Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. Grout lugs directed upward at approximately a 20° angle. Reinforcing ribs shall not exceed 4" centers.
         4) Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain lateral approximately equivalent to the length

of the contactor cell. The joints shall be gasket, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and watertight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease assembly and installation of the laterals.

b. Media Retainer:
   1) Injection molded thermoplastic.
   2) Media retainer shall be made from two separate sections that are permanently sealed together to form slots or openings.
   3) The media retainer shall replace the need for support gravel.
   4) Max Retainer Height: 1-1/4 IN.
   5) Hardware: Type 316 SS.

c. Air Header (if required):
   1) General: The air distribution system shall be generally comprised of a corrosion resistant header specially calibrated to evenly distribute air flow via properly located riser pipes to each under-drain lateral.
   2) The air header piping shall be type 316 stainless steel. The anchors and hardware for anchoring the air header shall be type 18-8 stainless steel. Air grid systems will not be considered. Provide isolating coupling as required to separate the air header from the low pressure air supply line.

d. Grout Retainer:
   1) Grout Retaining strips for bridging flumes shall be of high-impact polystyrene properly keyed to fit the under-drain blocks to allow adjustment of lateral center-to center distance without difficulty. Retaining strips shall be supplied by the contactor manufacturer. Plates for closing the ends of each row of the blocks shall be furnished by the filler supplier and installed by the contractor.

e. Grout
   1) The grout used in installing the blocks shall have a minimum compressive strength of 2500 psi after 30 days of curing.
   2) Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become "lumpy" shall not be used.
   3) Water: Water for mixing and curing shall be clean and clear and potable water. The water shall be considered potable it meets the requirements of the local government agencies. Water with a total dissolved solids of 1000 mg/l or higher, shall not be used.
   4) Chemical Admixtures: No chemical admixture shall be used.
   5) Strength: Provide quality control testing of the grout in accordance with Specification Section 03 31 30.

f. Anchorage:
   1) The underdrain shall be anchored only over the flume area.
   2) Anchors to be 316 stainless steel epoxy anchors.

## 2.4 BACKWASH COLLECTION SYSTEM

A. Furnish and install fiberglass wash water troughs of length and to locations as shown on plans. Provide hydraulic capacity for each trough of 3575 GPM with the water level inside the trough at least 2 IN below the weir edge.

B. Resin:
   1. The resin shall be a commercial grade, general purpose polyester thermosetting resin, which has either been evaluated in a laminate, or which has been determined by a previous documented service to be acceptable for the service conditions.
   2. Contact the factory for specific chemical resistant applications
      a. The resin shall contain no fillers except as follows:
         1) A thixotropic agent which does not interfere with laminate quality, or with the required chemical resistance of the laminate, may be added for viscosity control.

2) Resin may contain pigments, dyes or colorants which have been determined by at least five years previous service to be acceptable for the service condition without fading or chalking from original color standards.

C. Ultraviolet Resistance: All laminates have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.

D. Metal Reinforcement:
   1. When metal reinforcements are used, they shall be free of rust, oil and any foreign matter.
   2. They shall be completely encapsulated with a minimum of 1/8 inch (3.2 mm) thick laminate.

E. Glass Reinforcement:
   1. Glass reinforcements shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as herei`after described.
   2. Surfacing mat shall be type C, 10-20 mils thick, with a silane finish and a styrenesoluble binder.
   3. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder.
   4. The glass content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Table 1.

F. Manufacture:
   1. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.
   2. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (max. 2 oz. per sq. ft.) in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2 ½ % of laminate volume.
   3. The top edges of the trough shall be level and parallel with a tolerance of plus or minus inch (3.2 mm) (measured when the trough is not loaded).
      a. The length of a trough section shall have a tolerance of ± 1/8 inch (3.2 mm) per 10 feet (3 m) length.
      b. The laminate thickness tolerance shall be plus 1/8 inch (3.2 mm) minus 0.

G. Thickness at locations of supports such as saddles shall be at least 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of the specification.

H. End flanges and blind ends shall be a minimum of 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this specification.

I. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.

J. One inch diameter ABS spreaders shall be bolted between the trough walls on approximate 2 feet (610 mm) centers to enhance the structural rigidity of the trough system.

## 2.5 FILTER INSTRUMENTS

A. Instruments:
   1. Filter headloss sensing strainer and sediment trap, all stainless steel.
      a. Strainer to mount on ¾ IN pipe through filter wall and into filter. Provide sufficient pipe to reach sediment trap.
      b. Sediment trap for wall mounting with ¾ IN bottom drain and ball valve.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. The Contactor Equipment supplier shall verify that the structure is acceptable for the installation of the filtration equipment. If not, the Contactor Equipment supplier shall notify the contractor of any defects for remedy.

### 3.2 DELIVERY AND SITE STORAGE

A. Install equipment as soon as possible after delivery. Protect equipment during storage from weather or damage in accordance with manufacturer's recommendations. Equipment damaged in any fashion during storage shall be repaired or replaced to new condition and meet approval of Owner.

B. Place or store underdrains and specialties only in designated staging areas shown on the drawings and in accordance with manufacturer's recommendations.

C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

D. Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

### 3.3 INSTALLATION

A. See Specification Section 01 61 03.

B. Installation to conform to the requirements of AWWA B100.

C. Clean contactor boxes thoroughly and keep clean throughout installation. Install underdrain in a manner, which will prevent contamination from any source.

D. The engineer and an authorized representative of the Contactor Equipment supplier, prior to installation of media, shall inspect and test the installed underdrain system.

E. Follow standard procedures employing best practices of industry for installation of filter media to insure proper placement of each size and type of media. Insure against damage to filter underdrains, surface wash and backwash mechanisms during installation.

F. Each media layer shall be washed and skimmed in accordance with Section 4.5 of AWWA B100. Final media elevation after all backwashes and skimming shall be in accordance with the Contract Documents.

G. Employ and pay for services of manufacturer's field representative as required to supervise and inspect installation prior to start-up.

### 3.4 FIELD QUALITY CONTROL

A. Provide Manufacturer's Field Services as defined in Specification Section 01 75 00 to provide the following services:
   1. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
   2. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to provide written approval of installation.
   3. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.
   4. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
   5. Assistance during Demonstration Period functional and performance testing, and until product acceptance by the OWNER.

6. Training of OWNER's personnel in the operation and maintenance of respective product as required herein.
    a. See Specification Section 01 75 00 for duration and scheduling of training sessions required.
    b. Training may be specified as either during the Pre-Demonstration Period or Post Demonstration.
7. Completion of Manufacturer's Certificate of Proper Installation as include in Specification Section 01 75 00 with applicable certificates for proper installation and initial, interim, and final test service.
8. Complete Certificate of Successful Start-up as defined in Specification Section 01 75 00.

B. Field Verification testing
    1. Underdrain lateral flow distribution test.
        a. The contactor underdrain system in each contactor cell shall be given a series of visual, qualitative, flow distribution tests to verify that orifices are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the contactor media is placed.
        b. A water flow test in backwash mode will be conducted to observe distribution and structural integrity.
        c. During each test, the underdrain laterals shall be visually inspected for uniform distribution of water and for any signs of quiescent zones and excessive surface turbulence.
        d. The underdrain supplier shall provide both lab and field data showing that the hydraulic maldistribution if plus or minus three (3) percent at the design minimum and maximum backwash flow rates. The underdrain supplier shall submit the required copies of full and complete test reports for all test, describing the units tested; the type of test; test set-ups, procedures, and instrumentation; and test flow rates, pressures, levels, and all other data and results as required to demonstrate that all items tested meet specified requirements.

**END OF SECTION**

# SECTION 46 61 13
FILTER MEDIA

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Requirements for furnishing and installation of silica sand filter media.

B. Silica Sand.Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. 46 61 00 – Filtration Equipment.
   4. 46 31 90 – GAC Filter Media.

C. Completely coordinate with work of other trades.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. B100, Standard for Granular Filter Material.
      b. C653, Disinfection of Water Treatment Plants.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C123, Standard Test Method for Lightweight Particles in Aggregate.
      c. C128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
      d. D409, Standard Test Method for Grindability of Coal by the Hardgrove-Machine Method.
      e. D3174, Standard Test Method for Ash in the Analysis Sample of Coal and Coke from Coal.
      f. D3175, Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke.
      g. E11, Specification for Wire-Cloth Sieves for Testing Purposes.
   3. NSF International (NSF):
      a. 61, Drinking Water System Components – Health Effects.

B. Perform certified material testing of new filter media by an Owner approved independent testing laboratory employed by the Supplier.

C. Certified test results shall cover all physical, gradation, size, and chemical characteristics specified in this Section.
   1. All tests shall be made in accordance with test procedures as described in AWWA B100.

### 1.3 DEFINITIONS

A. Percent size: Size of the theoretical opening of a sieve through which that percentage of the filter media, by weight, will pass. (For example, if the size distribution of the filter media particles is such that 20 PCT of the sample is finer than 0.70 millimeters, the filter media shall be said to have a 20 PCT size of 0.70 millimeters.)
   1. Sieve dimensions: Per ASTM E11 and Table B.1 of the Appendix to AWWA B100.

B. Effective size (ES): 10 PCT size ($d_{10}$), i.e. 10 PCT of the sample is finer than the effective size.

C. Uniformity coefficient (UC): Ratio of media 60 PCT size ($d_{60}$) to media 10 PCT size ($d_{10}$)

D. Flat Particles: Particles in which a circumscribing rectangular prism exceeds five times the shortest axis.

## 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. The Contractor is responsible to provide submittal information for both Sections 46 31 90 and 46 61 13 to the Engineer for review simultaneously.

B. Product Data:
   1. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Manufacturer's installation instructions including media initial washing procedures.
   3. Test reports.

C. Samples:
   1. Media Sample: One-liter dry sample of each media type placed in tightly closed clear plastic jars and labeled appropriately.
   2. Test Laboratory:
      a. Submit name of independent testing laboratory along with statement of experience and qualifications to perform the specified tests.
         1) Engineer must approve independent laboratory.
         2) Engineer's rejection of any testing laboratory proposed by supplier shall not serve as basis for extra costs to Owner.
         3) Laboratory shall not be associated with supplier in any way.
   3. Laboratory Test Results:
      a. Submit analyses from test laboratory:

D. Certificates.
   1. Documentation of NSF 61 certification for all filter media to be supplied.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:
   1. Do not ship media materials until media submittal is approved by the Engineer.
   2. Package and deliver filter media in a manner to exclude all dust, dirt, or deleterious material and to protect particles from physical damage and unsuitable environments.
   3. Package filter media in ultraviolet resistant polyethylene super sacks with bottom pour spout on pallets.
   4. Clearly mark each bag of material with the following information:
      a. Effective size.
      b. Uniformity coefficient.
      c. Source.
      d. Date of bagging.
      e. Lot or stockpile identification.

B. Storage:
   1. Store filter media in a clean area protected from unsuitable environments and accessible at all times.
   2. Take care to maintain filter media and storage area for cleanliness and neat appearance.
      a. Contaminated or dirty media, as judged by the Engineer, will be rejected.
   3. Provide temporary protection of media after installation as required until acceptance.

## 1.6 SEQUENCING AND SCHEDULING

A. Schedule delivery of media so that it is placed in the filters within 30 days of arrival at the jobsite.

## PART 2 - PRODUCTS

### 2.1 SUPPLIERS

A. Subject to compliance with the Contract Documents, the following suppliers are acceptable:
   1. Silica Sand
      a. Northern Filter Media, 2509 Pettibone Avenue, Muscatine, IA 52761, 1-800-962-7190
      b. Red Flint Sand and Gravel LLC, 717 Short Street, Eau Claire, WI 54701, 1-800-238-9139

B. Submit request for substitution in accordance with Section 01 25 13.

### 2.2 MATERIALS

A. General:
   1. Material to conform to AWWA B100 as modified herein.
   2. Screen all material through standard sieves conforming to ASTM E11.

B. Silica Sand Media:
   1. Material Properties:
      a. Conform to AWWA B100 as modified herein.
      b. Composed of hard, durable, uncoated silica grains, containing not more than 1 PCT of flat or elongated particles free of clay, loam, silt, and organic matter.
      c. Maximum acid solubility: 5 PCT in accordance with AWWA B100
      d. Maximum permissible percentage loss on ignition: 2 PCT.
      e. Average apparent specific gravity: >2.65.
   2. Gradation:
      a. Effective size ($d_{10}$) (mm): 0.47 to 0.55.
      b. Uniformity coefficient (UC): < 1.40.
      c. Porosity (max): 0.45.
      d. Sphericity: 0.7 – 0.8.
   3. Filter Sand Layer:
      a. Thickness: 12-inches.
         1) Thickness tolerance: -0 and +1/2 IN tolerance after installation and washing.

C. Compatibility:
   1. Filter media shall be provided as a compatible system. The media provided by the manufacturer will meet the individual requirements identified in this specification as well as the following media system requirements.
      a. Dual media – For dual media filters, the manufacturer shall confirm prior to shipment that the following criteria is met as it relates to Section 46 31 90.
         1) GAC d90 size/Sand ES ratio of 2.8 to 3.2.
         2) L/d ratio > 1,000.

D. GAC Layer:
   1. See Section 46 31 90.

### 2.3 SOURCE QUALITY CONTROL

A. Laboratory Testing:
   1. Test and submit analyses from test laboratory with the following information:
      a. Silica sand:
         1) Gradation, including effective size, uniformity coefficient and shape factor.
         2) Average apparent specific gravity.
         3) Acid and caustic solubility.
         4) Loss on ignition.
   2. Supplier to pay all costs for media testing prior to shipment of the media.

### 2.4 MAINTENANCE MATERIALS

A. Extra Materials:

1. Supply at least 5 PCT of each type of filter media by volume to account for variations in filter box dimensions.
2. Anticipate 5 PCT media loss for each type of filter media due to washing and scraping.
3. All excess media to become property of Owner.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Before placing media, ensure all structural repairs are complete and fully cured.

B. Thoroughly clean filter box prior to placement of filter materials in accordance with AWWA C653, Section 4.1 and AWWA B100.

C. Do not place media until backwashing system is fully installed and tested.

### 3.2 INSTALLATION

A. Install products in accordance with supplier's instructions.

B. General
1. Place filter materials in accordance with AWWA B100 as modified herein.
2. Ensure against damage to filter underdrains and backwash mechanisms during installation.
   a. Repair or replacement of these systems if damaged by Contractor's operations will be at no additional cost to Owner.
3. Maintain clean environment throughout installation.
4. Level lines shall be placed on all sides of the filter basin designating the top elevation of each media layer
5. Install in a manner which prevents contamination from any source.
6. Prevent disturbance of previously installed layers.
7. Do not stand or walk directly on media; utilize boards or plywood to distribute weight without disturbing media.
8. Smooth top of each layer after installation.
9. Filter media depth shall be measured after the completion of backwashing and skimming.

C. Filter Sand Placement:
1. Provide for expansion of filter sand media due to segregation of different particle sizes by placing 10 to 15 PCT less media depth than specified prior to inundation.
2. Place remainder of specified depth after the filter has been thoroughly washed but prior to scraping.
3. Repeat backwashing to bring excess fine material to the surface prior to scraping.
4. After placement, wash filter sand at least 3 times with the Engineer present.
   a. Minimum duration: 10 minutes each.
   b. Initial wash rate not to exceed 2 GPM/SQFT.
   c. Gradually increase over a three minute period to a maximum of 22 GPM/SQFT and maintain for seven minutes.
   d. At the conclusion of each wash cycle, reduce flow rate to that which gives 10 PCT bed expansion and maintain for at least 30 seconds to properly restratify the media.
   e. Repeat until sand is clean and no further discoloration appears.
5. Scrape off and remove fine-grained materials that accumulate at surface of bed at end of each backwash period.
   a. Minimum depth of scraping: 1/2 IN, 1/4 IN, and 1/8 IN for successive washes.
   b. Continue scraping and wasting operations until filter sand remaining in filter contains no more than 10 PCT by weight of sand smaller than the specified effective size ($d_{10}$).
   c. Place sufficient excess material to anticipate this requirement.
6. If necessary, add additional sand to bring the bed up to the required mark
   a. Slowly refill filter, backwash and re-skim fines.

D. Disinfection:

1. After all work is completed, and before the GAC media is placed, disinfect entire filter by chlorination in accordance with AWWA C653 Section 4 as modified herein:
   a. Inject a sufficient amount of chlorine into the backwash water to produce a free chlorine residual of at least 25 MG/L throughout the filter.
   b. Allow the chlorinated water to stand in the filter for a period of at least 12 HRS with the water level no more than 6 IN below the top of the filter box.
   c. Test chlorinated water in filter after 12 HRS for free chlorine.
      1) Take at least two samples.
      2) If residual chlorine level is less than 15 MG/L, repeat steps a, b, and c.
   d. Upon completion of disinfection, waste filter water and thoroughly backwash filter to remove chlorine.
2. Bacteriological Sampling:
   a. After completion of chlorination and prior to placing filters in service, conduct bacteriological testing.
   b. Take at least two samples from each filter not less than 30 minutes apart and test for the presence of total coliform bacteria.
   c. If no coliforms are detected, the filter may be placed in service.
   d. If coliforms are present in any of the samples, proceed with 1 or 2 as follows:
      1) Take samples 24 HRS apart until no coliforms are present.
      2) Rechlorinate filter and conduct bacteriological testing as described above.

## 3.3 FIELD QUALITY CONTROL

A. Supplier's Field Services:
   1. Supplier shall employ and pay for two service days for media supplier representative services.
   2. Supplier's field representative shall:
      a. Inspect and verify proper installation of filter media as specified and per supplier's recommendations.
      b. Supervise installation of media in first filter.
      c. Assist in initial filter start-up.
      d. Assist in field test of filter media.
      e. Submit a certification of proper installation.

B. Field Testing of Media by Owner:
   1. Owner will conduct independent testing of media (prior to installation) in accordance with AWWA B100.
   2. Filter media not meeting the criteria specified herein will be rejected and replaced at no cost to the Owner.

## 3.4 SYSTEMS STARTUP

A. See requirements, Section 01 75 00 - Checkout and Start-Up Procedures.

**END OF SECTION**

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# SECTION 46 61 73
## AUTOMATIC STRAINING EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Automatic self-cleaning filters, valves, system controls and accessories.

B. Equipment Numbers:
   1. STR-1201
   2. STR-1202

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 40 05 23 - Valves: Basic Requirements.
   6. Section 40 61 13 – Process Control Systems General Requirements.

### 1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

B. Stipulated Price (Lump Sum). If Contract is a Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

### 1.3 QUALITY ASSURANCE

A. Reference Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME):
   3. National Electrical Manufacturer's Association (NEMA):

B. Manufacturer's Qualifications: Manufacturer shall have a minimum of five (5) years experience in the production of substantially similar equipment.

### 1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Manufacturer's descriptive literature, illustrations, specifications, identification of materials of construction and engineering data.
   4. Submit complete detailed Shop Drawings including physical layout of the strainer, drive unit and control equipment, piping diagrams and field wiring diagrams, control diagrams and a complete description of the control system, manufacturer's installation instructions, and equipment operating characteristics.
   5. All items required by Section 01 61 03.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Specification Section 01 65 50.

### 1.6 MAINTENACE

A. General: Furnish the following spare parts plainly tagged, marked for identification and for reordering and properly boxed:

| Qty | Description |
|---|---|
| 2 | Actuator assemblies |
| 6 | Dynamic seals |
| 6 | Diaphragms |
| 6 | Hydraulic seals |
| 4 | Discs sets |
| 2 | Pressure differential gauges |
| 2 | Solenoids |

### 1.7 WARRANTY

A. Provide manufacturers standard one year warranty from the date of Substantial Completion as defined in Division 00.

### 1.8 SYSTEM DESCRIPTION

A. Automatic backwash strainers specified herein shall be used to strain surface water prior to treatment as shown on the Drawings.

B. Two strainer systems shall be supplied. A single local control panel shall be provided to control both systems.

C. Strainer backwash initiation and control shall be by the strainers local control panel. Backwashing shall be initiated after a pre-set time has elapsed or the differential pressure across the strainers exceeds a pre-set value.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Amiad Water Systems, Arkal 4" Spin-Klin filter system, 2x 12 unit batteries.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

### 2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Self-cleaning strainers shall be designed for the following conditions of service:

| | | |
|---|---|---|
| 1. | Equipment Tag No(s): | STR-1201, STR-1202 |
| 2. | Number of filter systems: | 2 |
| 3. | Quantity of filters pods: | 24 (12 per filter system) |
| 4. | Strainer filter mesh opening: | 200 MICRON |
| 5. | Inlet/Outlet Flange Size: | 12 IN |
| 6. | Design flow: | 7.6 MGD (3.6 MGD per filter system) |
| 7. | System source water: | Raw surface water |

8. Water quality information:
   a. Turbidity 0 to 209 NTU
9. System upstream operating pressure: 70 PSIG
10. Design pressure: 145 PSIG
11. Feed water temperature: 34 to 90 DEGF.
12. Power supply: 480 VAC, 3 PH, 60 Hz.

B. Performance requirements:
   1. Filter systems shall provide continuous, uninterrupted flow during the backwashing operation.
   2. Each filter unit shall have a clean-screen pressure drop of no greater than 2.0 PSI at maximum flow specified herein.
   3. Filter systems shall be capable of operation and backwashing without the need for wash water booster pumping with minimum system pressure of 40 PSIG.

## 2.3 FABRICATION

A. Filter
   1. The filter units shall be an automatic, self-cleaning type. The body and covers of the filter shall be reinforced polypropylene. The body shall have roll groove 4" diameter connections for the inlet and outlet. The covers shall be secured with stainless steel clamp to facilitate access to the disc media. The maximum operating pressure of the filter body shall be 145 PSI and the maximum operating temperature shall be 140°F.
   2. Each filter unit shall accommodate five disc/spine assemblies.
   3. The filter media shall be disc type. Discs shall be constructed of polypropylene or polyamide. Each disc shall have micro-grooves on each side. These micro-grooves shall oppose the micro grooves on adjacent discs which shall create a series of intersections to trap suspended particulate. The discs shall be contained on a spine assembly utilizing a stainless steel spring to compress the discs during filtration. Each disc spine assembly shall incorporate tangential nozzles to enhance cleaning during the backwash cycle. To ensure complete cleaning of the filter disc elements, overall height of the disc media shall not exceed 9.25 inches.
   4. Filter elements with filtration degrees ranging from 400-microns to 20-microns shall be interchangeable in the same filter body.
   5. Backwash (flush) source water shall be taken from the filtered water outlet manifold.
   6. The backwash volume shall not exceed 85 gallons per backwash cycle per unit.
   7. The cleaning cycle shall last for no more than 30 seconds per unit.
   8. Minimum operating pressure during the cleaning cycle shall be 40 PSI.
   9. The complete filter battery shall have a clean-filter pressure drop of no greater than 2 PSI at the design flow rate.
   10. Each system battery shall include 12 units.
   11. Filter disc units shall be assembled in side-by-side configuration with six filter units in on each side (6+6), on a common inlet and outlet manifolds, and one drain manifold per row of filter units. Piping shall be fabricated from injection molded polypropylene. The inlet and outlet manifold flange connections shall be 12 inches in diameter. The drain manifold flange connection shall be 6 inches in diameter.
   12. Control valves shall be pneumatically actuated diaphragm type with corrosion resistant polymeric body and reinforced elastomeric diaphragm.
   13. Filter disc units shall have manual isolation butterfly valves, 3 valves per unit.
   14. The filtration system shall be mounted on an epoxy coated carbon steel skid.

B. Controls
   1. See Specification 40 61 96.

C. Pressure Differential Switch
   1. The differential pressure switch shall be factory set at 7 psi and housed in a NEMA 4 enclosure and shall be factory wired into the filter control panel. The differential pressure

switch shall be the fully automatic diaphragm type. Reinforced polyester body, stainless steel cover with neoprene gasket. Rated for ambient temperatures of 30-160°F and pressures up to 150 PSI. ¼" NPT connection.

D. Flush Control Valves
   2. Backwashing shall be accomplished by utilizing the pressure differential between the source of pressurized water and atmospheric pressure using flush control valves. The 3-way flush control valve shall be a solenoid activated Bermad 350 Series which is double chambered, hydraulically operated and diaphragm actuated. The valve body is polyamide with a Nylon reinforced natural rubber diaphragm, 304 stainless steel seal and washers, NBR seal and stainless steel spring, shaft and external bolts. The valve is rated for 10-145 PSI and up to 150°F.

## 2.4 CONTROLS AND INSTRUMENTATION

A. Controls
   1. A remote control panel shall be provided by the membrane system supplier. Local junction boxes shall be provided on each filter system. The Contractor will be responsible for wiring between the control panel and the two junction boxes.
   2. The filter control panel shall be complete factory wired. It shall contain all required control and power elements to provide automatic self-cleaning system operations as described herein. The filter control panel shall include IEC components including a main power disconnect switch, contactor, overloads, transformer, relays, indicating lights, brackets and accessories, wiring harnesses, terminal strips, wiring and an enclosure handle and hinged front door.
   3. The control system shall be PLC based.
   4. Panel face buttons:
      a. Flush Pushbutton – green pushbutton is used to initiate a system self-cleaning or flush cycle, providing the operator with a local means of self-cleaning/flushing the system
      b. Fault Reset pushbutton and light - red pushbutton and LED light is used to indicate when a fault has occurred and the pushbutton function is used to clear a fault condition when the issue has been corrected and the system is ready to resume normal operation.
   5. HMI - Filter status, fault notifications, self-cleaning (flush) counters, timers, and the filter configuration will be displayed and controlled using the HMI.
   6. The control system shall provide intermittent operation of the self-cleaning (flush or backwash) cycle. The controller shall open the exhaust valve and start the motor or pump (when applicable) and initiate a self-cleaning cycle for the required cleaning interval. After the cleaning interval is completed, the controller shall stop the motor or pump (when applicable), close the exhaust valve and reset the cleaning cycle for the next operation.
   7. Timers (integrated into the PLC and accessed via the HMI)
      a. Flush Interval Timer – defines the minimum time between self-cleaning cycles if initiated by timer only
      b. Flush Duration Timer – defines the duration of a self-cleaning cycle
      c. Valve Delay Timer – defines the length of time to allow motor driven valves to move position before moving to the next step of the self-cleaning sequence
      d. Dwell Time Timer – defines the length of dwell time before the next filter in multiple filter application starts a self-cleaning cycle
      e. Differential Pressure Fault Timer – defines the length of time DP can be above the initiation set-point ("high") before a fault is generated
      f. Master Delay Timer – defines the length of time allowed to open or close any upstream or downstream valves
   8. A differential pressure switch shall be factory connected to the filter inlet and outlet piping to initiate the cleaning cycle whenever a differential pressure across the filter exceeds a preset value. If the differential pressure does not return to normal before the Differential

Pressure Fault Timer elapses, then the control panel shall shut down operation and the Major Alarm Fault will be activated. A reset will be required to clear the fault.

9. The control panel enclosure shall be a 316 stainless steel NEMA 4X enclosure with interior back plate. The control panel shall be designed for wall mounting and shall only require conduit connections and lug wiring connections to the terminal strips in the field.
10. Control panel shall be UL 508A certified.
11. The following external interfaces are included as a part of the control system for monitoring and control.
    a. Flush in Progress – relay contact closure output
    b. System fault alarm (Major Alarm) – relay contact closure output
    c. Remote Flush Start - dry contact input
    d. Remote Flush Stop - dry contact input
    e. System On/Off – dry contact input
    f. Flush Lockout – dry contact input

### 2.5 ACCESSORIES

A. Equipment Anchor Bolts: Contractor shall provide anchor bolts as specified in Specification Section 01 61 03. Anchor bolts shall be sized by the strainer manufacturer.

B. Equipment Identification Plates: Contractor shall provide identification plate(s) securely mounted on each separate equipment component in a readily visible location as specified in Specification Section 10 14 00.

### 2.6 SOURCE QUALITY CONTROL

A. Each strainer shall be hydrostatically tested at the manufacturer's factory. Testing shall be performed at one one-half times the maximum system operating pressure.

B. Units shall also undergo manufacturer's standard quality assurance/quality control testing to demonstrate compliance with these specifications.

### 2.7 MAINTENACE MATERIALS

A. Furnish all special tools required for normal maintenance.

B. Furnish one set of all manufacturer recommended spare parts for each strainer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

### 3.2 FIELD QUALITY CONTROL

A. See Sections 01 61 03and 43 21 00.

B. The service of a manufacturer's field service representative shall be provided at the site to furnish installation oversight, inspection, start-up, and adjustment services to the Contractor as required in Section 01 75 00.

C. The service of a manufacturer's field service representative shall be provided at the site to furnish operations and maintenance training as required in Section 01 75 00.

## END OF SECTION

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# DIVISION 48

## ELECTRICAL POWER GENERATION

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# SECTION 48 14 10
## PV MODULE SUPPORT STRUCTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Design, fabrication, and installation of photovoltaic (PV) module support structures including PV Solar Fixed Tilt Racks (PV Racks).

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 05 50 00 – Metal Fabrications.

### 1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. 325, Manual of Steel Construction.
      b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      c. A500, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      d. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      e. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      f. A992, Standard Specification for Steel for Structural Shapes.
      g. F436, Standard Specification for Hardened Steel Washers.
      h. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
   3. American Welding Society (AWS):
      a. D1.1 Structural Welding Code Steel.
   4. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads for Buildings and Other Structures.
   5. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards in accordance with the local Building Official requirements, Edition including all amendments, referred to herein as Building Code.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. Underwriters Laboratories (UL):
      a. 2703, Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels.
      b. 3703, Standard for Solar Trackers.

B. Qualifications:
   1. PV Rack Manufacturer:
      a. Responsible for design, engineering, fabrication, and supply of work specified herein.
      b. Have been in 5-year continuous operation as a PV Rack manufacturer of projects with similar size and scope.

1) Provide references of a minimum of three previous projects within the past 5 years with similar applications and that have comparable MW output.

c. Engineer for the PV Rack structural design: Professional Engineer licensed in the state where the project is located.

## 1.3 SUBMITTALS

A. Product Data:
1. Manufacturer product data, including specifications and installation instructions for each component of the PV rack or the PV tracker.
2. Include laboratory test reports and other data, where applicable.

B. Structural Calculations: Signed and sealed by engineer currently licensed to practice in State where project is located and specializing in PV rack design and engineering. Structural calculations shall include:
1. Structural analysis of structural system under applicable wind, seismic and snow loads. This analysis shall consider the complete load path down to the foundation.
2. Wind tunnel test report(s) that is applicable to the project. Wind Tunnel testing shall show the dynamic wind effects in addition to the static wind effects. Engineer shall verify whether dynamic loads will occur and if the structure is stable during low as well as high wind events
3. Connection design including bolt, weld and ancillary member sizing and PV module attachment to the rack proper.
4. Steel pile design and the Geotechnical Report that the design is referencing.
5. Corrosion engineering report that the steel pile design is based on.

C. Arrangement Drawings:
1. Dimensioned and detailed drawings signed and sealed by licensed engineer registered to practice in the State that the project is located in:
a. Complete PV Rack structure, including plan view, elevations, details, and sections,
b. Precise interface geometry determination at the top of pile connection,
c. Reaction loads (for pile foundation design),
d. Connection details of the structural steel on the support structure proper,
2. Full and comprehensive installation procedure guide for field installation.

D. PV Rack:
1. Tilt angle of modules.
2. 3-second gust at 10m elevation design wind speeds. Include all wind speeds and corresponding tilt angles that the rack is designed to accommodate.

E. Connection details of module clamps showing how the clamps attach the modules to the support structure below.

F. Pile Tests:
1. Pile Pull Test Testing Protocol for pile tests performed during the design of the rack structure:
a. Test loads,
b. Number of tests performed so that the allowable skin friction values (tension and compression) can have a factor of safety, FS, of 1.5,
c. Location on site plan where each test is to be performed,
d. Planned pile set time – time between when the piles are installed to when they are tested,
e. Type of test at each site location (i.e., tension, compression, lateral).
2. Production Pile Testing Protocol for pile tests performed during installation of production piles (Intent is to verify pile strengths on site and not fail a pile as in the Pile Pull Test):
a. Test loads,
b. Number of tests performed,
c. Criteria for choosing a pile for testing,

d. Location on site plan where each test is to be performed,
e. Failure criteria,
f. Mitigation plan if a pile fails the test.

G. Pile Installation Mitigation Plan:
1. Mitigation Protocol for any pile that is not installed properly. Include:
a. Installation tolerances for rotation, twist, plumbness, embedment, projection.
b. Criteria for categorizing a pile as being installed improperly.
c. Mitigation plan for a pile that is not considered to be installed properly.

H. Certifications:
1. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
2. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
3. Welder qualification data and prequalified procedures.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members and all equipment that are to attach to the rack (i.e., interconnecting cables, wires, and PV modules) above ground on supports.
1. Keep free of dirt and other foreign material and protect against corrosion.

### 1.5 WARRANTY

A. Warrant all workmanship against defects for a period of 10 years, from date of substantial completion. All such manufacturer's warranties shall be assignable to the buyer.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. PV Racks:
1. RBI Solar Mounting Systems,
2. GameChange Solar,
3. Solar FlexRack,
4. Unirac,
5. Or Approved Equal.

B. Submit request for other manufacturers for approval.

### 2.2 MATERIALS

A. All materials shall be new, free of defects, and shall be in accordance with Section 05 50 00 Metal Fabrications.

B. All structural steel that makes up the PV Racks (i.e., the beams, girts, struts, x-bracing, gusset plates, and any component that is part of the gravity or the lateral force resisting system) shall be in accordance with an ASTM specification as listed in Part 1.2.2. Foreign steel specifications shall not be used unless the steel is dual certified to an approved ASTM specification.

C. All PV Rack hardware and accessories shall have proper corrosion resistant treatment, hot dip galvanizing or anodizing to withstand the project service lifetime and take into consideration the local climate conditions and installed conditions of the Project site.
1. Above grade structural steel in the PV Rack shall be either hot dipped galvanized or shall be galvanized in accordance with ASTM A653 specification with a minimum G140 coating. Coating thickness shall take into account local atmospheric corrosion risks and shall last for the life of the facility without any surface corrosion from occurring.
2. Steel piles shall be hot dipped galvanized in accordance with ASTM A123 and have a minimum of 3.3 mils of galvanizing. Galvanizing thickness may be increased up to the maximum shown in ASTM A123 to account for site specific soil corrosion potential. If piles

require more galvanizing to accommodate the corrosion potential of the soil, then the pile thickness shall be increased to accommodate higher corrosion rates.

3. Site touch-ups of the corrosion protection shall be done consistent with Good Utility Practices, ASTM A780 (for galvanized materials), and manufacturer's recommendation.
4. Factory end cut surfaces that come from the manufacturer in a healed state shall not be touched up onsite, unless deemed necessary by racking vendor or Independent Engineer structural review.
5. All field drilled holes, site modifications, field welds, shipping damage, etc. shall be touched up onsite.

## 2.3 DESIGN REQUIREMENTS

A. PV Rack Structural Design:

1. All structural steel that makes up the PV Racks (i.e., the beams, girts, struts, x-bracing, gusset plates, and any component that is part of the gravity or the lateral force resisting system) shall be checked against all applicable reactions generated by loads described in the Building Code and within solar industry standard practice. This includes, but is not limited to, dead, live, wind, seismic, and snow.
2. All loads and load combinations shall be as described in the Building Code.
   a. Design life of structures shall equal the facility design life.
   b. Risk Category: I.
   c. Ground snow Load: As specified in ASCE 7, 37 PSF minimum.
   d. Seismic ground accelerations: As specified in ASCE 7, S1 = 0.339, Ss = 0.597.
   e. Wind Speed 3-sec gust at 10 m elevation: 106 MPH minimum, Exposure C.
3. The racking design shall incorporate wind tunnel test data that is specific to the racking system and as specified in ASCE 7 in accordance with the below provisions.
   a. Wind pressures and shape factors shall be applied to PV Rack and pile foundation design as specified in the Building Code.
   b. Wind load shall apply to all system components and exposed equipment, including the racking system with all PV modules installed.
   c. Allowances shall not be made for the effect of shielding by any other structures, upstream racks, or fencing unless wind tunnel studies have been performed and have these structures and components taken into account.
   d. The racking design shall take into account both static and dynamic wind pressures.
   e. For PV racks, the fundamental natural frequency of the racking system shall be at least 5 Hz or greater. If a wind tunnel analysis is not developed for this racking system, then a minimum gust effect factor of 1.0 shall be used in the static wind design and dynamic wind effects due to vortex shedding shall be determined using rational methods.
   f. A wind tunnel analysis shall be performed on all PV Racks with a natural frequency of 5 Hz or less. The wind tunnel analysis shall account for the flexibility of the structural system (i.e., do not assume the structure is rigid). Structural analysis shall then be performed showing that the rack can support these dynamically amplified loads that result from the wind tunnel analysis.
   g. All wind speeds shall be checked for dynamic wind effects on the structural system which includes wind speeds starting at 10 mph up to the design extreme wind speed.
4. Snow loads shall take snow drifting into account across the modules by incorporating the tilt angle into the snow design, as well as the effects of snow drifting from the ground at the lower edge of the modules.

B. PV Rack Pile Design:

1. Pile design and selection shall take into consideration all geotechnical conditions at the site including but not limited to clay, rock, swamp areas, water table depth, and corrosion.
2. Pile design shall take into account interaction stresses due to both axial compression and bending above grade in accordance with AISC.

3. Pile design shall also take into account the increased bending stresses below grade and shall incorporate a rational method for determining this below grade, nonlinear soil-structure interaction between the steel pile and the soil.
4. Below grade corrosion rates of the steel piles and galvanizing shall be established by a Corrosion Engineer and shall include a factor of safety, FS, of 1.5. Geotechnical Engineer shall be directed by the Corrosion Engineer to perform enough tests in the field so that this factor of safety can be safety used throughout the project site.
5. Steel Piles shall be designed to account for the site-specific soil corrosion potential so that they will be able to resist the required extreme loads for the life of the facility even when they have reached the maximum expected corrosion. To accommodate the design level of corrosion on the piles either increase the minimum galvanizing thickness up to the maximum allowed by ASTM A123, increase the steel thickness, or a combination of both.
6. Pile design shall be based on site specific Geotechnical conditions such as resistance factors, moisture, corrosivity, and frost depth and shall account for adfreeze stress, allowable deflection at ground surface, compression, tension, and lateral forces.
7. Pile design allowable strengths shall be based on a pile load test program. The results of this program shall be used by the project Geotechnical Engineer to provide pile design recommendations including skin friction (tension and compression) with a factor of safety, FS, of 1.5 and LPile design parameters for lateral analysis.
8. Piles shall be designed to resist frost jacking forces and the associated frost adfreeze stress as provided by the Geotechnical Engineer. Pile structural calculations shall show how the pile resisting capacity exceeds the expected frost jacking forces and what embedment is required for equilibrium to occur in the piles.

C. Concrete Foundation Design:
1. All concrete footings supporting equipment or PV racking systems shall bear on soil that is below the frost level and shall be reinforced in accordance with ACI.
2. All slab on grade foundations that support equipment shall have a thickened edge around its entire perimeter and shall have compacted, engineer fill underneath down to at least the frost elevation. Engineered fill shall be in accordance with the Geotechnical Engineer's requirements.

D. Structural Design Calculations:
1. Refer to Article 1.3 for Submittal requirements for design calculations and drawings.

E. Electrical Design:
1. All PV Racks shall be UL-Listed and NRTL approved.
2. All PV Racks shall be manufactured and installed in accordance with UL 2703 and UL 3703.

# PART 3 - EXECUTION

## 3.1 FIELD QUALITY CONTROL

A. Inspection: All structural steel framing shall be inspected by the Contractor or by a qualified testing agency (TA) hired by the Contractor. TA shall have a minimum of 5 years performing similar work.
1. All such field testing and inspections shall be performed by TA or Contractor.
2. Field testing shall include verification of bolt tension per AISC and pile strengths per Pile Production Tests.
3. All field welds shall be inspected per AWS D1.1.

B. Pile installation records shall be kept and provided to the Buyer upon request. Installation records shall include:
1. The type and make of hammer and its stroke or rated energy (where driven piles are used);
2. The pile location, size, and length;
3. The pile driving sequence;

4. The final embedment depth and the tip and head elevations;
5. Inspection of verticality; and
6. Any difficulties or unusual conditions encountered during driving.

## 3.2 ERECTION

A. Comply with manufacturer instructions, approved shop drawings and applicable Building Code requirements.

B. Properly install all connections as per the PV Rack manufacturer's recommendations.

C. Contractor to provide all materials and equipment required for the erection and installation of the PV Rack and all PV modules and interconnecting wiring.

D. Contractor shall provide provisions during erection and installation of PV Racks for sudden wind events so that the PV Rack structures and the modules are not damaged.
   1. Contractor shall coordinate with the manufacturer on how to secure unfinished PV Racks if a wind event is about to occur and before the structure is completely built. This includes:
      a. How to properly secure modules to the structure when only some of the modules have been installed.
      b. How to properly store modules before they are adequately attached to the rack or during a wind event.

**END OF SECTION**

# SECTION 48 17 00
## BATTERY ENERGY ELECTRICAL POWER GENERATION EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section specifies the requirements for a fully functioning Battery Energy Storage System (BESS) including Power Conversion System, Energy Storage Management System, internal wiring, Battery Management System, and balance of plant equipment.

B. Consistent with the Contractor's design, the BESS shall be factory built and preassembled to the greatest extent possible.

C. BESS shall be located in pre-assembled non-combustible conditioned outdoor enclosures suitable for the installation location. NEMA 3R enclosures are acceptable.

### 1.2 QUALITY ASSURANCE AND SAFETY

A. Reference Standards
   1. Institute of Electrical and Electronics Engineers (IEEE)
      a. 519 Recommended Practice and Requirements for Harmonic Control in Electronic Power Systems
      b. 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems
   2. National Fire Protection Association (NFPA)
      a. 70 National Electrical Code (NEC)
      b. 855 Standard for the Installation of Stationary Energy Storage Systems (Latest Proposed)
   3. Underwriter Laboratory Laboratories (UL)
      a. 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
      b. 1973 Standard for Batteries for Use in Stationary Vehicle and Light Electric Rail Applications
      c. 9540 Standard for Energy Storage Systems and Equipment
      d. 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
      e. 61010-2-030 Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 2-030: Particular Requirements for Equipment Having Testing or Measuring Circuits
   4. Where no edition is identified, the design shall comply with the current edition.

B. BESS Equipment Supplier Qualifications
   1. BESS equipment supplier shall be ISO 9000 certified.

C. Safety
   1. The BESS and all scope of supply shall comply with the applicable federal OSHA regulations defined in 29 CFR 1910 and all relevant Michigan Occupational Safety and Health Administration, as well as local Authority Having Jurisdiction (AHJ) regulations.
   2. Prior to the shipment of the BESS, the BESS equipment supplier shall ensure that all safety measures and protective devices function as intended.

### 1.3 DEFINITIONS

A. Abbreviations and Acronyms
   1. BESS = Battery Energy Storage Systems
   2. BMS = Battery Management System
   3. BOL = Beginning of Life

4. DOD = Depth of Discharge
5. EMS = Energy Management System
6. RTU = Remote Terminal Unit
7. SCADA = Supervisory Control and Data Acquisition
8. SOC = State of Charge
9. UPS = Uninterruptable Power Supply

## 1.4 SUBMITTALS

A. Contractor shall provide submittals in accordance with Section 01 33 00 – Submittals and Section 01 33 04 – Operation and Maintenance Manuals

B. Product Data:
   1. Manufacturer product data, including specifications and installation instructions for each separately installed component or enclosure.

C. Include factory test reports and other data, where applicable.

D. Refer to Section 40 63 44 - POWER GENERATION SYSTEM SCADA CONTROL SYSTEMS for additional submittal requirements for the control system.

E. Certifications:
   1. Certificates of compliance with standards specified for all major components incorporated into work.
   2. The BESS shall be listed to UL9540. A UL9540A test report shall be provided in addition to UL9540 certification documents.

F. A PSSE model for the BESS, Power Conversion System, and BESS Control System.

G. For systems larger than 600kWh of stored energy or installed without the separations required by NFPA 855, the Contractor shall provide a hazard mitigation analysis to evaluate the potential energy storage system failure modes and the safety-related consequences attributed to the failures, in accordance with NFPA 855.

H. For systems larger than 600kWh of stored energy or installed without the separations required by NFPA 855, the Contractor shall provide a Pre-Incident Plan for the BESS before operations commence. The Pre-Incident Plan shall ensure that facility operations personnel, maintenance personnel, and emergency responders can address foreseeable hazards associated with the on-site systems.

I. The Contractor shall provide a commissioning plan in accordance with NFPA 855 requirements.

J. The BESS equipment supplier shall provide and Operation and Maintenance Manual in accordance with NFPA 855 requirements.

K. The BESS equipment supplier shall provide a decommissioning and recycling plan for expended battery cells. The decommissioning plan shall address remediation in the case of a fire or other event.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. The BESS shall be capable of withstanding normal shipping and handling shocks and vibration when shipped. Equipment and materials shall be prepared for shipment and shall be crated in a manner to provide maximum protection during shipment.

B. Refer to Section 01 65 50 – PRODUCT DELIVERY, STORAGE, AND HANDLING for general requirements.

C. When space heaters or other environmental conditioning equipment are provided, connect and operate during storage as recommended by the manufacturer.

## 1.6 APPLICATION DATA

A. General

1. The BESS shall be designed for a multi-use case scenario and Owner requires Contractor to present the following as a part of their offer:

| | |
|---|---|
| Nameplate Rating | 100 kW / 100kVA, minimum125 kW / 125kVA, maximum<br>400 kWH, minimum<br>550 kWh maximum<br>System should maintain requested energy capacity over the expected minimum 20-year lifetime |
| Duty Cycle | 1 time/day, 7 days/week |
| AC Round Trip Efficiency (100% DoD cycle) | >86% excluding auxiliary consumption |
| Availability | 95% annual availability |
| Voltage Operating Range | 480 V +/- 10% |
| Frequency Operating Range | 57.0 - 61.8 Hz |
| Seismic | See Section 01 81 10 - WIND AND SEISMIC DESIGN CRITERIA |

2. AC round trip efficiency of the BESS is defined as the ratio of the delivered discharge energy to the delivered charge energy at the BESS terminals, during a full cycle of charging and discharging the nameplate energy at nameplate power.
3. Availability is defined as the percentage of time that the entire BESS is available for operational service (charging, discharging, or in storage mode) and not removed from service for maintenance or due to failure. Availability calculations may credit periods of partial availability based upon the percentage of nameplate power or energy (whichever is more limited).

B. Use Case
1. The BESS shall have an EMS control system in place with the ability to:
   a. Monitor, respond to, and execute real and reactive power commands that originate in the Owner's control system.
   b. Monitor, respond to, and execute connection and disconnection signals that originate in the Owner's control system.
   c. Monitor, respond to, and execute operating mode commands that originate in the Owner's control system.
   d. Perform real and reactive power setpoint control to adjust total generation based upon real-time renewable generation and real-time facility metering values reported by the Owner's control system to avoid curtailment of Owner's systems. Limit total facility generation to the PV system nameplate capacity.
   e. Perform voltage control and reactive power control when placed in applicable operating modes.
2. The BESS shall be capable of nominally 365 annual equivalent full charge and discharge cycles but with no daily cycling restrictions and with the ability to meet varying annual cycling requirements over the resource life as a function of changes in storage use case.
3. The BESS shall be a capable of complete range of operation, including both full load and idle operation over an ambient temperature range of -20C to 45C with the full range of relative humidity.
4. Be dispatchable across the entire operating range of voltage and frequency.
5. Have a system latency of 1 second or less and a ramp rate (in both charging and discharging) of full capacity within 1 second.

C. When required by Owner, the BESS shall be capable of operating beyond the scenarios defined above only limited by the BESS component ratings themselves.

## 1.7 GENERAL REQUIREMENTS

A. The BESS shall be a completely integrated package inclusive of batteries, control systems, power conversion equipment, protection equipment, and auxiliary equipment. The assembled system shall be listed to UL 9540.

B. The BESS shall be designed for outdoor installation in BESS Equipment Supplier furnished enclosure(s). Enclosures shall be non-walk-in.

C. The BESS shall be a mature technology with more than two years of product availability to market.

D. The BESS Project shall have a minimum 20-year lifespan given the stated duty cycle herein. If this requirement cannot be satisfied, Contractor shall identify the achievable lifespan for the technology offered to be approved by Owner.

E. The BESS shall be maintainable by the Owner with an optional long term service agreement provided by the manufacturer or Contractor. Contractor shall include firm pricing for a maintenance service agreement to maintain the system for the duration of the term quoted.

F. The BESS shall consist of multiple battery cells in series and parallel to store from and discharge to the plant.

G. The BESS equipment supplier shall provide a decommissioning and recycling plan for expended battery cells.

H. The BESS shall be designed for component isolation, testing, diagnostic monitoring, and removal with minimal impact on the BESS system availability.

I. The BESS shall have disconnect switches to locally and manually isolate the battery from the PCS (DC switch) and locally and manually isolate the PCS from the output circuit (AC switch). These disconnect switches shall be lockable in the open position.

J. The BESS shall have overcurrent protection to provide equipment and conductor protection from all sources. DC overcurrent protection shall be current limiting.

K. Battery circuits shall have provisions to disconnect the series-connected strings into segments not exceeding 240 volts nominal.

L. Battery Enclosure
   1. The BESS shall be installed in pre-assembled non-combustible BESS enclosures specifically designed for installation outdoors. The enclosures shall be suitable for the environment in which they will be located.
   2. The BESS enclosure shall be lockable and suitable for installation in an area accessible to unqualified workers.
   3. The BESS fire protection shall include a fire detection and notification system and a fire suppression system that does not require interconnection to an external water supply. The notification system shall provide visible annunciation on the enclosure exterior.
   4. The BESS enclosures shall be provided with deflagration venting per NFPA 68 or an explosion prevention system per NFPA 69. Where active response systems are included, back-up power shall be provided for a minimum operational period of two hours.
   5. The BESS enclosures shall be supplied with an HVAC system of adequate size for heating, cooling, or ventilating the BESS and maintaining the BESS within safe operating temperatures, and within the operating parameters of the battery modules.
   6. General electrical requirements beyond those described herein shall be in accordance with Section 26 – Electrical.
   7. BESS auxiliary loads shall be supplied from an auxiliary power system derived from the charge/discharge path.
   8. As applicable, the BMS shall provide for thermal derating of the BESS to ensure battery life is not adversely affected by ambient temperature inside the individual battery enclosures.
   9. Backup power shall be provided in the case of a power outage. The backup power supply shall maintain fire protection system functions, communications, and data historian functions for a minimum of 4 hours.
   10. The BESS enclosures and equipment shall be factory labeled in accordance with NFPA 70 - 2023, NFPA 70E, NFPA 855, and certification standards.

11. The BESS enclosures and equipment labeling shall include emergency contact information for qualified service and maintenance providers.

M. Power Conversion System
   1. The BESS system shall include a four-quadrant PCS compliant with UL 1741-SB, allowing for extended high and low voltage ride through, high and low frequency ride through, active power control, reactive power control, power quality, and system protection.
   2. The power quality to the grid shall meet the harmonic requirements as indicated in IEEE 519.
   3. The Power Conversion System shall be capable of supporting all required operating modes of the BESS.

N. The Project shall meet, at a minimum, all applicable federal, state, and local noise requirements.

O. The Contractor shall provide a hazard mitigation analysis to evaluate the potential energy storage system failure modes and the safety-related consequences attributed to the failures, in accordance with NFPA 855.

P. The Contractor shall provide a Pre-Incident Plan for the BESS before operations commence. The Pre-Incident Plan shall ensure that facility operations personnel, maintenance personnel, and emergency responders can address foreseeable hazards associated with the on-site systems.

Q. The BESS shall include surge suppression to protect major equipment and components. Additional lightning mitigation strategies may be included if recommended by the BESS Equipment Supplier.

R. A work pad shall be provided around each side of the BESS enclosure that requires maintenance access. The work pad will consist of a five-foot-wide flat surface. The work pad and transition slope shall be covered with a minimum of three inches of gravel.

## 1.8 INSTRUMENTATION AND CONTROL REQUIREMENTS

A. General
   1. Instrumentation and control equipment for all systems shall be Contractor-furnished in accordance with the requirements defined herein. Refer to Section 40 61 13 - PROCESS CONTROL SYSTEMS GENERAL REQUIREMENTS and Section 40 63 44 - POWER GENERATION SYSTEM SCADA CONTROL SYSTEMS for additional requirements.
   2. The BESS control system shall be designed to provide for automatic, unattended, operation of the BESS. The control system design shall also provide for local manual operation, remote operation, or dispatch of the BESS from Owner's SCADA system. The BESS shall be configured for remote control, operations, and monitoring; and shall not require any on-site operations staff.
   3. The BESS control system shall be listed for use as an Energy Management System.
   4. The BESS control system shall meet all performance requirements of IEEE 1547-2018.
   5. The BESS control system shall provide all modes of operation, and its operational set-point functionality shall have the ability to be prioritized and remotely configured through Owner's control system. The control system and all control modes should operate via a logical closed-loop PID controller with set-points dynamically adjustable by the Owner.
   6. The BESS control system shall provide monitoring and control of the enclosure thermal management system.
   7. The BESS control system shall provide monitoring and control of the enclosure safety features including Fire monitoring and suppression.
   8. The BESS control system shall provide available energy forecasting to the SCADA system, including any thermal derate.
   9. The ramp rate of charging and discharging of the BESS shall be programmable or set to a defined value by manually or remotely entering a value into the BESS operator station or by Owner's SCADA system communicating a ramp rate set point.
   10. The system shall provide remote and local means for resetting alarms.

B. Supervisory Monitoring Requirements
   1. Supervisory instrumentation shall be included for data monitoring, alarming, and protective functions in the control system. The following shall be included as a minimum:
      a. Commands and Inputs from the Owner's SCADA System
         1) Operating Mode
         2) Manual Real Power Dispatch Command
         3) Manual Reactive Power Dispatch Command
         4) Real Power Ramp Rate
         5) Reactive Power Ramp Rate
         6) Utility Power Meter voltage and current.
         7) Utility Power Meter real and reactive power.
         8) PV System voltage and current.
         9) PV System real and reactive power.
      b. System Status:
         1) Operating Mode
         2) Inverter status.
         3) Inverter alarms/fault states.
         4) Inverter temperatures.
         5) Battery status.
         6) Battery contactor position.
         7) Battery alarms/fault states.
         8) Battery temperatures.
         9) Battery enclosure (HVAC) alarms/fault states.
         10) System Fire Alarm
         11) System Fire Alarm System Trouble/Fault
         12) Kilowatt power availability for charge and discharge
         13) Kilowatt-hour available and Battery state of charge
         14) Real Power Ramp Rate
         15) Reactive Power Ramp Rate
         16) Real Power Dispatch Command
         17) Reactive Power Dispatch Command
      c. System Metering:
         1) Inverter DC voltage and current.
         2) Inverter AC voltage and current.
         3) Inverter DC power
         4) Inverter AC real and reactive power
         5) Power factor.
         6) Frequency.
      d. Where power limits, available energy, or ramp rates may differ by application, provide all simultaneously active values.
   2. Historian function with up to 60 days of storage of all data points with a resolution of 1 second.
   3. Sequence of Events (SOE) recorder for all protective functions with 1 mS resolution

C. BESS Operator Workstations
   1. The BESS shall have one operator workstation located in its associated local electrical/control enclosure or designated location. The Operator Station shall provide the ability to control the complete BESS.

D. SCADA Interface
   1. The SCADA interface shall support BESS control commands, BESS data and alarms, alarm acknowledgement, logical events, and sequence of events which are recorded.
   2. Critical interface signals between the BESS and the SCADA shall be hardwired. All hardwired signals shall be voltage free contacts or isolated analog signals. Hardwired signals shall include the following as a minimum:
      a. Emergency trip pushbutton(s)

b. External trip requests
c. Electrical system faults

## 1.9 ELECTRICAL REQUIREMENTS

A. Electrical systems shall be designed and constructed in accordance with Section 26 - Electrical Systems.

B. Project design and implementation shall incorporate output of all studies and system design processes conducted as part of the Project including Section 26 05 74 - Short Circuit and Coordination Study, and Arc Flash Report.

C. Protection
1. Intertie protection shall be provided by a microprocessor-based protective device.

D. Energy Metering
1. Charging and discharge energy exchanged between the BESS and the plant power system shall be monitored by dedicated bi-directional electrical revenue metering.

E. Transformers
1. In addition to the requirements of Section 26 - Electrical Systems, transformers shall be designed to meet all requirements of the connected inverter including grounded electrostatic shield and pulse withstand.
2. Transformer grounding shall be as required by the BESS manufacturer's recommended practice but shall not introduce alternate fault current return pathways that may negatively impact ground fault detection schemes elsewhere in the plant.

F. Raceway
1. Dedicated raceway systems shall be established for DC power where required to interconnect multiple enclosures.
2. Conduit and cable tray entry to outdoor enclosures shall not be from the top. Bottom entry is preferred for rain protection. If bottom entry is not practical and side entry is required, entrances shall be installed with watertight fittings. All fastening hardware for enclosures, panels, etc. shall use the manufacturer's recommended attachment locations, variations will require manufacturer's approval.

G. Grounding
1. The BESS shall be provided with a ground ring about the equipment as shown on the Drawings.

## 1.10 WARRANTY

A. The Contractor shall provide a transferable warranty from the BESS equipment supplier that warrants the BESS to be free of defects and of good workmanship for a period of five (5) years from Substantial Completion as defined in the Contract. Any defects or repairs shall be performed by the BESS equipment supplier at no charge to Owner including any transportation or handling to remove the system from service.

## 1.11 SPARE PARTS

A. The Contractor shall provide all non-typical maintenance materials and tools for operating and maintenance of the units.

**B.** The Contractor shall provide their recommended spare parts for continuous operation of the BESS for the first two years of operation.

## 1.12 INSTALLATION

A. The Contractor shall provide the services of technically competent field services representative(s), including representatives of BESS Equipment Supplier as needed, to perform field erection, pre-commissioning, start-up, commissioning, testing, and tuning activities.

## 1.13 TRAINING

A. The Contractor shall provide the following training courses as a minimum:
   1. BESS Familiarization and Operation
   2. BESS Preventative Maintenance

B. In addition, the Contractor and Owner shall coordinate a walk-thru, inspection, and training to the local fire marshal or similar government official responsible for fire fighting if required by the local official. This training shall include an introduction to the system, method of emergency shutdown, and procedures for safely combating fires within the BESS.

## 1.14 STARTUP & COMMISSIONING

A. Following the erection of the BESS and auxiliaries, a systematic, comprehensive commissioning program shall be completed by Contractor, with technical direction provided by the BESS equipment supplier. The BESS equipment supplier shall provide a commissioning manual which shall include all necessary commissioning procedures, instructions, drawings and test forms for their equipment.

B. The Commissioning program shall include a capacity test to verify the nameplate power and energy ratings can be achieved.

**END OF SECTION**