CITY OF VANCOUVER

WATER STATION 14

PFAS TREATMENT SYSTEM

PROJECT – PRJ100893
FUND - 448
COST CENTER - CC0194

Issued for Bid

March 2026

SPECIFICATIONS

Volume 2 - Division 01-46

Brown AND Caldwell

CITY OF Vancouver WASHINGTON

CITY OF VANCOUVER

WATER STATION 14
PFAS TREATMENT SYSTEM

PROJECT - PRJ100893

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COST CENTER - CC0194

Divisions 01, 41, 43, 46

Specifications 09 90 00, 40 05 01 – 40 42 00: LYNN MICHELLE STEPHENS

Signer Name: Lynn Stephens
Signing Reason: I approved this document.
Signing Time: 2026-02-11 12:44:45(EST)



Divisions 22, 23

Specifications 08 91 19, 33 32 16, 40 05 02.89, 40 05 17, 40 05 33.13: WILLIAM D. STEWART

Signer Name: William D. Stewart
Signing Reason: I approved this document.
Signing Time: 2026-02-11 11:06:54(EST)

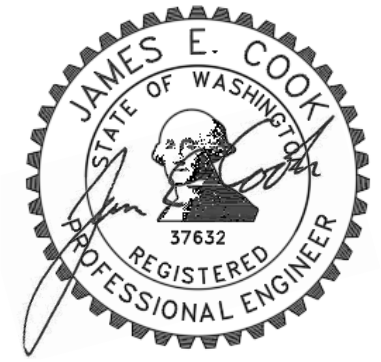


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Divisions 26: JAMES E. COOK

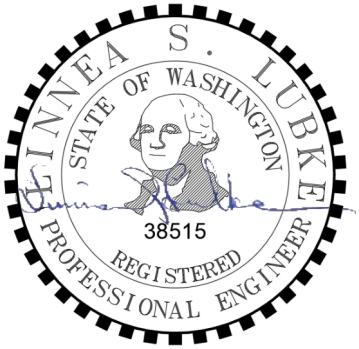
Signer Name: James Cook
Signing Reason: I approved this document.
Signing Time: 2026-02-11 12:58:02(EST)



Divisions 28

Specifications 40 06 70, 40 61 13 – 40 79 00: LINNEA S. LUBKE

Signer Name: Linnea Lubke
Signing Reason: I approved this document.
Signing Time: 2026-02-11 14:05:57(EST)



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WATER STATION 14
PFAS TREATMENT SYSTEM

PROJECT - PRJ100893

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Specifications 32 84 00 – 32 93 10: RAYMOND G. WILLIAMS

GreenWorks
Signer Name: Raymond G. Williams
Signing Reason: I approved this document
Signing Time: 2026-02-11 12:51:52(EST)



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WATER STATION 14
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Divisions 01, 41, 43, 46

Specifications 09 90 00, 40 05 01 – 40 42 00: LYNN MICHELLE STEPHENS



Signer Name: Lynn Stephens
Signing Reason: I approved this document
Signing Time: 2025-03-10 17:17:01(EDT)

Divisions 03, 04, 05

Specifications 01 73 24, 06 17 53, 07 10 00, 07 91 26, 08 31 20: JONATHAN F. HARPER



Signer Name: Jonathan Harper
Signing Reason: I approved this document.
Signing Time: 2025-03-10 16:58:42(EDT)

CITY OF Vancouver WASHINGTON

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Divisions 28

Specifications 40 06 70, 40 61 13 – 40 79 00: LINNEA S. LUBKE



Signer Name: Linnea Lubke
Signing Reason: I approved this document.
Signing Time: 2025-03-10 17:35:07(EDT)

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WATER STATION 14
PFAS TREATMENT SYSTEM

PROJECT - PRJ100893

FUND - 448

COST CENTER - CC0194

Divisions 01, 41, 43, 46

Specifications 09 90 00, 40 05 01 – 40 42 00: LYNN MICHELLE STEPHENS

Signer Name: Lynn Stephens
Signing Reason: I approved this document.
Signing Time: 2025-01-24 15:01:58(EST)



Divisions 31, 33

Specifications 01 57 13, 32 12 16 – 32 31 15, 40 05 31.17, 40 05 31.19: NATALIE CHOW

Signer Name: Natalie Chow
Signing Reason: I approved this document.
Signing Time: 2025-01-24 14:12:14(EST)



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Divisions 03, 04, 05

Specifications 01 73 24, 06 17 53, 07 10 00, 07 91 26, 08 31 20: JONATHAN F. HARPER

Signer Name: Jonathan Harper
Signing Reason: I approved this document.
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Divisions 22, 23

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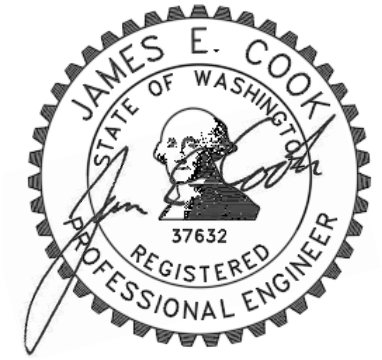
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Divisions 26: JAMES E. COOK

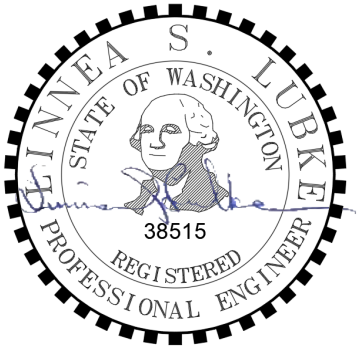
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Signing Reason: I approved this document.
Signing Time: 2025-01-24 15:44:05(EST)



Divisions 28

Specifications 40 06 70, 40 61 13 – 40 79 00: LINNEA S. LUBKE

Signer Name: Linnea Lubke
Signing Reason: I approved this document.
Signing Time: 2025-01-24 14:27:46(EST)



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WATER STATION 14
PFAS TREATMENT SYSTEM

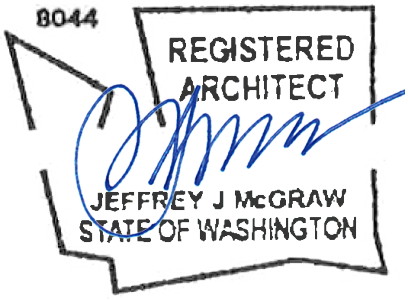
PROJECT - PRJ100893

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Divisions 06, 07, 08, 10: JEFFREY J MCGRAW

Signer Name: Jeffrey McGraw
Signing Reason: I approved this document.
Signing Time: 2025-01-24 00:18:00(EST)



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WATER STATION 14
PFAS TREATMENT SYSTEM

PROJECT - PRJ100893

FUND - 448

COST CENTER - CC0194

Specifications 32 84 00 – 32 93 10: RAYMOND G. WILLIAMS

Signer Name: Raymond G. Williams
Signing Reason: I approved this document
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CITY OF Vancouver WASHINGTON

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. The Work to be performed under this Contract at City of Vancouver's (Owner) Water Station 14 (WTP) facility shall consist of furnishing all labor, tools, equipment, materials and supplies, transportation, and performing all work or other operations required for the fulfillment of the Contract in accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly indicated or called out in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided at no increase in cost to the Owner.

1. The completed Work provides a new PFAS treatment system that ties into the existing WTP. Equipment will be installed at the existing facility and include pressure vessels with granular activated carbon for PFAS removal, along with support systems like: rinse water tank and discharge pump station; restroom and storage building; modifications to the existing booster pumps; and associated stormwater, site civil, electrical, and instrumentation improvements. The existing WTP will have targeted shutdown periods to accommodate booster pump modifications and yard piping tie-in connections.

1.02 CONTRACTS

A. The construction work in this contract will be performed by a Contractor who will be selected by the Owner in a competitive bidding process at the completion of design.

B. The Owner has contracted with Brown and Caldwell for the engineering design of the Work. The term Engineer and Owner's Representative will represent Brown and Caldwell in the construction documents.

1.03 WORK OF THIS CONTRACT

A. The Work includes: the furnishing of all labor, materials, and equipment for the supply, delivery, fabrication, installation, testing, and other materials and services required for the Water Station 14 PFAS Treatment System Design Project. Specific areas include, but are not limited to:

1. B01 – Treatment Building.
2. B02 – Restroom and Storage Building.
3. P01 – PFAS Treatment.
4. P02 – Rinse Water Tank.
5. W01 – Wellhouse 1.
6. W02 – Wellhouse 2.
7. U01 – Valve Vault 1.
8. U02 – Injection Vault.
9. U03 – Valve Vault 3.
10. U04 – Grinder Pump.

11. U05 – Grinder Pump Meter Vault.

B. The Water Station 14 PFAS Treatment System Design Project features include, but are not limited to:
   1. Site Work:
      a. Construct new fence around the perimeter of the site.
      b. Improve site grading to move stormwater to the north and east of the site.
      c. Install temporary vehicle access surfaces as required for construction around the site.
      d. Install new site lighting.
      e. Install landscaping improvements throughout the site.
      f. Install raw water, effluent PFAS treatment, rinse water supply, rinse water discharge, potable water, and sewer piping between existing systems and new facilities and process areas.
      g. Install a raw and effluent water tie-in vault for new waterlines.
      h. Install a sewer manhole lift station with grinder pump and force main adjacent to the restroom and storage building and out to tie-in location along NE Andresen Rd. Install additional force main piping from the storage room to the tie-in location along NE Andresen Rd.
      i. Construct new restroom and storage building with supporting mechanical room. This area will include new HVAC equipment including exhaust fans and louvers, unit heaters, and all supporting appurtenances.
      j. Construct new PFAS treatment area south of the existing WTP. This space will include pressure vessels, piping, and appurtenances for pressure vessel treatment system.
      k. Construct new rinse water tank east of the new PFAS treatment area. This space will include piping and appurtenances for storage and metered discharge of rinse water either to sewer or to the treatment building's booster pump wet well.
      l. Install a rinse water discharge pump system inside the storage room.
      m. Install instrumentation and control system improvements, as shown on the drawings, to existing PLC control system, instrumentation, and SCADA system for control of the PFAS treatment and auxiliary support processes.
      n. Install electrical system improvements, as shown on the drawings, to existing wellhouse 1 and as needed to support and operate new processes and facilities described herein, including site lighting and entry gate improvements.
      o. Install additional site security features including provisions for augmented security camera system.
      p. Install remote PLC I/O panel for control of equipment in building.
      q. Install new electrical conduit and wiring, local control panels, instrumentation, receptacles cable trays, and other electrical appurtenances required for a fully functional electrical and control system as shown on the drawings.
      r. Pave vehicle access surfaces around PFAS Treatment, Rinse Water Tank, and Restroom and Storage Building.

C. Substantial Completion

1. The Work will be considered Substantially Complete when Phase 4 Commissioning: Acceptance Test Phase is complete as defined in 01 91 00.

1.04 WORK NOT COVERED BY CONTRACT DOCUMENTS

A. Control system integration will be conducted by the Owner and/or Jacobs. Contractor is required to coordinate with the Owner for control system integration scheduling as the Project progresses. This work includes, but is not limited to:

1. Programming for all actuated valves that support pressure vessel and rinse water tank operations.
2. Programming for all control panels supporting the rinse water discharge pump and grinder pump supporting sewer systems.
3. Programming for all heat tracing control panels.

END OF SECTION

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SECTION 01 11 80

ENVIRONMENTAL CONDITIONS

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes the environmental conditions which have been taken from ASHRAE's Climatic Design Conditions summary from a weather station near the project site location and which may reasonably be anticipated throughout the life of the Project.

1.02 CLIMATE CONDITIONS

A. The site of the Work is at an elevation of approximately 271 feet above mean sea level.

B. Outdoor climatic data are obtained from the 2021 ASHRAE Fundamentals Handbook for Pearson Airport, Vancouver, Washington, WMO 727918, and are described as follows:

Description	Value
Location and WMO#	Pearson Field Airport, Vancouver, WA, WMO 727918
Lat/Long	45.621N, 122.657W
Elevation	9.1 m
Standard Atmospheric Pressure	14.69 psia
Winter (99.6%)	24.4 deg F dry bulb temperature
	9.0 deg F dewpoint
	1.2 meters per second design wind speed at corresponding dry bulb temperature of 24.4 deg F
Summer (0.4%)	91.4 deg C dry bulb temperature
	66.7 deg C mean coincident wet bulb temperature
Evaporation (0.4%)	69.1 deg C wet bulb temperature
	86.5 deg C mean coincident dry bulb temperature
Annual Extreme Temperatures	18.3/ 17.6 deg F dry bulb/wet bulb – Annual Minimum
	99.1 / 72.0 deg F dry bulb/wet bulb – Annual Maximum
Temperature Extremes (n = 10)	11.6 / 10.4 deg F dry bulb/wet bulb – 10 Year Minimum
	103.3 / 74.8 deg F dry bulb/wet bulb – 10 Year Maximum

1.03 INDOOR CONDITIONS

A. The HVAC and other interior systems shall be designed to provide or accommodate the desired environmental conditions within the various spaces and to protect the equipment and processes from freezing or overheating.

B. The indoor design conditions presented below shall be used for the design of these types of interior systems within the identified spaces.

C. Refer to technical specifications for additional guidance and requirements associated with indoor systems design, installation and testing.

Area		Temperature	Ventilation Rate [e]
Storage Room/Chemical Room	Summer	103.2 degrees F dry bulb temperature [a, b]	As required to maintain summer design temperature, or as required by the 2021-Washington State Mechanical Code.
		74.8 degrees F; mean coincident wet bulb temperature [d]	
	Winter	50 degrees F dry bulb temperature	
		34 degrees F; mean coincident wet bulb temperature [d]	
Restroom	Summer	85.8 degrees F dry bulb temperature	Per ASHRAE 55 and ASHRAE 62.1 Ventilation rate 100 CFM for single occupancy restroom.
		74.6 degrees F; mean coincident wet bulb temperature (50%RH)	
	Winter	68 degrees F dry bulb temperature	
		34 degrees F; mean coincident wet bulb temperature [d]	

Notes:

a. Electrical equipment in process areas is generally rated for an ambient temperature of 40°C (104°F). Occasional excursions of higher temperatures in the room can be expected for a few hours on the hottest, unseasonable day type of scenario.

b. Non-conditioned ventilation-cooling fans will be sized on the basis of the electrical general ambient temperature rating minus the summer design temperature ventilation air cooling differential temperature.

c. Space temperature will fall and rise based on outside air temperature but is not expected to drop below the winter design temperature due to heat capacity of the structure and other internal space heat gains.

d. Humidity was not a design factor in the design and is, subsequently, not being monitored or controlled.

e. Ventilation air will be brought into the degree necessary to pressurize space.

D. Pressurization:

1. Designing minimum pressure differentials, values are with respect to ambient pressure and to adjacent spaces, discourages undesirable air transfer from one space to another.

Space Type	Pressure Differential (inches WC – with respect to ambient)
Chemical Room	[-0.10]
Restroom	[-0.10]

1.04 APPLICABLE CODES/STANDARDS

ASHRAE		
55	Thermal Environmental Conditions for Human Occupancy	as referenced by State of Washington
62.1	Ventilation for Acceptable Indoor Air Quality	as referenced by State of Washington
90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings	as referenced by State of Washington
NFPA		
70	2020 National Electrical Code	as referenced by State of Washington
820	202] Standard for Fire Protection in Wastewater Treatment and Collection Facilities	Owner adopted standard

International Code Council		
IBC	2021 International Building Code, with Washington State and local amendments	as referenced by State of Washington
IECC	2021 International Energy Conservation Code, with Washington Stateand local amendments	as referenced by State of Washington
IFC	2024 International Fire Code, with Washington State and local amendments	as referenced by State of Washington
IFGC	2024 International Fuel Gas Code, with Washington State and local amendments	as referenced by State of Washington
IMC	2024 International Mechanical Code, with Washington State and local amendments	as referenced by State of Washington
IPC	2024 International Plumbing Code, with Washington State and local amendments	as referenced by State of Washington
IWUIC	2024 International Wildland Urban Interface Code, with Washington State and local amendments	as referenced by State of Washington

1.05 ADDITIONAL CONDITIONS

A. Additional conditions which may be applicable are specified in other sections.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 12 16

WORK SEQUENCE

PART 1 GENERAL

1.01 CONTINUITY OF PLANT OPERATIONS

A. Except as specified, the Contractor shall plan and execute the Work without impeding of the ongoing operation of the existing operations at Water Station 14, which treats and conveys potable water to the Owner's distribution system. The Contractor shall protect existing utilities and maintain access to the existing facilities on the Site. If access is temporarily blocked, the Contractor shall provide alternate access for operations and maintenance personnel.

B. The Contractor shall be responsible for coordinating the tie-in of the existing infrastructure with the proposed infrastructure constructed as part of this Work. All portions of this Work shall be satisfactorily tested before new connections to the existing system are allowed. Any required shutdowns or service interruptions must be approved by and scheduled with the Owner.

1.02 SUBMITTAL

A. In accordance with Section 01 33 00 and 01 14 19 the Contractor shall submit a detailed plan for any activities that require removing equipment or facilities from service. Plans shall be made to minimize impact of outages. The plan shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section.

1.03 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. The construction schedule required in the General Conditions of the Contract Documents shall provide sequencing for the following areas of work:
   1. Site Work
   2. P01 – PFAS Treatment
   3. P02 – Rinse Water Tank
   4. B01 – Treatment Building
   5. B02 – Restroom and Storage Building
   6. W01 – Wellhouse 1
   7. U03 – Valve Vault 3
   8. U04 – Grinder Pump
   9. U05 – Grinder Pump Flowmeter Vault

B. The Plan shall be coordinated with the Contractor's Construction schedule and meet the restrictions and conditions specified in the Contract Documents.

C. The Plan shall describe the Contractor's means and methods for performing the tasks listed above and the length of time required to complete the tasks.

D. The above tasks are not meant to serve as a comprehensive list nor indicate the order in which these tasks are completed.

1.04 SCHEDULE, SHUTDOWN, AND CONSTRUCTION CONSTRAINTS

A. Work shall be completed so as to not impair or reduce the Owner's ability to meet customer demands for treated drinking water.

B. Construction Constraints:
   1. Portable restrooms are acceptable for the Contractor's employees, but they will be required to be kept within the fenced area away from public access.
   2. Integrator will perform programming of SCADA and PLC applications software for certain portions of Process Instrumentation and Control Subsystem (PICS).
      a. Contractor shall coordinate work and provide an allowance for interruptions to the Work because of testing by Integrator of Integrator-developed applications software:
         1) During Functional Testing and Performance testing, Contractor shall plan for interruption of testing of the Work to allow Integrator to investigate software problems, make software configuration changes, and conduct additional testing.
         2) Allowance for Interruptions: 5 days for each system affected by the work, including booster pumps and disinfection.
   3. Existing site and facilities do not include functioning sewer connection. Work as part of this project includes construction and commissioning of equipment and systems that will connect Water Station 14 to sewer systems owned and operated by Clark Regional Wastewater Department (CRWWD).
      a. Contractor shall not exceed allowable instantaneous flow rate of 45 gpm to CRWWD sewer under any circumstances. Throughout all phases of the Work, the Contractor shall be responsible for independently collecting and removing/disposing of all waste streams, including any disinfected waters or flush waters, without utilizing the finished water distribution system or CRWWD sewer systems without explicit Owner approval.

C. Shutdowns and Service Interruptions:
   1. All planned connections to existing systems which require service interruptions shall be identified in the construction schedule and require coordination, planning, and written approval with the Owner a minimum of 2 weeks in advance for general approval.
   2. Contractor shall organize all Work to minimize number of scheduled shutdowns.
   3. The Contractor shall provide 48-hour notification to Owner and Engineer prior to any planned/scheduled shutdown.
   4. Owner shall have the ability to cancel scheduled shutdown on the day of scheduled shutdown.
   5. Limitations:
      a. Booster pump improvement activities may only be completed with one pump at a time and the Contractor must schedule separate shutdowns with Owner approval to complete.

b. Between May and end of September shutdowns should be avoided and are not allowable without Owner coordination and approval.
c. Work requiring shutdowns in excess of these limitations shall brought to the attention of the Owner.

END OF SECTION

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SECTION 01 14 16

COORDINATION WITH OPERATION OF EXISTING FACILITIES

PART 1 GENERAL

1.01 DESCRIPTION

A. The existing water treatment works will be in operation throughout the execution of this contract. The Contractor, therefore, shall schedule and conduct work so as to minimize interference with plant operation and maintenance. It is the intent of this Contract that the construction activity, insofar as possible, shall not interfere with the operation of the plant. Where delays are caused by reason of unexpected operation of the plant, the Contractor will be allowed compensatory time but no change in contract compensation.

1.02 OPERATION

A. Unless otherwise specified, normal daily operation and maintenance of the existing plant will be performed by Owner's personnel. Whenever operational functions are required to permit construction operations, these functions will also be performed by Owner's personnel.

1.03 GENERAL

A. When modification, addition or connection to existing structures, systems, circuits or equipment is required, the Contractor shall schedule such activities with the Owner. These tie-in activities, shutdown activities, etc. that may impact Owner's operation are to be coordinated and tracked as "Maintenance of Plant Operations" events (MOPOs). The Contractor shall notify the Owner, in writing, a minimum of 2 weeks in advance of the time when construction operations will require connection to, or modification of, in-service portions of the existing Facility. No system, structure, circuit or individual unit shall be modified, de-watered, de-energized or removed from the Facility unless authorized by the Owner.

B. The Contractor shall coordinate all equipment installation, testing, startup, and commissioning with the Integrator, which shall be completed by the Owner and/or Jacobs. Coordination activities shall include at least the following:
   1. Pre-coordination meeting: One in-person meeting up to one half day in duration for the Owner, Contractor, and Integrator to discuss construction sequencing and provide Owner and Integrator with opportunity to evaluate and provide comment for Contractor's proposed schedule with regard to all integration activities.
   2. Pre-startup meeting: Two in-person meetings up to one day in duration for the Owner, Contractor, and Integrator to discuss startup and commissioning plan and provide Owner and Integrator with opportunity to evaluate and provide comment for Contractor's proposed startup and commissioning activities and schedule.

1.04 REMOVAL OF EXISTING PIPING AND EQUIPMENT

A. All existing piping, equipment, fixtures, conduit, wiring, and other appurtenances which are to be removed and are not specified or indicated on the Drawings to be relocated or reused will be designated by the Owner as either salvage or junk. Material designated as salvage shall be cleaned carefully and neatly stored at the Facility site as directed by the Owner. Material designated as junk shall become the property of the Contractor and shall be removed from the site and lawfully disposed of by the Contractor.

1.05 MODIFICATION OF STRUCTURES

A. The Contractor shall connect to the new electrical equipment with a minimum of interruption to plant services. The Contractor shall inform the Owner in writing, of the intention to interrupt any power supply for the purpose of making required connections at least 2 weeks in advance of such interruption and shall also inform the Owner of the estimated period of interruption.

B. In no case shall the Contractor cause an intentional power interruption without written authority from the Owner.

1.06 SUBMITTAL OF MOPO PLANNING AND ANTICIPATED MOPOS

A. The contractor shall review the Contract Documents and submit an initial MOPO tracking list. The MOPO tracking list shall be submitted with the initial schedule submittal. The MOPO tracking list shall include the following:
   1. Identify the MOPO with number and name (e.g., MOPO 01 – Raw Water Pipe Tie In).
   2. The time needed by the contractor to conduct the MOPO (e.g., 12 hours).
   3. The constraints identified by the Owner such as maximum shut down time allowed during the tie-in.

B. The MOPO tracking list shall be maintained throughout the contract period. The MOPO tracking list shall be supplemented by specific MOPO Plan for each MOPO. The MOPO Plan shall describe detailed shut down periods, work sequences, tools, staff, and steps to be taken by Contractor and Owner during a given MOPO. Each MOPO Plan shall include signature blocks for the Owner, Contractor and Engineer. All three signatures shall be complete prior to executing a MOPO.

C. The following is an initial list of anticipated MOPOs; contractor shall review the Contract Documents and develop a more detailed MOPO tracking list. The MOPO tracking list will be reviewed periodically and kept current. Anticipated MOPOs include:
   1. Raw water tie-in.
   2. PFAS effluent water tie-in.
   3. Rinse water discharge and sanitary sewer tie-in to NE Andreson Rd manhole.
   4. Network tie-in.
   5. Electrical feeder tie-in.
   6. Potable water tie-in.

D. See Section 01 12 16 for shutdown constraints.

PART 2 NOT USED

PART 3 NOT USED

END OF SECTION

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SECTION 01 14 19

USE OF SITE

PART 1 GENERAL

1.01 SUMMARY

A. The Owner's operating personnel will be responsible for operating the existing treatment plant throughout the execution of this contract. Equipment presently installed in the treatment plant must be available to plant personnel at all times for use, maintenance, and repair. If it is necessary in the course of operating the plant, for the Contractor to move his equipment, materials, or any material included in the work, he shall do so promptly and place that equipment or material in an area which does not interfere with the plant operation. The Contractor shall not adjust or operate serviceable or functioning equipment or systems except as specifically required by this contract.

B. The existing treatment plant will remain in operation throughout the execution of this contract. The Contractor shall schedule and conduct his work to minimize necessary shutdowns and interference with normal plant operations and maintenance.

C. The Contractor shall notify the Construction Manager, in accordance with Section 01 12 16, 2 weeks in advance of the time it is necessary to take out of service any existing tank, pipeline, channel, electrical circuit, equipment or structure. The Contractor shall be responsible for providing whatever temporary piping, pumping, power, and control facilities as are required to maintain continuous plant operation and complete treatment except as otherwise specified. The integrity of existing plant utilities shall be maintained by the Contractor at all times.

D. Contractor shall be responsible for conducting and paying for all underground locating services necessary to conduct the Work. This includes, but is not limited to, underground utilities, electrical, water pipes, stormwater pipes, sewer pipes, telecom and fiber optic, and other types of utilities that may be located on the project site.

1.02 OVERALL WORK RESTRICTIONS

A. Contractor shall account for the following construction requirements for scheduling, estimating, and performing the Work:
   1. The work is located inside the City's fenced water facility.
   2. Work Hours: 7:00 a.m. to 6:00 p.m. Monday through Friday. For Work outside those hours, Contractor shall obtain both the required permits and written approval from the approving agencies.
   3. The work area is within a City water supply facility. Fuel storage on site shall be limited to 500 gallons, provided the containers are double wall containment tanks. Any spill to the ground of materials shall immediately be reported to Water Operations and immediately contained/removed.
   4. Any vehicle that in the Owner's Representative's opinion is leaking fluids, is not in good mechanical condition, or is a potential hazard to the public or the well field, will not be allowed onsite and shall be removed immediately.
   5. Concrete washout activities will not be allowed at the Site, unless authorized by the Owner in writing.

6. Contractor shall adhere to the conditions set forth in the Construction Permits for this Project.
7. No washing, screening or crushing of rock is permitted onsite.

B. Inadvertent Discovery Plan
   1. Prepare and submit an Inadvertent Discovery Plan prior to beginning any ground-disturbing activities onsite. Refer to Attachment A for the required contents of the plan.
   2. Discovery of any cultural resources or human remains shall be managed in accordance with the approved Inadvertent Discovery Plan.

END OF SECTION

SECTION 01 14 19-A

INADVERTENT DISCOVERY PLAN (IDP) TEMPLATE

Project Name: [Insert Project Name]

Project Location: [Insert Address or Coordinates]

Project Sponsor/Agency: [Insert Agency or Organization]

Prepared By: [Insert Name and Title]

Date: [Insert Date]

1. Purpose

   This IDP outlines procedures to follow if cultural resources or human remains are inadvertently discovered during ground-disturbing activities associated with the [Project Name].

2. Scope of Work

   Brief description of the project and types of ground disturbance involved:

   [e.g., trenching for water lines, excavation for building foundations, grading for road construction]

3. Discovery Protocol

   If any potential cultural materials or human remains are discovered:

   a. Stop Work Immediately

      All work within 50 feet of the discovery must cease.

   b. Secure the Area

      Protect the site from further disturbance.

      Do not touch, move, or remove any objects.

   c. Notify Authorities

      Immediately contact the following:

4. Types of Discoveries Covered

   This plan applies to the following types of inadvertent discoveries:

   Prehistoric or historic artifacts (stone tools, ceramics, metal objects)

   Structural remains (foundations, wells, hearths)

   Human skeletal remains

   Modified natural features (e.g., culturally modified trees, rock art)

5. Tribal Coordination

   [Insert Tribe Name] has been notified of this project and will be contacted immediately in the event of a discovery. Tribal representatives will be invited to participate in any follow-up investigation or consultation.

6. Training and Awareness

   All personnel involved in ground-disturbing activities will receive a briefing on this IDP prior to project start. A copy of this plan will be kept on-site at all times.

7. Acknowledgment

   By signing below, the project team acknowledges receipt and understanding of this IDP.

   Signature: _____

   Name/Title: _____

   Date: _____

SECTION 01 29 00

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements for determining Contractor payments.

1.02 SCHEDULE OF VALUES

A. The Contractor shall submit a detailed Schedule of Values (SOV) for the Work of the Contract, including quantities and unit prices—with each facility as a top heading, and with further breakdown of the activities within each facility or activity and by trade—aggregating from the conformed Bid Form and/or the Lump Sum Contract Price, for approval in accordance with Article 15 of the General Conditions - Section 00 72 00 and the bid forms.

B. If any unit price in the approved Schedule of Values requires that the said unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not also be measured or paid for under any other pay item which may appear elsewhere in the Specifications.
   1. Schedule shall be listed in tabular form and include the following:
      a. Schedule item numbers.
      b. Schedule item descriptions.
      c. Unit cost description, bid quantity, bid unit cost, bid total amount per item.
      d. Estimated quantities for previous period, current application period, and total to date per item.
      e. Amount previously billed, amount billed this period, total amount billed and percent completion per item.
   2. Include a proportional amount of Contractor's overhead and profit for each item.
   3. If progress payments will be requested for materials or equipment stored either on or off site, show the following:
      a. Cost of the materials, delivered and unloaded, with taxes paid.
      b. Total installed value.

C. Upon request, submit documentation to support the values assigned to the Work. Sum of all values shall equal the Total Bid.

D. Schedule will be reviewed by the Engineer.
   1. Upon approval by the Engineer, the schedule will become the official reporting form upon which Application Payment will be calculated.
   2. Provide additional breakdown of bid item costs if requested by the Engineer.
   3. Failure to submit this schedule or receive approval may result in withholding of approval of Application for Payment.
   4. An unbalanced or front-end loaded schedule will not be accepted.
   5. Summation of the complete schedule representing all of the Work shall equal the Contract Price.

6. An Excel spreadsheet schedule shall be submitted.

E. Lump Sum Work:
   1. Reflect specified cash and contingency allowances and alternatives, as applicable.
   2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
   3. Breakdown by Divisions 02 through 49 with appropriate subdivision of each specification for facility and activity of the project.

1.03 MEASUREMENT OF QUANTITIES

A. Work completed under the Contract shall be measured according to the standards of weights and measures recognized by the U.S. Bureau of Standards.

B. The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the Contract will be those methods generally recognized as conforming to good engineering practice.

C. Measurement for area computations will be made on the surface. Pay measurements for area computations will not exceed the neat dimensions indicated on the Contract Drawings, unless otherwise ordered in writing by the Construction Manager or Engineer.

D. Structures will be measured according to neat lines indicated on the Contract Drawings or as altered to fit field conditions. No payment will be made for length, width, or depth, in excess of that indicated on the Contract Drawings or specified for any construction, unless otherwise approved by the Construction Manager or Engineer in writing.

E. Items which are measured by the linear foot, such as pipe, will be measured parallel to the base or foundation upon which such items are placed.

F. In computing volumes of excavation (when part of a unit price project component), the average end area method, based on horizontal measurements, or other acceptable methods, will be used. If the excavation is incidental or part of a lump sum bid item, no additional payments will be made.

G. The term "each", when used as an item of payment, will mean complete payment for the Work described in the payment item in the Contract Documents. The work described is not intended to be exhaustive.

H. The term "lump sum", when used as an item of payment, will mean complete payment for the Work described in the Contract Documents, including all necessary fittings and accessories, and required testing completed.

I. The term “complete in place”, means the completion of the Contract item or portions thereof as determined by the Construction Manager or Engineer including the furnishing of all materials, equipment, tools, labor, and work incident thereto, unless otherwise specified.

J. Contingent unit price items work is work not shown on the Contract Drawings and shall be performed only at the direction of the Construction Manager or Engineer.

K. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

L. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.

M. Materials that are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

N. Quantities Based on Profile Elevations: Existing ground profiles shown on Drawings were taken from a topographic map drawn with contour intervals of 1 foot.

O. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

P. Pursuant to RCW 39.04.180, trench safety systems are required to meet the Washington industrial safety and health act, Chapter 49.17 RCW for any excavation exceeding 4 feet of depth and listed on the bid proposal as a separate item. Payment for 'Trench Safety System' shall be made at the unit Contract price per linear foot of those sections of trench which are actually mechanically shored or over excavated specifically for the sole purpose of providing a safe work environment for workers. Any bid item for trench safety less than $3.00 per linear foot will be unilaterally changed to read $3.00 per linear foot, item extensions will be adjusted accordingly and be reflected in the total bid price for award purposes.

1.04 SCOPE OF PAYMENT

A. The Contractor will receive and accept compensation provided for in the Contract Documents as full payment for furnishing materials, labor, tools, and equipment and for performing Work under the Contract in a complete and acceptable manner and for all risk, loss, damage, or expense of whatever character arising out of the nature of the Work or the execution thereof, subject to the provisions of the General Conditions.

1. Payment for all Lump Sum Work shown or specified in the Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.

B. Schedule of Estimated Progress Payments:

1. Show estimated payment requests through Contract Times aggregating initial Contract Price.

2. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

C. Application for Payment:
   1. Transmittal Summary Form: Attach one Summary Form as provided by Owner with each detailed Application for Payment and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized Contractor representative.
   2. Use detailed Application for Payment Form suitable to/or provided by Owner.
   3. Include accepted Schedule of Values for each schedule or portion of Lump Sum Work and the unit price breakdown for the Work to be paid on a unit priced basis.
   4. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.
   5. Preparation:
      a. Round values to nearest dollar.
      b. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable, and such supporting data as may be requested by Engineer.

D. Mobilization:
   1. When included in the Contractor's Schedule of Values, mobilization shall consist of the assembling and setting up for the project, the Contractor's necessary general plant, including Contractor's offices, Construction Manager and Engineer's field office, shops, plants, storage areas, sanitary and any other facilities, as required by the Specifications and special requirements of the Contract, as well as by local or State law and regulation. The determination of the adequacy of the Contractor's facilities, except as noted above, shall be made by the Contractor. The cost of required insurance and bonds and/or any other initial expense required for the start of Work will be included in this item. The Contractor shall furnish all materials and furnishings required, and these materials and furnishings will not be considered as part of the other various items of the completed Contract.
   2. No additional payment will be made for demobilization. Costs for demobilization shall be included in this item.
   3. Mobilization will be paid at the approved lump sum price for mobilization and demobilization included in the Contractor's Schedule of Values. The lump sum price for this item shall be payable to the Contractor in accordance with the following schedule:
      a. On the first monthly application for Progress Payment, the amount approved for mobilization or three percent of the total Contract Price, excluding the price for this item, whichever is less, will be paid.
      b. Whenever Work performed equals 25 percent of the total Contract Price excluding the approved price for this item, any remaining amount for mobilization, or an additional two percent of the total Contract Price excluding the approved price for this item, whichever is less, will be paid.

c. Upon completion of the Project, any remaining amount approved for mobilization will be paid.

E. Nonpayment for Rejected or Unused Products:
   1. Payment will not be made for following:
      a. Loading, hauling, and disposing of rejected material.
      b. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
      c. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
      d. Material not unloaded from transporting vehicle.
      e. Defective Work not accepted by Owner.
      f. Material remaining on hand after completion of Work.

F. Partial Payment for Stored Materials and Equipment:
   1. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer. Invoices for materials, location of materials stored, and a release of liens for the equipment must be provided prior to payment. Payment for Materials on Hand will only be for the materials that can be inventoried by the Owner.
   2. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

G. Partial Payment for Undelivered, Project-specific Manufactured or Fabricated Equipment:
   1. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made for products listed below when all following conditions exist:
      a. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
      b. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
      c. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.
      d. Authorization has been provided for access to storage Site for Engineer and Owner.
      e. Equipment meets applicable Specifications of these Contract Documents.
   2. Payment of 15 percent of manufacturer's quoted price for undelivered, Project-specific manufactured equipment will be considered following Shop Drawing approval.
   3. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Contractor shall provide for physical arrangements for meetings throughout progress of the Work. Contractor shall prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

A. A preconstruction meeting shall be held, in accordance with Article 2.04 of the General Conditions. The Owner will schedule and conduct the meeting. Contractor and appropriate staff, subcontractors, etc., are expected to attend the meeting.

B. Contractor shall be prepared to discuss the following subjects, as a minimum:
   1. Required schedules.
   2. Status of Bonds and insurance.
   3. Sequencing of critical path work items .
   4. Project changes and clarification procedures.
   5. Use of Site, access, office and storage areas, security and temporary facilities.
   6. Major product delivery and priorities.
   7. Contractor's safety plan and representative.
   8. Emergency Plan for Water Operations: Determine action plan if an accidental shutdown were to occur. Contractor to be informed City contact and plan for Contractor's role in resolving problem and creating solution to maintain operations.

C. Attendees will include:
   1. Owner's representatives, including Construction Manager.
   2. Contractor's office representative.
   3. Contractor's resident superintendent.
   4. Contractor's quality control representative.
   5. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
   6. Engineer's representatives.
   7. Contractor's erosion control specialist.
   8. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 16.

1.04 PROGRESS MEETINGS

A. Owner will schedule regular progress meetings at Site, conducted weekly to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.

B. Attendees will include:
   1. Owner's representative(s), as appropriate, including Construction Manager.
   2. Contractor, Subcontractors, and Suppliers, as appropriate.
   3. Others as appropriate.

1.05 QUALITY CONTROL MEETINGS

A. Not used.

1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

A. As work progresses to involve PICS work, the Engineer will schedule meetings at Site, conducted bi-weekly to review specific requirements of PICS work, when the work is being accomplished.
   1. PCIS Subcontractor/Installer will include Owner and/or Jacobs performing programming of SCADA and PLC application software for certain portions of the project scope.
   2. Contractor shall coordinate and allow for interruptions to the Work to accommodate testing by Engineer or PCIS Subcontractor/Installer for:
      a. Functional Testing and Performance Testing: Contractor shall plan for interruption of testing of the Work to allow Owner to investigate software problems, make software configuration changes, and conduct additional testing.

B. Attendees will include:
   1. Contractor.
   2. Owner and/or Engineer.
   3. PICS Subcontractor/Installer.
   4. Integration Engineer's representatives.
   5. Manufacturer’s representatives, as appropriate.

1.07 COORDINATION MEETINGS

A. Hold coordination meetings as required by the progress of the Work. The purpose of the coordination meetings is to discuss preparatory work issues, quality control issues, safety issues, facility shutdown and start-up issues, and coordination with work of this Contract. Provide all necessary documentation and information required for the meeting.

B. Before any shutdown or restart of existing facilities can occur, a coordination meeting must be held between the Owner, Construction Manager, Engineer, Operations Staff, and Contractor.

C. Contractor shall attend and arrange for such subcontractor's representatives as may be needed to attend, pending subject matter. The Construction Manager, Engineer and any other interested party, such as public utility, local government representatives, and suppliers when needed, will also attend.

D. Hold the meetings at the Project Site unless otherwise agreed by the Engineer.

1.08 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene at Site prior to commencing the Work of that section.

B. Require attendance of entities directly affecting, or affected by, the Work of that section.

C. Notify Construction Manager and Engineer 5 working days in advance of meeting date.

D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.09 FACILITY STARTUP MEETINGS

A. As required in Section 01 99 00.

1.10 OTHER MEETINGS

A. In accordance with Contract Documents and as may be required by Owner, Engineer, and Construction Manager.

END OF SECTION

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SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SCOPE

A. This section specifies the procedures for preparing, updating, and revising the cost-loaded construction schedule used for planning and managing construction activities. The schedule provides a basis for determining the progress status of the project relative to the completion time, specific dates, and for determining the acceptability of the Contractor's progress payment estimates. The schedule provides the basis for evaluating time impacts in the context of the status of the project.

1.02 DESCRIPTION

A. The Contractor shall prepare a time scale network schedule using a critical path method. A general guide for preparing such a schedule is contained in "The Use of CPM in Construction, a Manual for Contractors," published by the Associated General Contractors of America.

B. The schedule shall depict all significant administrative activities, activities for the review of submittals, procurement activities, construction activities and all items of work listed in the breakdown of contract prices submitted by the Contractor in accordance with the General Conditions of the Contract Documents.
   1. Show activities including, but not limited to the following:
      a. Notice to Proceed.
      b. Permits.
      c. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00.
      d. Early procurement activities for long lead equipment and materials.
      e. Initial Site work.
      f. Earthwork.
      g. Specified Work sequences and construction constraints.
      h. Contract Milestone and Completion Dates.
      i. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
      j. System startup summary.
      k. System commissioning period.
      l. Project close-out summary.
      m. Demobilization summary.
   2. Assigned values for each part of the work shall be indicated. The dependencies between activities shall be indicated so that it may be established what effect the progress of any one activity has on the schedule.
   3. The Contractor shall incorporate the plans and anticipated production rates of any subcontractors in the schedule.

C. Completion time and all specific dates given in the Contract Documents, and sequencing requirements described in Section 01 12 16, shall be shown on the schedule. Activities making up the critical path shall be identified. The critical path shall be defined as the longest path.

D. No activity on the schedule shall have a duration longer than 15 working days or assigned value greater than $100,000, unless approved by the Construction Manager. Activities comprising only fabrication and delivery may extend for more than 15 working days. Activities which exceed these limits shall be divided into more detailed components. The scheduled duration of each activity shall be assigned to work calendars that reasonably depict the time periods that work can productively take place during the normal 40 hour work week and that include any applicable restrictions as defined in the Contract Documents, including but not limited to allowances made for legal holidays and normal weather conditions.

E. Float, which may exist for a given activity, milestone, or the project, is not the exclusive property of any party to this Contract. Float may be consumed by any party without penalty or damage to any other party (or parties) to the contract. The Contractor shall not employ any techniques to artificially reduce the amount of float.

F. The cost loading of the activities shall be accomplished by a resource being assigned to each activity as a placeholder for the cost. Costs shall not be assigned by an activity expense. The budgeted value of an activity shall not exceed $50,000 unless approved by the Construction Manager.

1.03 SUBMITTAL PROCEDURES

A. Within 15 working days after the date of the Notice to Proceed or at least 5 working days prior to the pre-construction conference (whichever occurs first), the Contractor shall complete a construction schedule conforming to paragraph 1.02 Description and representing in detail all planned procurement and on-site construction activities.

B. The Contractor shall utilize Primavera Project Management Software or Primavera Contractor Software and not Surtrak or MS Project. Upon completion of the schedule, the Contractor shall submit to the Construction Manager in accordance with Section 01 33 00.

C. Within 10 working days after receipt of the submittal, the Construction Manager and Engineer shall review the submitted schedule and return to the Contractor. If the Construction Manager finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy, returned to the Contractor for corrections and resubmitted as specified in Section 01 33 00.

D. Progress Schedule-Bar Chart:

1. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, "Construction Project Planning and Scheduling Guidelines." If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.
    a. Format:
        1) Provide electronic and four hardcopies (size appropriate to read).

2) Title Block: Show name of project and Owner, date submitted, revision or update number, and name of scheduler.
3) Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
4) Identify each activity with a unique number and a brief description of the Work associated with that activity.
5) Legend: Describe standard and special symbols used.
6) Contents:
    a) Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:
    b) Obtaining permits, submittals for early product procurement, and long lead time items.
    c) Mobilization and other preliminary activities.
    d) Initial Site work.
    e) Specified Work sequences, including the logic of Section 01 12 16.13, Construction Constraints, and Milestones, including Substantial Completion date(s).
    f) Subcontract Work.
    g) Major equipment design, fabrication, factory testing, and delivery dates.
    h) Delivery dates for Owner-furnished products, as specified.
    i) Each facility separated into:
    j) Presite Work requirements.
    k) Sitework.
    l) Concrete Placement Work.
    m) Structural steel Work.
    n) Equipment Work.
    o) Mechanical Work.
    p) Electrical Work.
    q) Instrumentation and control Work.
    r) Coordination with Owner provided Integration Engineering.
    s) Other important Work for each major facility.
    t) Facilities, equipment and system startup and test activities.
    u) Project closeout and cleanup.
    v) Demobilization.

2. All schedule submittals shall include:
    a. A narrative detailing all pertinent information related to the schedule, including:
        1) A description of any assumptions used in the development of the schedule;
        2) A description of any potential conflicts or delays that may impact any activity in the schedule;
        3) A description of the amount of labor resources that will be employed on the project;
        4) A description of the progress that has been attained during an update period (for an update submittal);

b. Statements explaining why the start or finish date of an activity has varied from the baseline or a previous update (for an update submittal); and
c. Other information or explanation of a schedule submittal that may be required by the Construction Manager.
d. A .xer file for the use of the Construction Manager and .pdf file for the use of the Engineer and Owner; and
e. Other files or reports that may be requested by the Construction Manager.

E. These reports will serve as the basis for the Contractor's progress payment requests. The Construction Manager may withhold payment if the Contractor does not submit a schedule in accordance with the requirement of this specification. Acceptance of any schedule submittal by the Construction Manager shall only mean that it is in reasonable compliance with the requirements of this Section and does not warrant its accuracy. Acceptance of any schedule submittal shall not relieve the Contractor of responsibility for the adequacy of the schedule and for managing all construction activities including those of subcontractors and suppliers.

1.04 SCHEDULE REVISIONS

A. As the project progresses, it is anticipated that the Contractor will need to revise the schedule to incorporated changes to plan, added work, budget changes, or for other reasons. The Contractor shall give written notification of any change prior to incorporating that change into the schedule. All changes in logic, activity duration, or the budgeted cost assigned to an activity shall be explained in detail in the narrative.

B. Changes in timing for activities which are not on the critical path may be modified with written agreement of the Contractor and Construction Manager.

C. A change affecting the contract value of any activity, the timing of any activity on the critical path, the completion time and specific dates in the Contract Documents and work sequencing Section 01 12 16 may be made only in accordance with applicable provisions of the General Conditions of the Contract Documents.

1.05 PROJECT STATUS UPDATE

A. The Contractor shall provide an updated schedule with every pay estimate and/or no less than once a month as indicated in Section 01 29 00. The update shall incorporate the progress that was made during the pay period or update period and the costs that the Contractor intends to bill as part of the progress payment request. The Contractor shall not change the original duration of an activity without the approval of the Construction Manager.

B. Updated Progress Schedule shall reflect:
1. Progress of Work to within 5 working days prior to submission.
2. Approved changes in Work scope and activities modified since previous submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.

7. Report of changed logic.

C. Produce detailed sub-schedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

D. The contractor shall include activities for delays and time impacts in the schedule. The schedule will serve as the basis for any potential request for additional time. Request for additional time shall be accompanied by and based on a Time Impact Analysis as described in AACE International Recommended Practice No. 52.

E. If Contractor fails to complete activity by its latest scheduled completion date and this Failure is anticipated to extend Contract Times (or Milestones), Contractor shall, within 5 working days of such failure, submit a written statement as to how Contractor intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to Contract Price or Contract Times. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to complete milestone activity by its completion date or satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

F. Narrative Progress Report:
   1. Format
      a. Organize same as Progress Schedule.
      b. Identify, on a cover letter, reporting period, date submitted, and name of author of report.
   2. Contents
      a. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
      b. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
      c. Contractor's plan for management of Site (e.g., lay down and staging areas, construction traffic), utilization of construction equipment, buildup of trade labor, and identification of potential Contract changes.
      d. Identification of new activities and sequences as a result of executed Contract changes.
      e. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
      f. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
      g. Changes to activity logic.
      h. Changes to the critical path.
      i. Identification of, and accompanying reason for, any activities added or deleted since the last report.
      j. Steps taken to recover the schedule from Contractor-caused delays.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 23

PRE- AND POST-CONSTRUCTION SURVEYS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor and materials necessary to perform all surveying and staking essential for the completion of construction in conformance with the Drawings, Specifications, and Contract Documents.

B. The Contractor shall perform all the necessary Work and calculations required to accomplish the Work in accordance with this Division.

C. This Section establishes a minimum standard of field survey specifications and procedures to properly control the construction project.

D. The Contractor shall insure that commonly accepted practices of survey methods and procedures are followed.

E. The Owner shall coordinate and/or conduct all survey work.

F. Errors or damages resulting from the Contractor's survey shall be corrected or made whole at the expense of the Contractor.

G. The Owner shall not be held liable for any additional expense.

H. Any method conflicting with these survey specifications must be approved by the Construction Manager prior to its use.

I. The Contractor shall notify the Construction Manager twenty-four (24) hours in advance prior to beginning Work.

J. All requests for information or determinations concerning the project shall be directed to the Construction Manager.

1.02 PAYMENT

A. Payment for this Work incidental with other work in accordance with Section 01 29 00.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 PROJECT CONTROL

A. The Owner will provide project horizontal and vertical control monuments to facilitate construction staking. The Contractor shall recover project survey control monuments shown on the Drawings or establish project survey control monuments to ensure the project is properly located and constructed according to the Contract Documents.

B. Survey control monuments may be shown on the Drawings. Prior to construction, the Contractor shall locate these monuments to ensure they have not been destroyed. In the event the Contractor is unable to locate certain monuments, the Contractor shall notify the Construction Manager immediately and provide 5 working days for the Construction Manager to reestablish the missing monumentation.

C. The Contractor shall have no basis for a claim requesting additional compensation for costs incurred due to missing survey control which is shown on the Drawings, unless the Construction Manager fails to reestablish said control within 5 working days after written notification from Contractor. The Contractor may be entitled an extension of time as the Construction Manager may determine. Claim for extension of time shall be in accordance with Section 01 32 16.

D. The Contractor shall notify the Construction Manager immediately if a discrepancy exists between the field conditions and the Contract Documents. Project staking, which would be directly affected by the discrepancy, shall cease until further notice by the Construction Manager. Work unaffected by the discrepancy shall continue uninterrupted.

E. The Contractor is responsible for preserving, protecting, and replacing all monuments and lot corners, line stakes, grade stakes, reference points, and hubs. In the event of their loss or destruction, the Contractor shall pay all costs for their replacement.

F. Monuments:
   1. General Description
      a. A monument is defined as a material object used to physically identify a measured point on the earth's surface that was determined by a land survey.
      b. The term "monument" will be deemed generic to identify public land corners, private property corners and public agency vertical and horizontal control monuments.
      c. If a question arises as to the validity of a found object being a monument, it should be submitted to the Construction Manager for clarification prior to disturbance or removal.
   2. Existing Monument Search
      a. Contractor shall perform a monument search before commencement of construction staking.
      b. Contractor shall locate and verify all project survey control monuments shown on the Drawings to ensure that they have not been disturbed or destroyed.
      c. In the event the Contractor is unable to locate any survey control monument that is shown on the Drawings, the Contractor shall notify the Construction Manager immediately.
      d. The Construction Manager shall have 5 working days to reestablish the missing monument or make a determination whether the project can be accurately staked without the missing monument.
   3. Requirement to Establish Monuments
      a. The Contractor shall replace any monument that exists within the construction limits if it is disturbed or removed due to project activity.
      b. All monumentation disturbed or removed shall be replaced with the same type monument or monument approved by the Construction Manager.

c. Should a physical impediment prevent a monument from being reestablished at its original location, one or more reference monuments shall be established.

d. The establishment of reference marks shall be coordinated with the Construction Manager.

G. Project Control Accuracy:

1. Horizontal Control

a. The maximum permissible linear error allowed in establishing horizontal control is 1:10,000 feet.

b. The maximum error allowed in unadjusted angular closure shall be calculated by the formula "15 times the square root of N." The term "N" signifies the number of transit setups in a traverse and "15" signifies fifteen seconds.

2. Vertical Control

a. Vertical datum shall originate from the established site benchmarks.

b. All level circuits run to establish temporary benchmarks shall have an accuracy no less than the value computed by the equation (three-hundredths feet (0.03') times the square root of the distance in miles).

c. Foresights and backsights shall be balanced. The maximum sighting distance shall not exceed three hundred feet (300').

d. All leveling circuits establishing TBMs will be adjusted utilizing recognized standard surveying adjustment methods.

e. Side shots to establish an elevation on TBMs will not be allowed.

f. A minimum of two known benchmarks shall be utilized when establishing TBMs to verify correct elevation information.

g. A sufficient number of TBMs shall be set to control a project with a maximum spacing of eight hundred feet (800') between marks.

h. Typically, a TBM should not be greater than two hundred feet (200') outside the construction limits of the project.

i. All TBMs shall be located and be comprised of sufficient materials such that their integrity will not be compromised throughout the life of the project.

3. Construction Centerline

a. The construction centerline location and stationing shall conform to that shown on the Drawings.

b. Any errors found in the line shall be corrected and shown on the specific plan view with reference to the centerline stationing.

c. If control points do not exist, they shall be established and referenced so that the line can be readily re-established when required.

d. A minimum of two reference points shall be established to reference each project control point or monument. Each reference point shall be visible to the other reference point.

e. The method of referencing control points shall be done in accordance with the Standard Details of these specifications.

f. Reference points shall be placed at locations where there is the least possibility of their being disturbed during the construction period.

g. Measurements and sketches of the reference points shall be kept in the horizontal control survey field book.

4. Check Existing Ground Profile
    a. A centerline profile shall be run prior to establishing construction grade stakes.
    b. The existing ground elevations shall be checked against the existing profile elevations shown on the Drawings to verify design grade relative to the existing ground conditions.
    c. The Contractor shall review the centerline profile information and immediately notify the Construction Manager of any elevations that do not match the plan profile information. The Construction Manager will direct the Contractor how to proceed.

3.02 DRAINAGE FACILITIES

A. The location, type, size, length, and invert elevations for drainage facilities are given on the Drawings.

B. Minor changes in locations and grades to meet existing field conditions may be made where necessary, but only with the approval of the Construction Manager.

C. If the planned design grade is found to be unworkable in the field, the Construction Manager shall be notified immediately, and all grade staking of the facility shall cease until further notice from the Construction Manager.

3.03 MAJOR STRUCTURES

A. Construction survey procedures shall be reviewed by the Construction Manager prior to commencing any construction staking.

B. The Construction Manager's review and approval of survey procedures is required prior to commencing construction activities for major structures including piling foundations, drainage control facilities and buildings.

C. Horizontal and vertical control for the project shall be verified by the Contractor prior to any construction activity.

D. The Contractor shall verify existing field elevations where planned foundations, pilings, piers, and support structures are to be placed prior to any construction activity.

E. If any discrepancies are found between the Contract Documents and existing conditions the Contractor shall inform the Construction Manager immediately.

3.04 MISCELLANEOUS CONSTRUCTION

A. The Contractor shall provide sufficient stakes for adequate control of all structures and incidental construction not specifically covered above.

B. A staking diagram with respect to centerline and measurements for pay quantities shall be maintained in the field notes.

C. Other items such as horizontal and vertical control shall be shown in the field book and shall be governed by procedures established in previous articles of this Specification.

3.05 RECORD SURVEYS AND RECORD DRAWINGS

A. Record survey measurements shall be required for all constructed facilities and improvements to confirm the dimensions, lines, grades, locations, or materials as shown on the Drawings.

B. Survey measurements shall be taken, field notes shall be kept, and accuracy shall be attained in accordance with this Division.

C. Record information shall be marked on a clean set of full-size paper copy.

D. Drawings shall be submitted at the completion of construction activity in accordance with Section 01 78 39. The Drawings shall be clearly stamped "Record Drawings."

E. No final project payment will be made to the Contractor until the record Drawings have been submitted to and approved by the Construction Manager.

F. The following abbreviations shall be used on the Record Drawings to denote a deviation from the Drawings:
   1. REC "Record" - The actual horizontal, vertical, dimension, or quantity measured by survey after it has been constructed.
   2. F.C. "Field Change" - Revision or change of original design made in the field.
   3. "DELETED" - Not constructed.

G. Minimum requirements for construction of Record Drawings:
   1. Record Work shall be marked in red ink or red pencil to clearly identify the changes to the original design.
   2. A straight line drawn through stationing, elevations, and notes shall show a change, deletion, or omission and shall be followed with the appropriate symbol.
   3. Storm sewer, water, sanitary sewer, gas lines, or any construction that has been deleted or relocated will be crosshatched.
   4. Crossed out information should still remain legible.
   5. The scale of new gas lines, water, sewer, or any new construction not shown should conform to the scale of the drawings.
   6. Reference information used to prepare Record Drawings, such as change orders, and field books, shall be noted on the drawings.
   7. Profile changes will be made with elevations or stationing only. The profile line need not be re-drawn unless the change is significant.
   8. Record drawings for water, sewer, gas lines, and storm drain systems shall be accurate within three-hundredths feet (0.03’) vertically and one-half feet (0.5’) horizontally. Record Information shall be referenced to existing subdivision survey control and/or monumented centerline of the right-of-way control.
   9. Record drawings for structures shall be accurate to within one-half inch (1/2”) vertically and horizontally.
   10. The name of the Record Drawing preparer, the employer, and the date of the preparation shall appear in the appropriate title block on each Record Drawing sheet.

H. The construction of Record Drawings is incidental to other Work and no measurement or payment shall be made.

END OF SECTION

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies progress photographs to be provided for pre-construction, during construction, and post-construction.

1.02 SUBMITTALS

A. Photographs shall be submitted in accordance with Section 01 33 00 - Submittal Procedures.

B. Submit monthly photographs and video log to Owner.

PART 2 PRODUCTS

2.01 PHOTOGRAPHS

A. Photographs shall be taken using a digital camera. Photographs shall be in color and shall have a minimum image file size of 1.4 MB.

B. Upload, maintain, and organize the photographs monthly using a commercially available photo management system. Organize files by area, year, and month. Assign file names that include location by area, direction, description and date taken.

C. Submit photographs in digital format on a monthly basis with payment application via disk or external drive unit.

PART 3 EXECUTION

3.01 GENERAL

A. Photographs shall be taken at locations designated by the Owner and Construction Manager.

B. The photographer shall be equipped to photograph interior and exterior exposures, with lenses ranging from wide-angle to telephoto and flash equipment as necessary for interior spaces.

C. The photographer shall be experienced in construction photography.

D. High-definition video 1080p at 30 fps or higher images may be acceptable for certain operations. Confirm with Construction Manager.

3.02 PRE-CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide preconstruction photographs prior to commencement of work on the Site.

3.03 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide construction photographs showing the progress of the Work. The photographs shall be taken of such subjects as may be directed by the Owner and Construction Manager.

B. Photographs of all underground piping and structures prior to backfilling. Include associated location information.

3.04 POST-CONSTRUCTION PHOTOGRAPHS

A. Take the number of exposures specified until Final Acceptance of the Work. Locations shall be designated by the Owner and Construction Manager.

3.05 REQUIRED NUMBER OF PHOTOGRAPHS

A. For the work of this Contract, photographs shall provide the minimum number of photographs as follows:

Category	Number of Photographs
Preconstruction	100
	6 aerial
Construction	25 weekly
	100 monthly
	6 aerial quarterly
Acceptance	100
	6 aerial

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes administrative and procedural requirements for submittals applicable to the Contractor's Work.

B. Detailed submittal requirements are also in technical specification sections.

1.02 ADMINISTRATIVE REQUIREMENTS

A. General:

1. Furnish submittal items as specified in the Contract Documents.
2. Review submittal information to verify it is accurate and fulfills specified submittal requirements before submitting for review and comment.
3. Edit submittal content to clearly indicate only those items, models, or series of equipment, which are being submitted for review. Cross out or otherwise obliterate extraneous materials.
4. Ensure there is no conflict with other submittals and notify the Owner's Representative in each case where the submittal may affect the work of another contractor or the Owner.
5. Coordinate submittals among subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in the Contract Documents.
6. For each submittal, certify field conditions, compliance with the Contract Documents, and review of the submittal prior to submitting for review.
7. Designate the installation location within the facility, application, or intended purpose for each submittal item. Review comments are solely applicable to the circumstances designated in the submittal.
8. Coordinate submittals with the work so that work will not be delayed. Coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with others.
9. No extension of time will be allowed because of failure to properly schedule, coordinate or compile submittals.
10. Submittals will be rejected for lack of legibility, lack of coordination, ambiguity, or are incomplete. Incomplete submittals will be returned without review.
11. Do not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
12. If desired, authorize material or equipment suppliers to deal directly with the Owner's Representative regarding a submittal. Such dealings require written authorization from the Contractor and are limited to contract interpretations to clarify and expedite the work.

1.03 DEFINITIONS

A. Action Submittals:
   1. Action Submittals content require review and response by the Owner's Representative before proceeding with incorporating the subject equipment, materials, or procedure into the work.
   2. Review comments on Action Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

B. Informational Submittals:
   1. Informational Submittals are examined to verify that the specified submittal contents have been furnished as specified.
   2. The Contractor's actions are not contingent on the disposition of review comments on Informational Submittals.
   3. Review comments on Informational Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

C. Closeout Submittals:
   1. Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work.
   2. Review comments on Closeout Submittals, and perform the subsequent actions based on the REVIEW ACTION requirements specified below.

D. Product Data:
   1. Product Data, including information specified in individual sections, consists of but is not limited to, standard manufactured product data and catalog information, product specification and installation instructions, printed statements of compliance and applicability, availability of colors, product photographs, roughing-in diagrams and templates, wiring diagrams, performance curves and operational range diagrams, production or quality control inspection, testing reports, and certifications, mill reports, operating and maintenance instructions, recommended spare parts lists, and warranties.

E. Shop Drawings:
   1. Shop Drawings include but are not limited to drawings that include fabrication, erection, and installation drawings, scheduled information, actual manufacturing instructions, coordination drawings, setting diagrams, and individual system or equipment inspection and test data including performance curves and certifications.

F. Samples:
   1. Samples include partial sections of components, cuts, or containers of materials, color range sets, and swatches showing color, texture and pattern.
   2. Samples may be Action or Informational submittals.

G. Mock-Ups:
   1. Mock-ups are scale representations of items to be constructed as part of the work as required in the Contract Documents.
   2. Mock-ups are Action Submittals.

H. Review Actions:
   1. The following definitions and actions are associated with the REVIEW ACTIONS DEFINED below:
      a. NO EXCEPTIONS TAKEN: If the review indicates that the material, equipment or work method complies with the Contract Documents, submittal will be marked "NO EXCEPTIONS TAKEN." Implement the work method or incorporate the material or equipment covered by the submittal.
      b. MAKE CORRECTIONS NOTED: If the review indicates limited corrections are required, submittals will be marked "MAKE CORRECTIONS NOTED." Implement the work method or incorporate the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, provide a corrected copy.
      c. AMEND AND RESUBMIT: If the review reveals that the submittal is insufficient or contains incorrect data, submittals will be marked "AMEND AND RESUBMIT." Do not undertake work until the submittal has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
      d. REJECTED – SEE REMARKS: If the review indicates that the material, equipment, or work method does not comply with Contract Documents, the submittal will be marked "REJECTED - SEE REMARKS." Do not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" except at your own risk.
      e. RECEIPT ACKNOWLEDGED: Filed for Record. This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules, work plans, test reports, health and safety plans, etc.

1.04 MASTER SUBMITTAL LIST

A. Contractor shall provide updated submittal lists as the construction progresses during design. A maximum of fifteen (15) business days following the delivery of Issue for Construction (IFC) documents, the Contractor will provide the Owner's Representative a Master Submittal List listing anticipated submittal requirements for the contract.

B. Contractor shall update the list as submittals are completed and transmit to the Owner's Representative. Provide updated list to Owner's Representative monthly.

C. Include the following as a minimum in the updated list:
   1. Submittal number.
   2. Date submitted.
   3. Requested time for return of comments.
   4. Special requests, if any, for that particular submittal.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SUBMITTAL PROCEDURES

A. General:
   1. Owner's Representative will review submittal information for completeness and forward to Engineer for review. Engineer will review and indicate a REVIEW ACTION. Review of submittals does not relieve the Contractor of responsibility for performance of the work according to the Contract Documents.
   2. Coordinate submittal transmittal for related elements of work to ensure the submittals are processed as needed to meet the intent of the work and that delays are minimized.
   3. Submittal review activity will be prioritized based on the order received unless otherwise requested by the Contractor.
   4. Submittal sequencing should coincide with the Construction Schedule in Section 01 32 16 - Construction Progress Schedule.
   5. A review duration of 21 calendar days is allotted for each submittal, from the date of receipt by the Owner's Representative to the date of return to the Contractor.

B. Submittal Preparation:
   1. Excepting, mock-ups, spare parts, physical samples, and other items that cannot be converted to electronic media, furnish submittal contents electronically in a searchable PDF format.
      a. Include a table of contents and labeled divider sheets that are coordinated with the table of contents.
         1) Sequentially number all pages within the submittal.
         2) All bookmarks and pages must match the table of contents and appear as expanded bookmarks when the PDF file is opened for review.
      b. Diagrams, drawings, pictures, and illustrations presented with a consistent orientation.
         1) Low resolution images or documents are not allowed.
         2) Include field measurements and dimensions of equipment and adjacent features.
      c. Action and Closeout Submittals: One digital copy of submittal.
      d. Informational Submittals: One digital copy of submittal.
   2. Shop Drawings, Samples and Mock-ups:
      a. Submit one electronic copy per the requirements described above and the following:
         1) Shop Drawings: One digital copy of submittal.
         2) Samples: three (3) samples.
         3) Mock-up: As required by individual specification.
         4) Demonstrations: As required to facilitate installation and inspection.

b. Prior to submittal for review Contractor shall check and verify that all shop drawing information, including measurements, materials, and details, conforms to the intent of the drawings and specifications. Contractor shall return and coordinate revisions with any subcontractors prior to submittal. Submitted shop drawings found to be inaccurate or otherwise in error shall be regarded as an incomplete submittal and returned to Contractor.

c. Shop Drawing information shall include:
   1) Layout.
   2) Nameplate information.
   3) Manufactured dimensions from front, side, rear, top, and bottom with all dimensions clearly labeled.
   4) Weight.
   5) Finish.
   6) Locations of access plates and conduits.

d. Include all Product Data as defined in paragraph 1.03 and as required in individual sections.

e. Reference applicable specifications for additional requirements.

C. Submittal Completeness:
   1. Submittals without all required information are not acceptable and may be marked "REJECTED" and returned without review.
   2. For a submittal to be deemed complete, provide the information required below and specified in specification sections, including those elements in the special transmittal procedures where required.

D. In the event of the need to "revise and resubmit", provide a complete stand-alone submittal with corrections, revisions, and new information clearly identified.

E. Resubmit changes to submittals that require a stamp and signature by a licensed engineer or other certification with the requisite stamp and signature or certifications.

3.02 TRANSMITTAL PROCEDURE

A. General:
   1. Include the following information on the submittal transmittal form:
      a. Project names and date
      b. Name of Contractor and Subcontractor
      c. Name of supplier and name of manufacturer
      d. Number and title of appropriate specification section
      e. Drawing number and detail references, as appropriate
   2. Equipment and Material Submittals: Unless otherwise specified, complete the Transmittal Form 01 33 00-A - Submittal Transmittal Form specified in Section 01 99 90 - Reference Forms.
   3. Operation and maintenance manuals, information and data Submittals: Complete the Transmittal Form 01 78 23-A - Operation and Maintenance Transmittal Form specified in Section 01 99 90 - Reference Forms.

4. Use a separate form for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which a submittal is required. Identify the appropriate equipment numbers for submittal documents common to more than one piece of equipment. Submit a single form for multiple items, if the items taken together constitute a Supplier's package or are functionally related, to facilitate checking or reviewing the group or package as a whole.
5. Assign a unique sequential number to each transmittal form accompanying each item submitted.
    a. Format submittal numbers as follows: "SS SS SS-XXX"; where "SS SS SS" is the referenced 6-digit section number from the Specifications and "XXX" is the sequential number assigned by the Contractor.
    b. Format resubmittals as follows: : "SS SS SS-XXX-YY"; where "XXX" is the originally assigned submittal number and "YY" is a sequential number assigned for resubmittals, i.e., 00, 01, or 02 being the original, 1st, and 2nd resubmittals, respectively. Submittal 43 23 50-001-02, for example, is the second resubmittal of submittal 001 pertaining to Section 43 23 50.
6. Deviation from contract: If deviations from the material, equipment or method of work are proposed, describe the proposed deviation and explain the reason for proposing the deviation under "deviations" on the transmittal form accompanying the submittal copies.

B. Document Management System Specific Procedures:
    1. Unless otherwise specified, submittals regarding material and equipment shall be submitted electronically using a document control program/website.
    2. Login information and instructions will be provided to Contractor.

C. Check Marked Specification Transmittal Procedures:
    1. All submittals require a "marked" copy of the specification marked as indicated below. Provide the following when transmitting the submittal:
        a. Provide a copy of the specification section(s) that specifies a marked copy of the specification. Include addendum updates and referenced specification sections, with addendum updates. Complete the following:
            1) Checkmark each paragraph to indicate submittal compliance with that specification requirement. Check marks (✓) shall denote full compliance with that paragraph as a whole.
            2) Mark paragraphs where deviations are proposed by underlining text that is the subject of the proposed deviation. Denoting each proposed deviation with a number in the margin to the right of the identified paragraph and provide a detailed written explanation for each numbered deviation. The remaining portions of the paragraph not underlined signify compliance with specified requirements.
            3) The Engineer is the final authority for determining acceptability of requested deviations.

b. For equipment specifications, provide a copy of the control diagrams, process and instrumentation diagrams, and all pertinent design drawings relating to the submitted equipment, with addendum updates that apply to the subject equipment. Complete the following:
    1) Mark drawings or diagrams to show specific changes necessary for the equipment proposed in the submittal.
    2) If no changes are required, mark the drawings or diagrams with "no changes required".

D. Provide a Certificate of Unit Responsibility assigning unit responsibility in accordance with the requirements of the specification Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with the Specifications.

E. Samples and Mock-ups:
    1. Submit samples and mock-ups in accordance with the Contract Documents. Package samples to facilitate review. Include the following with the Submittal Transmittal Form:
        a. Generic description of the sample
        b. Sample source
        c. Product name and name of manufacturer
        d. Compliance with recognized standards
        e. Submittal Number
        f. Availability and delivery time
        g. Specification Section
    2. Submit samples and mock-ups before installation. Where variation in color, pattern, texture or other characteristics are inherent in the material, submit four units to show variation range.
    3. Where samples are for selection of appearance characteristics from a range of standard choices, submit a full set of choices for the material or products.
    4. Maintain sets of approved samples and mock-ups at the Project Site, for quality comparisons throughout the course of construction.
    5. Demolish and remove all samples and mock-ups prior to substantial completion.

3.03 REVIEW PROCEDURE

A. General:
    1. Owner’s Representative will compile Engineer’s review comments and provide response for each submittal, indicate a REVIEW ACTION, and return to the Contractor.
    2. Returned submittals indicate one of the following REVIEW ACTIONS: NO EXCEPTIONS TAKEN, MAKE CORRECTIONS NOTED, AMEND AND RESUBMIT, REJECTED – SEE REMARKS, or RECEIPT ACKNOWLEDGED.

3.04 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

A. General:

1. Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, does not relieve the Contractor of responsibility for errors therein and is not regarded as an assumption of risks or liability by the Engineer, Owner's representative, or the Owner, or by any officer or employee thereof, and the Contractor has no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" means that the Owner has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

END OF SECTION

SECTION 01 35 23

SAFETY AND HEALTH

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the requirements for safety and health at the Site and include:
   1. Contractor's Responsibilities
   2. Potential Exposures during Execution of the Work
   3. Safety and Health Regulations
   4. Safe Access to the Work
   5. Construction Safety Program
   6. Safety Equipment
   7. Emergency Response Plan
   8. Accidents

1.02 CONTRACTOR'S RESPONSIBILITIES

A. Initiate, maintain, and supervise safety precautions and programs in connection with the Work. This does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Take necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to the following:
   1. Persons on the Site or who may be affected by the Work.
   2. Work and materials and equipment to be incorporated therein, whether in storage on or off the Site
   3. Other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Comply with applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain necessary safeguards for such safety and protection. Notify owners of adjacent property and/or Underground Facilities prior to starting the Work.

1.03 POTENTIAL EXPOSURES DURING EXECUTION OF WORK

A. Portions of the Work provide potential exposure to chemicals in both a concentrated and diluted form. The Contractor shall be experienced and qualified to anticipate and meet this Project's safety and health requirements.

B. Provide in the Safety Program a Plan indicating understanding of the Project's safety and health dangers and demonstrates experience and qualifications to perform the Work indicated.

1.04 SAFETY AND HEALTH REGULATIONS

A. Comply with federal, state, city, and local Safety and Health Regulations for Construction.

B. Safety provisions shall conform to the Federal and State Departments of Labor Occupational Safety and Health Act (OSHA) and applicable federal, state, county, and local laws, ordinances, codes, the requirements set forth herein, and any regulations that may be specified elsewhere in these Contract Documents. Where provision conflicts with another, the more stringent requirement shall be followed. The Contractor's failure to become thoroughly familiar with the safety provisions shall not relieve the Contractor from compliance with the obligations or penalties set forth therein.

C. The Contractor shall comply with Safety and Health Regulations for Construction, promulgated by the Secretary of Labor under Section 107 of the Contract Work Hours and Safety Standards Act, as set forth in Title 29, C.F.R. Copies of these regulations may be obtained from Labor Building, 14th and Constitution Avenue N.W., Washington, DC 20013.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SAFE ACCESS TO THE WORK

A. Provide proper facilities for safe access to the work for the Owner including testing personnel and authorized government officials.

3.02 CONSTRUCTION SAFETY PROGRAM

A. Within 30 days after the Notice to Proceed and prior to mobilization, develop and implement a Project-specific safety program and submit the plan to the Owner for information and not technical review. The Owner will review the Contractor's safety program and may provide comments to the Contractor. The Owner review will not relieve the Contractor of their responsibility for safety, nor shall it relieve the Contractor from liability for any incompleteness or inadequacy of their safety program. The Contractor's plan shall include, but not be limited to, the following items:
   1. Safety organization and representatives
   2. Employee training and orientation
   3. PPE requirements
   4. Procedure for mandatory initial and refresher confined space training for all Contractor and Subcontractor On-Site personnel
   5. Procedures for electrical and mechanical Lock-Out/Tag-Out
   6. Procedures for Hot Works
   7. General site safety regulations
   8. Record keeping and reporting requirements.
   9. Safety promotion programs or incentive goals
   10. Documentation incorporated into the Contractor's safety manual whereby its personnel have been informed about and know what health precautions should be taken when working in a water treatment plant and in any parts of the water treatment system.
   11. The Contractor's plan shall include a list with emergency phone numbers that shall allow the Owner to obtain responses to an emergency at any time day or night.

3.03 SAFETY EQUIPMENT

A. Implement a hardhat and PPE system for all employees and Subcontractors. Company logos must also be provided on all hard hats. All hardhats and PPE used on the Project must comply with OSHA requirements and applicable standards and be always in good working condition.

3.04 EMERGENCY RESPONSE PLAN

A. Develop and implement an *Emergency Response Plan*. The plan shall be submitted to the Owner within 60 days after the Notice to Proceed for review and acceptance. The Contractor's plan shall include, but not be limited to, the following:
   1. Emergency evacuation procedures
   2. Emergency notification plan
   3. Emergency supplies
   4. Disaster supply kit

B. Develop and maintain a program for confined space entry before, during, and after the construction work has been executed. This program shall comply with state, federal, and local regulations.

3.05 ACCIDENTS

A. Report immediately by telephone or messenger to the Owner if the accident causes death, serious injuries, or serious damages. Report other accidents to the Owner within 24 hours.

B. Complete and submit a written report to the Owner providing full details and witness statements no later than 7 days after the accident. Follow this procedure for accidents resulting from or in conjunction with performing the Work, whether on or adjacent to the Site.

C. If anyone makes any claim against the Contractor or a Subcontractor due to an accident, report the facts in writing to the Owner giving full details about the claim no later than 24 hours after receiving notice of the claim.

END OF SECTION

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SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 SITE MAINTENANCE

A. The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.
   1. Temporary Disturbance Areas:
      a. The disturbance areas are shown on Drawings. These disturbance areas are highly prescriptive and shall be required to be observed by the Contractor in performing the Work. Before any ground disturbance occurs, construction limit fencing and tree protection fences shall be installed. The limits shall be observed at all times for all construction activities. The Contractor shall not perform work outside of the defined disturbance areas.
   2. Tree Protection Fences:
      a. Tree protection fences shall be installed around all trees to remain before any construction activity commences and require Owner's inspection and approval.

1.02 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

1.04 NOISE CONTROL

A. Contractor shall meet the requirements of the City of Vancouver Municipal Code (VMC).

B. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Between 7:30 p.m. and 7:00 a.m., noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at a distance of 50 feet from the noise source.

D. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.

END OF SECTION

SECTION 01 42 19

REFERENCE STANDARDS

PART 1 GENERAL

1.01 ABBREVIATOINS

A. Wherever used in the project manual, the following abbreviations will have the meanings listed:

Abbreviation	Meaning
AA	Aluminum Association Incorporated P.O. Box 753 Waldorf, MD 20604
AABC	Associated Air Balance Council 1518 K Street N.W. Washington, DC 20005
AAMA	American Architectural Manufacturers Association 1540 East Dundee Road, Suite 310 Palatine, IL 60067
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W., Suite 249 Washington, DC 20001
ABMA	American Bearing Manufacturers Association 1200 19th Street N.W., Suite 300 Washington, DC 20036
ACI	American Concrete Institute 22400 West Seven Mile Road P.O. Box 19150, Redford Station Detroit, MI 48219
AEIC	Association of Edison Illuminating Companies 600 North 18th Street P.O. Box 2641 Birmingham, AL 35291
AGA	American Gas Association ATTN: Records 1515 Wilson Boulevard Arlington, VA 22209
AGMA	American Gear Manufacturer's Association, Inc. 1500 King Street, Suite 201 Alexandria, VA 22314
AHA	American Hardboard Association 1210 West Northwest Highway Palatine, IL 60067
AISC	American Institute of Steel Construction One East Wacker Drive, Suite 3100 Chicago, IL 60601

Abbreviation	Meaning
AISI	American Iron and Steel Institute 1101 Seventeenth Street, NW, Suite 1300 Washington, DC 20036
AITC	American Institute of Timber Construction 7012 South Revere Parkway, Suite 140 Englewood, CO 80112
ALSC	American Lumber Standard Committee P.O. Box 210 Germantown, MD 20875
AMCA	Air Movement and Control Association, Inc. 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 11 West 42nd Street, 13th Floor New York, NY 10036
APA	American Plywood Association 7011 South 19th Street Tacoma, WA 98466
API	American Petroleum Institute 1220 "L" Street N.W. Washington, DC 20005
ARI	Air-Conditioning and Refrigeration Institute 4301 North Fairfax Drive, Suite 425 Arlington, VA 22203
ASCE	American Society of Civil Engineers United Engineering Center 345 East 47th Street New York, NY 10017
ASCII	American Standard Code for Information Interchange United States of America Standards Institute 10 East 40th Street New York, NY 10016
ASE Code	American Standard Safety Code for Elevators, Dumbwaiter and Escalators American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. 1791 Tullie Circle, NE Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017

Abbreviation	Meaning
ASTM	American Society for Testing and Materials 100 Barr Harbor Drive West Conshohocken, PA 19428
AWPA	American Wood-Preservers' Association 9549 Old Fredrick Road Ellicott City, MD 21042
	or P.O. Box 286 Woodstock, MD 21163-0286
AWS	American Welding Society 550 NW LeJeune Road P.O. Box 351040 Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BOCA	Building Officials and Code Administrators, International, Inc. 4051 West Flossmoor Road Country Club Hills, IL 60478
CALTEST	Materials Manual, State of California, Business and Transportation Agency Department of Public Works State of California, Department of Transportation 6002 Folsom Boulevard Sacramento, CA 95819
CALTRANS	Standard Specifications, State of California, Department of Transportation State of California, Business and Transportation Agency P.O. Box 1499 Sacramento, CA 95807
CBM	Certified Ballast Manufacturers 2120 Keith Building Cleveland, OH 44115
CMAA	Crane Manufacturers Association of America, Inc. (Formerly called: Overhead Electrical Crane Institute) (OECI) 8720 Red Oak Boulevard, Suite 201 Charlotte, NC 28217
CRSI	Concrete Reinforcing Steel Institute 933 N Plum Grove Road Schaumburg, IL 60173
CSA	Canadian Standards Association 178 Rexdale Boulevard Rexdale, Ontario, M9W IR3, Canada
DEMA	Diesel Engine Manufacturer's Association 30200 Detroit Road Cleveland, OH 44145

Abbreviation	Meaning
DHI	Door and Hardware Institute 14170 Newbrook Drive Chantilly, VA 22021
DIS	Division of Industrial Safety California Department of Industrial Relations 2422 Arden Way Sacramento, CA 95825
DOC	U.S. Department of Commerce 1401 Constitution Ave NW Washington, DC 20230
EEI	Edison Electric Institute 90 Park Avenue New York, NY 10016
EIA	Electronic Industries Association Order from: Global Engineering Documents 18201 McDurmott West Irvine, CA 92714
EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
ESO	Electrical Safety Orders California Administrative Code, Title 8, Chap. 4, Subarticle 5 Office of Procurement, Publications Section P.O. Box 20191 8141 Elder Creek Road Sacramento, CA 95820
FEDSPEC	Federal Specifications General Services Administration Specification and Consumer Information Distribution Branch Washington Navy Yard, Bldg. 197 Washington, DC 20407
FEDSTDS (see FEDSPECS)	Federal Standards
FM	Factory Mutual Engineering and Research Corporation 1151 Boston-Providence Turnpike P.O. Box 9102 Norwood, MA 02062
HEI	Heat Exchange Institute 1300 Sumner Avenue Cleveland, OH 44115
HI	Hydraulic Institute 9 Sylvan Way, Suite 180 Parsippany, NJ 07054

Abbreviation	Meaning
HPVA	Hardwood Plywood & Veneer Association 1825 Michael Faraday Drive P.O. Box 2789 Reston, VA 22090-2789
IAPMO	International Association of Plumbing and Mechanical Officials 20001 Walnut Drive S Walnut, CA 91789
ICBO	International Conference of Building Officials 5360 Workman Mill Road Whittier, CA 90601
ICEA	Insulated Cable Engineers Association P.O. Box 440 South Yarmouth, MA 02664
IEEE	Institute of Electrical and Electronics Engineers 445 Hoes Lane P.O. Box 1331 Piscataway, NJ 08855
IES	Illuminating Engineering Society of North America 120 Wall Street New York, NY 10017
ISA	Instrument Society of America 67 Alexander Drive P.O. Box 12277 Research Triangle Park, NC 27709
JIC	Joint Industrial Council 7901 West Park Drive McLean, VA 22101
MFMA	Metal Framing Manufacturers Association 401 N. Michigan Avenue Chicago, IL 60611
MILSPEC	Military Specifications Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MSS	Manufacturers Standardization Society of the Valve & Fittings Industry, Inc. 127 Park Street, N.E. Vienna, VA 22180
NAAMM	National Association of Architectural Metal Manufacturers 11 South La Salle Street, Suite 1400 Chicago, IL 60603
NACE	National Association of Corrosion Engineers 1440 South Creek Drive Houston, TX 77084
NBC	National Building Code Published by BOCA

Abbreviation	Meaning
NEC	National Electric Code National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NELMA	Northeastern Lumber Manufacturers Association, Inc. P.O. Box 87A Cumberland Center, ME 04021
NEMA	National Electrical Manufacturer's Association 2101 L Street, NW, Suite 300 Washington, DC 20037
NESC	National Electric Safety Code American National Standards Institute 1430 Broadway New York, NY 10018
NFOR	National Forest Products Association (Formerly National Lumber Manufacturer's Association) 1111 19 Street NW, Suite 700 Washington, DC 20036
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269
NHLA	National Hardwood Lumber Association 6830 Raleigh LaGrange P.O. Box 34518 Memphis, TN 38184-0518
NIST	National Institute of Standards and Technology 100 Bureau Drive Gaithersburg, MD 20899
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 130140 Ann Arbor, MI 48113
OSHA	Occupational Safety and Health Act U.S. Department of Labor Occupational and Health Administration San Francisco Regional Office 450 Golden Gate Avenue, Box 36017 San Francisco, CA 94102
PCI	Precast/Prestressed Concrete Institute 175 West Jackson Blvd., Suite 1859 Chicago, IL 60604

Abbreviation	Meaning
PPIC	The Plumbing & Piping Industry Council, Inc. 510 Shatto Place, Suite 402 Los Angeles, CA 90020
RIS	Redwood Inspection Service California Redwood Association 405 Enfrente Dr., Suite 200 Novato, CA 94949
RMA	Rubber Manufacturers Association 1400 K Street NW, Suite 900 Washington, DC 20005
SAE	Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096
SAMA	Scientific Apparatus Makers Association One Thomas Circle Washington, DC 20005
SBC	Standard Building Code Published by SBCCI
SBCCI	Southern Building Code Congress International Inc. 900 Montclair Road Birmingham, AL 35213
SCMA	Southern Cypress Manufacturers Association 400 Penn Center Boulevard, Suite 530 Pittsburg, PA 15235
SDI	Steel Door Institute 30200 Detroit Road Cleveland, OH 44145
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc. P.O. Box 221230 Chantilly, VA 22021
SPI	Society of the Plastics Industry, Inc. 1275 K Street NW, Suite 400 Washington, DC 20005
SPIB	Southern Pine Inspection Bureau 4709 Scenic Highway Pensacola, FL 32504
SSPC	Society for Protective Coatings 40 24th Street, 6th Floor Pittsburgh, PA 15222
SSPWC	Standard Specifications for Public Works Construction Building News, Inc. 3055 Overland Avenue Los Angeles, CA 90034
TEMA	Tubular Exchanger Manufacturer's Association 25 North Broadway Tarrytown, NY 10591

Abbreviation	Meaning
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719
UBC	Uniform Building Code Published by ICBO
UL	Underwriters Laboratories Inc. 333 Pfingsten Road Northbrook, IL 60062
UMC	Uniform Mechanical Code Published by ICBO
UPC	Uniform Plumbing Code Published by IAPMO
USBR	Bureau of Reclamation U.S. Department of Interior Engineering and Research Center Denver Federal Center, Building 67 Denver, CO 80225
WCLIB	West Coast Lumber Inspection Bureau 6980 SW Varns St. P.O. Box 23145 Portland, OR 97223
WWPA	Western Wood Products Association (Formerly called: West Coast Lumbermen's Association (WCLA)) Yeon Building 522 SW 5th Avenue Portland, OR 97204

END OF SECTION

SECTION 01 45 00

CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for quality control services, field inspections and field testing of civil and structural constructs required for this project.

B. The Contractor is responsible for the quality assurance and quality control of their respective work for the construction of this project in accordance with the Contract Documents.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.

1. Section 01 45 23 Testing and Inspection Services

1.03 DEFINITIONS

A. Quality Control System (QCS): The quality control, assurance, and inspection system established and carried out to ensure compliance with the Plans and specifications.

B. QCS Supervisor: That person in responsible charge of the work occurring, as designated by the Contractor in the QCS Plan.

C. QCS Inspector: Responsible, certified personnel inspecting the various constructs at specified milestones and during the project overall and designated by the Construction Manager.

D. Factory Test: Tests made on various materials, products and component parts prior to shipment to the job site.

E. Field Tests: Tests and analyses made at or in the vicinity of the job site in connection with the actual construction.

F. Certified Inspection Report: Reports signed by approved inspectors attesting that the items inspected meet the specification requirements other than any exceptions included in the report.

G. Certificate of Compliance: Certificate from the manufacturer of the material or equipment identifying said manufacturer, product and stating that the mateiral or equipment meet specified standards, and shall be signed by a designated officer of the manufacturer.

H. Standard Compliance: Condition whereby specified materials or equipment must conform to the standards of organizations such as the American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL) or similar organization.

I. Quality Assurance: The day-to-day, in-process supervisory observations of work and materials conducted by the Contractor to assure that the proper methods and materials are being used and installed by tradesmen.

J. Source Quality Control: The in-process testing and inspections conducted by the QCS Inspector(s) to verify that the materials, equipment; workmanship and shop manufactured constructs are in compliance with the Contract Documents, applicable Codes and standards.

K. Field Quality Control: The testing and inspections conducted by the QCS Inspector(s) in the field during and at the completion of each construct to verify that the in-process and completed construction is in compliance with the Contract Documents, applicable Codes and standards.

L. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the local governing authorities having jurisdiction (AHJ) as having the competency necessary to inspect a particular type of construction requiring special inspection.

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Written description of Contractor's proposed QCS plan in sufficient detail to illustrate adequate measures for verification and conformance to defined requirements. The QCS plan and submittal shall include a log showing anticipated inspections, QCS Inspectors, Special Inspections, and source and field Quality Assurance procedures. Submittal of the QCS plan shall be made prior to commencing field work.
      a. QCS Plan shall include the following, as a minimum:
         1) Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the QCS staff will implement the plan for all aspects of the Work specified.
         2) QCS Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.

3) Letters of Authority: A copy of a letter to the QCS Supervisor signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the QCS Supervisor, including authority to stop Work which is not in compliance with the Contract. The QCS Supervisor shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
4) Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
5) Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
6) Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
7) Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
8) Reporting procedures, including proposed reporting formats; include a copy of the QCS report form.

5. QCS Reports shall be submitted at minimum every 7 calendar days that account for all days throughout the life of the Contract and include copies of test reports and reports prepared by QCS staff.
   a. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
   b. Contractor/subcontractor and their areas of responsibility.
   c. Operating plant/equipment with hours worked, idle, or down for repair.
   d. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
   e. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
   f. Material received with statement as to its acceptability and storage.
   g. Identify submittals reviewed, with Contract reference, by whom, and action taken.
   h. Offsite surveillance activities, including actions taken.
   i. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
   j. List instructions given/received and conflicts in Drawings and/or Specifications.
   k. Contractor's verification statement.
   l. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.

m. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

6. Contractor's proposed QCS Supervisor and QCS Inspectors (other than the Special Inspectors provided by Owner), including qualifications, responsibilities, and if requested, references.
7. Complete structural system information describing Contractor designed structural systems, including sealed calculations, shop and erection drawings, product literature for the various components, International Code Council (ICC) Evaluation Reports for structural components, and a discussion of risk issues associated with the proposed system which could adversely impact overall project completion.
8. If requested by the Construction Manager during the work, manufacturer's field services and reports.

A. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' field services and reports unless requested by Construction Manager to be submitted for review.
   3. Special Inspection reports, unless otherwise directed in each technical specification Section.

1.05 REGULATORY REQUIREMENTS

A. GENERAL: Comply with all Federal, State, and local Codes as referenced herein. Such regulations apply to activities including, but not limited to, site work and zoning, building practices and quality, on and offsite disposal, safety, sanitation, nuisance, and environmental quality.

B. SPECIAL INSPECTION: Special Inspection shall be performed by the Special Inspector under contract with the Owner or registered design professional in responsible charge acting as the Owner's agent in conformance with the IBC. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

C. STRUCTURAL OBSERVATION: Registered Design Professional shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system in accordance with IBC 1704.6 Structural Observations requirements.

1.06 CONTRACTOR'S RESPONSIBILITIES

A. Monitor quality assurance over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Coordinate with, schedule specified inspections by, and provide normal and customary assistance to the QCS Inspectors and Owner provided Special Inspectors.

C. Coordinate with, schedule specified structural observations by Engineer, and provide normal and customary assistance to Engineer performing structural observations.

D. Comply fully with manufacturers' instructions, including each step in sequence.

E. Should manufacturers' instructions conflict with Contract Documents, request clarification before proceeding from Construction Manager.

F. Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

G. The Contractor shall retain the services of a licensed land surveyor, registered in the State of Washington, to perform survey work including but not limited to establishing line and grade, in advance of the construction; and to perform other surveying services for the work included under the Contract. The surveyor to be retained by the Contractor shall not be the same surveyor engaged for the Engineer's use. The surveyor shall be subject to the approval of the Engineer. Survey drawings shall be submitted to the Engineer for approval.

H. The Contractor shall take all necessary measurements in the field to verify pertinent data and dimensions shown on the Drawings or to determine the exact dimensions of the Work.

1.07 FIELD SAMPLE PROCEDURES

A. When field samples are specified in a unit of work, construct each field sample to include work of all trades required to complete the field sample prior to starting related field work. Field samples may be incorporated into the project after acceptance by Construction Manager. Remove unacceptable field samples when directed by Construction Manager. Acceptable samples represent a quality level for the work.

1.08 CONTRACTOR DESIGNED STRUCTURAL SYSTEMS

A. DESIGN ENGINEERING: Contractor shall employ and pay for engineering services from a Professional Engineer registered in the State of Washington for structural design of Contractor designed structural systems including but not limited to temporary shoring and bracing, formwork support, interior wall and ceiling systems, and support systems for fire sprinkler, plumbing, mechanical, and electrical systems and equipment.

B. TESTS AND INSPECTIONS OF CONTRACTOR DESIGNED STRUCTURAL SYSTEMS: Contractor shall pay for preliminary testing of concrete, grout, and mortar mix designs where required by Code or these specifications prior to start of work. Contractor shall pay for required shop and site inspection of Contractor designed structural systems where required by Code or these specifications.

1.09 JOB SITE CONDITIONS

A. Schedule to ensure all preparatory work has been accomplished prior to proceeding with current work. Proceeding with the work constitutes acceptance of conditions. Allow adequate time for materials susceptible to temperature and humidity to "stabilize" prior to installation. Establish and maintain environmental conditions (i.e., temperature, humidity, lighting) as recommended by the various material manufacturers for the duration of the work.

1.10 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:
   1. Relieve Contractor of responsibility for providing adequate quality control measures.
   2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance.
   3. Constitute or imply acceptance.

C. Affect the continuing rights of Owner after acceptance of the completed Work.

D. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

E. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.

F. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. CONTRACTOR RESPONSIBILITIES: Provide source quality control according to the reviewed and accepted QCS plan and paragraph 1.06 herein. Coordinate with Construction Manager to facilitate the work of the Testing Laboratory specified in Section 01 45 23 and Special Inspector. Provide ready access to sampling and inspection locations and incidental labor customary in such sampling and inspections. Timely prepare and submit submittals, and revise as indicated by review comments. Comply with technical requirements in each specification Section that applies to the work.

B. CONSTRUCTION MANAGER RESPONSIBILITIES: Review Contractor's tracking of QCS activities at biweekly meetings. Facilitate completion of submittal review per Section 01 33 00. Assist Contractor to ensure that Special Inspection occurs where and when specified.

C. ACCEPTANCE CRITERIA: Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Field quality control responsibilities of the Contractor and Construction Manager are substantially the same as described in paragraph 2.01, with the exception that this work occurs primarily on the jobsite as the work progresses, and Special Inspection will occur more often than at the source.

B. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

3.02 REGULATORY COMPLIANCE – SPECIAL INSPECTIONS

A. The types of work requiring Special Inspection are specified in the Construction Documents and required to obtain regulatory approval by State or required by local governing authorities having jurisdiction over the building permit of the project.

B. Section 01 45 23 describes Testing Laboratory sampling, testing and reporting.

C. Contractor designed structural systems are subject to the same Special Inspection requirements as all other work.

3.03 CORRECTION OF DEFECTIVE WORK

A. Any defective or imperfect Work, equipment, or materials furnished by the Contractor which is discovered before the Final Acceptance of the Work, or during a warranty period, shall be removed immediately even though it may have been overlooked by the Engineer and approved for payment. The Contractor shall repair such defect, without compensation, in a manner satisfactory to the Engineer.

B. Unsuitable materials and equipment may be rejected, notwithstanding that such defective Work, materials and equipment may have been previously overlooked by the Engineer and accepted or approved for payment.

C. If any workmanship, materials or equipment shall be rejected by the Engineer as unsuitable or not in conformity with the Specifications or Drawings, the Contractor shall promptly replace such materials and equipment with acceptable materials and equipment at no additional cost to Owner. Equipment or materials rejected by the Engineer shall be tagged as such and shall be immediately removed from the site.

D. The Engineer may order tests of imperfect or damaged Work equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor, and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the Work, equipment, or material was not impaired, the Work, equipment or materials may be deemed acceptable, in the discretion of the Engineer. If the results of such tests reveal that the required functional capability of the questionable Work, equipment or materials has been impaired, then such Work, equipment or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect Work, equipment or material in lieu of performing the tests.

3.04 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the QCS Plan, schedule a meeting with Engineer and Owner to discuss the quality control system to be used by the Contractor.

B. Develop a mutual understanding of the system details, including the forms for recording the QCS operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

END OF SECTION

SECTION 01 45 23

TESTING AND INSPECTION SERVICES

PART 1 GENERAL

1.01 SUMMARY

A. GENERAL REQUIREMENTS: Comply with the testing and inspection specified in this Section and elsewhere in the Construction Documents. For the purpose of this Section, all references made herein to Testing Agency or Special Inspector or Geotechnical Consulting Firm shall be referred to as those tests or inspections which will be conducted by an inspector provided by the Owner.

1. The Owner or registered design professional in responsible charge acting as the Owner's agent will select and employ an independent Testing Agency to conduct the tests and inspections in accordance with applicable standard methods of American Society for Testing and Materials (ASTM) or other standards specified by the local governing authorities having jurisdiction (AHJ) as a requirement of the building permit. The Owner may require other special inspection services to inspect and verify the Work installed is in accordance with the Construction Documents and construction industry standards.
2. The Contractor shall provide and pay for other inspection and testing services where specified in the Construction Documents or required to obtain regulatory approval by Washington State or AHJ.

1.02 DEFINITIONS

A. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the AHJ as having the competency necessary to inspect a particular type of construction requiring special inspection.

B. Testing Agency - firm responsible for performing specific inspections and/or tests as part of the Special Inspection program.

1.03 QUALITY ASSURANCE

A. QUALIFICATIONS: The inspector for all Work as hereinafter specified, except for geotechnical inspections, waterproofing and roofing, shall be a registered Special Inspector employed by an approved inspection and/or Testing Agency as listed by the WABO Special Inspection Registration Program. All inspection personnel used on this Project are subject to being disapproved from the Project at the discretion of the Owner. Minimum levels of qualifications as stated in WABO Special Inspection Registration Program for various portions of the required inspections and testing must be complied with.

1. The Special Inspector shall have the required technical knowledge and experience for the product or construction element being installed.
2. Geotechnical Inspection will be performed by a licensed Geotechnical Consulting Firm.

1.04 DUTIES OF OWNER'S TESTING AGENCY

A. GENERAL: The Owner's Testing Agency will conduct testing and inspection services, interpret them, and evaluate the results for compliance with the building permit, the site development permit, and the Construction Documents; agency will report findings to the Owner, Contractor, and AHJ. Testing and inspection services shall be in accordance with applicable standard methods of ASTM or other standards specified by AHJ, the Construction Documents, and construction industry standards. The Testing Agency will reasonably support overtime, second shift, and out-of-area activity if requested by the Contractor and approved at the Owner's sole discretion.

B. TESTING AND INSPECTION: Materials to be tested are specified by the building permit and as required by the Construction Documents, as directed by Owner, or required by AHJ. Quantities and extent of tests and inspections shall be as specified and/or required by the Owner's Inspector or AHJ.

C. NON-CONFORMING WORK: The Owner's Inspector shall document and immediately notify the Contractor and Owner of any Work found defective or not in accordance with the requirements of the Construction Documents. Non-conforming Work shall be corrected.

D. The Owner's inspectors are not authorized to do the following:
   1. Release, revoke, alter or enlarge on requirements of Construction Documents.
   2. Approve or accept any portion of the Work, except as allowed by the special inspection duties delegated by governing AHJ for building permit inspections and testing.
   3. Perform any duties of the Contractor.
   4. Stop Work.

1.05 COSTS

A. The Owner's Testing Agency and Special Inspector costs for initial testing and inspection as specified in the Construction Documents will be paid for by the Owner or registered design professional in responsible charge acting as the Owner's agent. Initial tests and inspections are defined as those required to complete the first tests and inspections specified. Costs for subsequent re-testing and re-inspection of items found not to be in compliance with Construction Documents shall be borne by the Contractor.

B. Additional tests and inspections not herein specified, but requested by the Owner, shall be paid for by the Owner. However, if the results of such tests or inspections are found to be not in compliance with Construction Documents, the Contractor will be back charged for all costs for initial testing as well as re-testing, re-inspection and Owner's Consultants services.

C. Costs for additional tests or inspections required because of Contractor changes to reviewed and accepted products or materials provided, or source, or supply shall be borne by the Contractor.

D. Costs for any Work which is required to correct any deficiencies shall be borne by the Contractor.

E. Costs of any testing which is required solely for the convenience of Contractor in its scheduling and performance of the Work shall be borne by the Contractor.

F. Costs for verification testing of Work done without prior notice, with improper supervision, or contrary to construction practice shall be borne by the Contractor.

G. Costs for testing of materials for which fabrication and mill reports are required but not furnished shall be borne by the Contractor.

H. The cost, if any, of providing access for inspections and tests shall be considered part of the normal expense of conducting business and therefore non-reimbursable.

I. In those instances where inspector(s) arrive at the agreed-upon location, at the agreed upon date and time, and find articles to be inspected are not ready for inspection, the inspector(s) shall return to their home office and all expenses incurred shall be borne by the Contractor.

1.06 TESTS AND INSPECTION REPORTS

A. Copies of Owner and Contractor test and inspection reports shall be distributed at weekly intervals. All reports will be signed by a Washington Association of Building Officials certified Special Inspector or Professional Engineer registered in the State of Washington, as appropriate. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory; a final report should be submitted documenting corrective work done on of any unsatisfactory material and or work identified in the testing or inspection reports. Samples taken, but not tested, shall also be reported. Records of special sampling operations that are required shall also be reported. Test and inspection reports shall be distributed as follows:
   1. Owner
   2. Owner's Testing Agency
   3. Contractor
   4. Authority Having Jurisdiction

B. A report shall be prepared for each inspection and test and shall include:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. COORDINATION: It is the Contractor's responsibility to initiate, coordinate, and conform to the required tests and inspections of governing State and AHJ. Inspection of the Work by the Owner's Special Inspectors and/or Testing Agency shall not relieve the Contractor from responsibility for compliance with the Construction Documents requirements. Owner's Special Inspectors and/or Testing Agency and Owner shall have authority to reject Work whenever the provisions of the Construction Documents are not being complied with, and the Contractor shall instruct his employees accordingly.

B. ACCESS FOR THE PURPOSE OF INSPECTION: Ensure the Owner's Special Inspectors and/or Testing Agency have free access to all parts of the Work and to the shops where the Work is in preparation; are provided proper facilities and safe access for such inspection; and are reasonably furnished access, equipment, tools, samples, certifications, test reports, design mixes, storage, and assistance as requested by the Owner's Inspector.

C. STORAGE FACILITIES: Furnish adequate storage facilities as approved by the Owner for the sole use of the Owner's Testing Agency for safe storage and curing of such specimens which must remain on the site prior to transport to the laboratory.

D. DATA: Furnish records, Contract Drawings and shop drawings, certificates, approved Change Orders, and similar data as required by Owner's Inspectors to perform their work to assure compliance with the Construction Documents.

E. NOTICE: Furnish notice to Owner and coordinate with Owner's Inspectors a minimum of five (5) working days in advance of all required tests and a minimum of forty-eight (48) hours in advance of all required inspections, unless otherwise specified.

F. NON-CONFORMING WORK: Remove and replace Non-conforming Work at no additional cost to the Owner prior to Final Completion. Where Non-conforming Work requires design modifications, such re-design shall be performed by the Engineer of Record and costs shall be borne by the Contractor.

G. CANCELLATIONS: Contractor shall give sufficient advance notice to Owner and Inspectors to allow rescheduling of their work load in the event of cancellation or time extension of any scheduled test or inspection

1.08 TEST FAILURES

A. GENERAL: The Owner may require re-test of a sampled material when a sample or procedure has failed to pass the required tests. In the event any test or inspection indicates failure of a material or procedure to meet requirements of Construction Documents, all costs for re-testing or re-inspection shall be borne by the Contractor. The Contractor may opt to replace the imperfect Work, equipment or material in lieu of performing the tests.

1.09 REPORT TEST FAILURES

A. GENERAL: Immediately upon determination of a test failure, the Owner's Inspector shall notify the Owner and Contractor. By the end of the following day the Owner's Inspector shall send written test results to those named on the distribution list.

B. Contractor shall similarly report test failures to Owner resulting from work of testing agencies provided by the Contractor.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION

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SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the requirement for temporary facilities including:
   1. Provide temporary facilities for the proper completion of the Work as required and specified.
   2. Allow other authorized entities to use temporary services and facilities without cost, including, but not limited to:
      a. Owner
      b. Construction Manager
      c. Engineer
      d. Testing agencies.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A 117.1: Accessible and Usable Buildings and Facilities.

B. American Society for Testing and Materials (ASTM):
   1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750^{o}C.

C. National Fire Protection Association (NFPA):
   1. 70: National Electrical Code.
   2. 241: Standard of Safeguarding Construction, Alteration, and Demolition Operations.
   3. 701: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.03 OFFICE

A. Contractor shall maintain a temporary field office near the Site for their own use during the period of construction at which readily accessible copies of all Contract Documents shall be kept. In charge of this office, there shall be a competent Superintendent of the Contractor.
   1. The office shall be located where it will not interfere with the progress of the Work as approved by Owner.

B. Field Offices shall be prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

C. Within the field office, space shall be provided for the use of the Construction Manager.

D. Field offices shall be provided within 15 working days of Notice to Proceed / site mobilization.

E. The Contractor's attention is directed to the condition that no payment for mobilization, or any part thereof, will be approved for payment under the Contract until all field office facilities specified herein, have been provided.

1.04 POWER

A. The Contractor shall provide power for construction at the Site.

B. Contractor shall make arrangements with the electrical utility and with the Owner for power takeoff points, voltage and phasing requirements, transformers and metering and shall pay the costs and fees arising therefrom.

C. The Contractor shall provide the special connections required for his work.

1.05 SANITARY FACILITIES

A. The Contractor shall provide toilet and washup facilities for his work force at the Site.

B. The facilities shall comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

C. Contents shall be removed and disposed of in satisfactory manner by Contractor at a minimum of weekly intervals.

D. Contractor shall enforce sanitary regulations amongst employees and take precautions against infectious diseases as deemed necessary. Isolate infected employee(s) and arrange for immediate removal of such person(s) from site.

E. Contractor shall provide separate sanitary facilities for field offices.

F. Existing indoor plant sanitary facilities are not available for the Contractor’s use.

1.06 POTABLE WATER

A. Contractor shall provide his own water source for his construction operations and those of his subcontractors.

B. Contractor shall provide sufficient potable quality drinking water for workers at project site.

1.07 UTILLTY WATER

A. Contractor shall provide his own water source for his construction and testing operations and those of his subcontractors.

B. Contractor shall provide sufficient quality utility water for operations at project site. Water need not be potable, but Contractor retains all responsibility for treatment and filtering as needed to satisfy testing and operating conditions.

1.08 SUBMITTALS

A. Copies of permits and approvals for construction as required by laws and regulations of all governing agencies on the project.

B. Site Plan. Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

C. Utility Plan. Show water supply and distribution plans.

D. Fire Safety Program. Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire prevention program.

E. Dust and Control Plan. Submit coordination drawing and narrative that indicates the dust control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
   1. Locations of dust control partitions at each phase of Work.
   2. Location of proposed air filtration system discharge.
   3. Waste handling procedures.
   4. Other dust control measures.

1.09 QUALITY ASSURANCE

A. Electric Service. Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections. Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. During adverse weather and against the possibility thereof, take necessary precautions so that the Work may be properly completed and is satisfactory. When required, protection shall be provided by use of tarpaulins, wood, and building-paper shelters, or other suitable means.

D. During cold weather preheat materials, if required, and keep sufficiently warm the materials and adjacent structure into which they are to be incorporated so that a proper bond will take place and a proper curing, aging, or drying will result. Artificially heat protected spaces by suitable means that will result in a moist or a dry atmosphere according to the requirements of the Work being protected. Sufficiently heat ingredients for concrete and mortar so the mixture will be warm throughout when used.

PART 2 PRODUCTS

2.01 TRAILER (OFFICE) FOR CONSTRUCTION ACTIVITIES

A. Contractor will provide for Construction Manager a double wide trailer with 4 offices/workstations and one unisex bathroom. Office trailer shall include at a minimum:
   1. Electricity
   2. Windows with mesh screen
   3. Adequate 120-volt duplex electrical receptacles
   4. Proper ventilating, heating and air conditioning equipment
   5. Each office/workstation to include:
      a. Desk and chair
   6. High-speed wireless internet
   7. Printer
      a. Replacement ink and toner as needed.
      b. Replacement paper supply in letter and tabloid sizes as needed.
   8. Refrigerator
   9. Microwave
   10. Drinking water
   11. Adequate lighting
   12. Secure and lockable entry.

B. Provide janitorial service on a weekly basis.

2.02 EQUIPMENT

A. Fire Extinguishers. Portable, UL rated with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment. Provide vented, self-contained, electric, liquid propane gas or fuel oil heaters with individual space thermostatic control.
   1. The use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
   2. Heating Units. Listed and labeled for the type of fuel being consumed by a qualified testing agency acceptable to authorities having jurisdiction and marked for the intended location and application.

C. Air Filtration Units. Primary and secondary HEPA filter equipped portable units with four-stage filtration. Provide a single switch for emergency shutoff. Configure to run continuously.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Coordinate locations with Construction Manager and Owner.

B. Provide each temporary facility ready for use when needed to avoid delay. Do not remove until the facilities are no longer needed or are replaced by the authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION

A. General. Install temporary service or connect to existing service. Arrange with utility company, the Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage. Provide temporary utilities to remove effluent lawfully. Connect temporary sewers to the municipal system as directed by authorities having jurisdiction.

C. Water Service. Install water service and distribution piping in sizes and pressures adequate for construction.
   1. Hydrant Water:
      a. Contractor to comply with City of Vancouver "Temporary Access to Water from Hydrants Policy."
      b. Use only special hydrant-operating wrenches to open hydrants. Make certain hydrant valve is open full, since cracking valve causes damage to hydrant. Repair damaged hydrants and notify appropriate agency as quickly as possible. Hydrants shall be completely accessible to fire department at all times.
      c. If needed, include costs to connect and transport water to construction areas in Contract Price.
      d. No new hydrants will be installed.
   2. Furnish and install temporary piping and facilities to transport water to the Work.
   3. Contractor shall bear costs of necessary water for Project use.
   4. Provide means to prevent water used for testing from flowing back into source pipeline.

D. Sanitary Facilities. Provide temporary toilets, wash facilities, and drinking water for the use of construction personnel. Comply with the requirements of authorities having jurisdiction for the type, number, location, operation, and maintenance of fixtures and facilities.

E. Heating. Provide temporary heating required by construction activities for the curing or drying of completed installations or for protecting the installed construction from the adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on the completed installations or elements being installed.

F. Isolation of Work Areas in Occupied Facilities. Prevent dust, fumes, and odors from entering the occupied areas.
   1. Prior to commencing Work, isolate the HVAC system in an area where Work is to be performed.
      a. Disconnect the supply and return ductwork in the Work area from the HVAC systems servicing occupied areas.
      b. Maintain negative air pressure within the Work area using HEPA-equipped air filtration units, starting with the commencement of temporary partition construction and continuing until the removal of temporary partitions is complete.
   2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited Work within occupied areas using portable dust-containment devices.
   3. Perform daily construction cleanup and final cleanup using approved, HEPA filter-equipped vacuum equipment.

G. Ventilation and Humidity Control. Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from the adverse effects of high humidity. Select equipment that will not have a harmful effect on the completed installations or elements being installed. Coordinate ventilation requirements to produce the required ambient condition and minimize energy consumption. Provide dehumidification systems when required to reduce substrate moisture levels to the level required to allow installation or the application of finishes.

H. Electric Power Service. Provide and pay for electric power service and a distribution system of sufficient size, capacity, and power characteristics required for the construction operations.

I. Lighting. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
   1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

J. At the main construction office entrance, post a list of important telephone numbers including, but not limited to, those listed below and the Site's address.
   1. Police and fire departments.
   2. Ambulance service.
   3. Contractor's home office.
   4. Contractor's emergency after hours telephone number.
   5. Owner's Representative's offices.
   6. Owner's project point of contact.
   7. Principal subcontractors' field and home offices.
   8. Map of the nearest clinic and nearest emergency room.

K. Provide the superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.03 SUPPORT FACILITIES INSTALLATION

A. General. Comply with the following:
   1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.
   2. Maintain support facilities until Construction Manager schedules Substantial Completion inspection. Remove before Final Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.

B. Temporary Roads and Paved Areas. Construct and maintain temporary roads and paved areas adequate for construction operations in coordination with the Construction Manager. Provide dust control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Permanent Roads and Paved Areas. Locate temporary roads and paved areas in same location as permanent roads and paved areas to the extent practicable. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install subbase and base for temporary roads and paved areas.
   3. Recondition the base after temporary use including removing contaminated material, regrading, proof rolling, compacting, and testing.
   4. Delay installation of final course of permanent hot mix asphalt pavement until immediately before Substantial Completion. Repair hot mix asphalt base course pavement before installation of final course.

D. Traffic Controls. Comply with the requirements of authorities having jurisdiction.
   1. Protect existing site improvements to remain including curbs, pavement, and utilities.
   2. Maintain access for firefighting equipment and access to fire hydrants.

E. Parking. Provide temporary parking areas for construction personnel. Provide designated parking for the Construction Manager's onsite staff.

F. Dewatering Facilities and Drains. Comply with requirements of authorities having jurisdiction. Maintain Site, excavations, and construction free of water.
   1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
   2. Remove snow and ice as required to minimize accumulations.

G. Waste Disposal Facilities. Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.

1. The Contractor shall be responsible for providing dumpsters for the collection and disposal of waste and debris, except for hazardous or unsanitary waste materials which shall be handled by Contractor producing such waste.
2. Location of dumpsters shall be proposed by the Contractor and approved by the Owner.
3. Comply with NFPA 241 for removal of combustible materials.
4. Hazardous materials shall be containerized for removal from site.

H. Lifts and Hoists. Provide facilities necessary for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

I. Temporary Stairs. Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

J. Existing Stair Usage. Use of the Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of corrective Work.

K. Temporary Use of Permanent Stairs. Use of new stairs for construction traffic will be permitted. However, the stairs must be protected, and the finishes must be restored to a new condition at the time of Substantial Completion.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities. Protect existing vegetation, equipment, structures, utilities, and other improvements at the Site and on adjacent properties except those indicated to be removed or altered. Repair damage to existing facilities.

B. Pest Control. Engage pest control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Final Completion. Perform control operations lawfully, using environmentally safe materials.

C. Security Enclosure and Lockup. Coordinate additional security requirements with site security personnel.

D. Barricades, Warning Signs, and Lights. Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

E. Temporary Egress. Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

F. Temporary Enclosures. Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

G. Temporary Partitions. Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
   1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
   2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire retardant treated plywood. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
   3. Where fire resistance rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
   4. Insulate partitions to control noise transmission to occupied areas.
   5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
   6. Protect air handling equipment.
   7. Provide walk-off mats at each entrance through temporary partition.

H. Temporary Fire Protection. Install and maintain temporary fire protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire prevention program.
   1. Prohibit smoking in construction areas.
   2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
   3. Develop and supervise an overall fire prevention and protection program for personnel at the Site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
   4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

I. Temporary Barricades and Lights:
   1. Provide as required in sufficient quantity to safeguard public and the Work.
   2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
   3. Protect existing facilities and adjacent properties from potential damage.
   4. Locate work areas to enable access by facility operators.
   5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.

6. Locate barricades at the nearest intersecting public thoroughfare on each side of blocked section.
7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.
8. Provide at obstructions, such as material piles and equipment.
9. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

J. Temporary Trees and Plantings Protection:
   1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on Drawings to remain undisturbed.
      a. Where practical, tunnel beneath trees when on or near line of trench.
      b. Employ hand excavation as necessary to prevent tree injury.
      c. Do not stockpile materials or permit traffic within drip lines of trees.
      d. Provide and maintain temporary barricades around trees.
      e. Water vegetation as necessary to maintain health.
      f. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
      g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of Engineer.
      h. Dispose of removed trees in a legal manner off the Site.
   2. Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Nursery and Landscape Association. Balls shall be firm and intact and made-balls will not be accepted. Handle ball and burlap trees by ball and not by top.
   3. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
   4. Replace each plant that dies as a result of construction activities.

3.05 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture Protection Plan. Avoid trapping water in finished Work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase. Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
   1. Protect porous materials from water damage.
   2. Protect stored and installed material from flowing or standing water.
   3. Keep porous and organic materials from coming into prolonged contact with concrete.
   4. Remove standing water from decks.
   5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase. After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
   1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
   2. Keep interior spaces reasonably clean and protected from water damage.
   3. Periodically collect and remove waste containing cellulose or other organic matter.
   4. Discard or replace water damaged material.
   5. Do not install material that is wet.
   6. Discard, replace, or clean stored or installed material that begins to grow mold.
   7. Perform Work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction. After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
   1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
   2. Use a permanent HVAC system to control humidity.
   3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
      a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during construction and remain wet for 48 hours are considered defective.
      b. Measure the moisture content of materials that have been exposed to moisture during the construction operations or after installation. Record readings beginning at the time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to the Construction Manager.
      c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.06 OPERATION, TERMINATION, AND REMOVAL

A. Supervision. Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance. Maintain facilities in good operating condition until removal. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover. Do not change over from using temporary security and protection facilities to permanent facilities until Final Completion.

D. Termination and Removal. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. The Owner reserves right to take possession of the Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period.

END OF SECTION

SECTION 01 55 26

TRAFFIC CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Contractor shall develop detailed traffic control plans for construction along roadways, trails, and sidewalks and submit it to the City of Vancouver for review and approval prior to the start of any construction. The Contractor shall obtain and pay for all necessary permits.

B. The Contractor shall plan, install, and maintain all signs, barricades, traffic cones, drums, lights, flashers, flagmen, and other devices and perform all work necessary to direct and control vehicular and pedestrian traffic through and around the work site so as to protect the public, workmen, and the work from injury or damage.

C. The Contractor shall, at the time of preconstruction conference, designate a specific person to be responsible for the installation and maintenance of the traffic control devices and establish a method of contacting this person during both working and non-working hours. This information shall be provided to the Owner.

D. All traffic control devices shall conform to the "Washington State Manual on Uniform Traffic Control Devices for Streets and Highways" (MUTCD), latest edition and all revisions thereto, as adopted by Washington State Department of Transportation as well as the standards set by the Washington State Department of Transportation.

1. No substitutions for the devices required by the above referenced manuals, or changes in the methods of maintaining traffic as outlined herein, will be allowed without the written approval of the Owner.

E. Contractor shall adhere to requirements included in the contract documents. All lane closures if required must be approved through City of Vancouver and indicated on the traffic control plan.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 GENERAL:

A. Contractor shall design and install all signing, barricades, channelizing devices, and all other devices in accordance with the requirements of the MUTCD and in accordance with the changing work in progress each day. Layouts for all temporary signing and channelizing shall be submitted to Owner and other agencies having jurisdiction for review. Contractor may be required to add additional signs and/or barricades as directed by Owner or other agencies.

B. Traffic control devices and signing shall be in place before the affected construction begins.

C. Contractor shall be responsible for maintaining traffic during placement of devices and signs.

D. Temporary surfacing for roads and walks shall be a minimum three-inch thick layer of crushed rock. Increase the layer thickness for areas where heavy equipment or heavy daily traffic flow are expected. Monitor and repair surfacing regularly during construction, until the temporary surfacing is removed and replaced with new surfacing as shown or specified.

E. Permanent and temporary construction signs and traffic control devices shall be promptly removed or masked when their use is not required for Contractor's then current operations or job conditions.

F. Signing and traffic control devices shall be continuously maintained in serviceable condition.
   1. Daily inspections shall be conducted by the Contractor.
   2. All damaged devices shall be promptly repaired or replaced.
   3. Sign faces shall be cleaned as often as necessary to maintain legibility and reflective properties.
   4. Sign masking material shall be sturdy cloth. Paper and tape are not acceptable.

G. Remove temporary equipment and facilities when no longer required. Restore grounds to original or better, or specified condition when no longer required.

H. Repair roads, walkways, and other traffic areas damaged by operations. Keep traffic areas free of excavated materials and maintain in a manner to eliminate dust, mud, and hazardous conditions.

I. All operations and repairs shall meet approval of owners or agencies having jurisdiction.

END OF SECTION

SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENTATION CONTROL (TESC)

PART 1 GENERAL

1.01 SCOPE

A. This section covers work to implement structural and nonstructural best management practices (BMPs) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this section and shown on drawings are part of the project Temporary Erosion and Sedimentation Control Plan (TESC Plan) and are the minimum for all project construction sites and conditions. This specification covers all project activities, including material sources, disposal sites, and offsite mitigation areas unless specific project activities are excluded elsewhere in this specification or in other contract documents controlling the work.

B. Temporary and permanent erosion and sedimentation controls include grassing and mulching of disturbed areas and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by Section 402 of the Federal Clean Water Act and applicable codes, ordinances, rules, regulations, and laws of state, local, and municipal authorities having jurisdiction (AHJ). For installation and maintenance guidance, refer to the Washington State or City of Vancouver, Washington Erosion Control Manual, latest edition.

C. National Pollutant Discharge Elimination System (NPDES): Comply with federal, state, and local laws, rules, and regulations, and the NPDES Construction Stormwater Discharge Permit or Permits applicable to the project. NPDES General Construction permits are required on projects that involve disturbance of 1 acre or more with potential to discharge stormwater to surface waters. Submit a TESC plan, SWPPP, and NPDES application to AHJ for soil disturbance greater than 1 acre.

D. Other Regulations: A local government erosion and sediment control permit may apply, and some local agency requirements may be more stringent than this specification.

1.02 SYSTEM DESCRIPTION

A. Erosion and Sediment Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases during construction period.

B. Erosion and Sediment Control (ESC) Qualified Personnel:
   1. Identify the ESC Qualified Personnel at the preconstruction discussions and in the TESC Plan. The ESC Qualified Personnel shall have certification in construction site erosion and sediment control defined as a Certified Erosion and Sediment Control Lead (CESCL) as required by State and Local jurisdictional requirements.
   2. The ESC Qualified Personnel (CESCL) shall implement the TESC Plan, including the following:
      a. Installing and maintaining all temporary erosion and sediment control BMPs included in the TESC Plan to assure continued performance of their intended function. Damaged or inadequate TESC BMPs shall be corrected immediately.

b. Updating TESC Plan to reflect current field conditions.
c. Terminating TESC Plan.

3. When a TESC Plan is included in the contract plans, ESC Qualified Personnel (CESCL) shall also inspect all areas disturbed by construction activities, all onsite erosion and sediment control Best Management Practices (BMPs), all stormwater discharge points, and all temporarily stabilized inactive sites per schedule in the NPDES and/or Local Erosion Control Permit or as directed by Engineer. Complete erosion and sediment control inspection form provided by AHJ for each inspection and submit a copy to Engineer weekly following inspection.

C. Personnel Training: Prior to commencement of construction, responsible personnel (CESCL) must have an understanding of the NPDES and/or Local Erosion Control Permit requirements and their specific responsibilities under the permit. At a minimum, personnel must be trained to understand the following as it relates to the scope of their job duties:
   1. The location of all stormwater controls and how to maintain them.
   2. Procedures for complying with the pollution prevention requirements.
   3. Procedures for conducting inspections, recording findings, and taking corrective action.
   4. Creation and maintenance of required documentation and files.

D. Owner or Engineer may identify additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the work.

E. Install all sediment control devices including, but not limited to, sediment ponds, perimeter silt fencing, or other sediment trapping BMPs prior to any ground disturbing activity. Do not expose more erodible earth than necessary during clearing, grubbing, excavation, borrow, or fill activities without written approval by Engineer. Engineer may increase or decrease the limits based on project conditions. Erodible earth is defined as any surface where soils, grinding, or other materials may be capable of being displaced and transported by rain, wind, or surface water runoff. Cover inactive areas of erodible earth, whether at final grade or not, within specified time period per State or Local permit requirements, using an approved soil covering practice. Phase clearing and grading to maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.

F. Water Management:
   1. Manage site water in accordance with the conditions of the waste discharge permit from a local permitting authority. If site water management is not subject to permit, manage as follows:
      a. Groundwater: When groundwater is encountered in an excavation, treat and discharge as follows:
         1) When groundwater conforms to State or local jurisdictional Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.

2) When turbidity of groundwater is similar to turbidity of site runoff, groundwater may be treated using same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.

3) When groundwater turbidity is greater than turbidity of site runoff, treat groundwater separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.

b. Process Water:

1) Do not discharge high pH process water or wastewater (non-stormwater) that is generated onsite, including water generated during concrete grinding, washout, and hydrodemolition activities, to waters of the jurisdiction, including wetlands. Water may be infiltrated upon approval of Engineer. Offsite disposal of concrete process water is subject to approval of Engineer.

2) Treat all water generated onsite from construction or washing activities that is more turbid than site runoff separately until turbidity is the same or less than site runoff, and then it may be combined with site runoff and treated as described above. Water may be infiltrated upon approval of Engineer.

c. Offsite Water: Prior to disruption of normal watercourse, intercept offsite stormwater and pipe it either through or around the project site. This water shall not be combined with onsite stormwater. Discharge offsite water at its preconstruction outfall point preventing an increase in erosion below the site. Submit proposed method for performing this work for Engineer's approval.

G. Dispersion/Infiltration: Convey water only to dispersion or infiltration areas designated in the TESC Plan or to sites approved by Owner. Water shall be conveyed to designated dispersion areas at a rate such that, when runoff leaves the area and enters waters of the jurisdiction, the required turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.

H. Pollution Control: Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicles and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:

1. Written spill prevention and response procedures
2. Employee training on spill prevention and proper disposal procedures
3. Spill kits in all vehicles
4. Regular maintenance schedule for vehicles and machinery
5. Material delivery and storage controls
6. Training and signage
7. Covered storage areas for waste and supplies

I. If Owner or Engineer orders the work suspended, continue to control erosion, pollution, and runoff during the shutdown.

J. Nothing in this section shall relieve Contractor from complying with other contract requirements.

1.03 SUBMITTALS

A. Submit product data in accordance with the requirements of Section 01 33 00 of these Specifications.

B. Prior to any construction activity, the Contractor shall submit, for the Engineer's approval, a schedule for the accomplishment of temporary and permanent erosion and sedimentation control work. No work shall be started until the erosion and sedimentation control schedule and methods of operation have been approved by the Engineer.

C. Provide proposed changes to the TESC plans for approval by the Engineer per jurisdictional requirements. Allow at least 5 working days for Engineer to review, approve and incorporated any revisions to the current TESC Plan.

1.04 QUALITY ASSURANCE

A. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. Any additional erosion and sedimentation control measures required by the Contractor's means, methods, techniques, and sequence of operation will be installed by the Contractor at no additional cost to the Owner.

B. Perform all work under this Section in accordance with all pertinent rules and regulations including, but not necessarily limited to, those stated in these Specifications. Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.

C. Provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with Washington State Erosion Control Regulations, local ordinances, other permits, local enforcing agency guidelines and these Specifications.

D. Basic Principles

1. Coordinate the land disturbance activities to fit the topography, soil types and conditions.
2. Minimize the disturbed area and the duration of exposure to erosive elements.
3. Provide temporary or permanent stabilization to disturbed areas immediately after rough grading is complete.
4. Safely convey run-off from the site to a stable outlet to prevent flooding and damage to downstream facilities resulting from increased runoff from the site.
5. Retain sediment on-site that was generated on-site.
6. Minimize encroachment upon watercourses.

E. Implementation

1. The Contractor is solely responsible for the control of erosion within the Project site and the prevention of sedimentation from leaving the Project site or entering waterways.

2. The Contractor shall install temporary and permanent erosion and sedimentation controls which will ensure that runoff from the disturbed area of the Project site shall pass through a filter system before exiting the Project site.
3. The Contractor shall provide temporary and permanent erosion and sedimentation control measures to prevent silt and sediment from entering the waterways. The Contractor shall maintain the required undisturbed vegetative buffer along any on-site stream, pond, or regulated waterway, per State and local regulations. If disturbance of a vegetative buffer is permitted, the Contractor shall exercise extreme care during land disturbance operations within this buffer to prevent degradation of the stream, pond, or regulated waterway.
4. The Contractor shall limit land disturbance activity to those areas shown on the Drawings.
5. The Contractor shall maintain erosion and sedimentation control measures within disturbed areas on the entire site at no additional cost to the Owner until the acceptance of the Project. Maintenance shall include mulching, re-seeding, clean-out of sediment barriers and sediment ponds, replacement of washed-out or undermined rip rap and erosion control materials, to the satisfaction of the Engineer.
6. All fines imposed for improper erosion and sedimentation control shall be paid by the Contractor.
7. The Contractor shall use all means necessary to control dust on and near the work and all off-site borrow areas, in accordance with the Washington State and/or City of Vancouver, Washington Erosion Control Manual, latest edition. The Contractor should thoroughly moisten all surfaces and/or control dust within the acceptable means and methods required by State and local regulations, as required to prevent dust from being a nuisance to the public, neighbors and concurrent performance of work on the site.

F. References:
1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geosynthetic Specification for Highway Applications
ASTM C139	Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes

Reference	Title
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D822	Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D977	Standard Specifications for Anionic Emulsified Asphalt
ASTM D2974	Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and other Organic Soils
ASTM D3776	Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D3786	Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
ASTM D4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D5035	Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D6241	Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D6459	Standard Test method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion
ASTM D6460	Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion
ASTM M6475	Standard Test Method for Measuring mass per Unit Area of Erosion Control Blankets
ASTM D7322	Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions
ASTM D7367	Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting
ASTM G23	Standard Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
National Stone, Sand and Gravel Association (NSSGA)	Quarried Stone for Erosion and Sediment Control, 1991
NWS	Precipitation-Frequency of the United States by State/Territory, 2012
NWS	Precipitation Frequency Data Server, 2012
USDA NRCS	Urban Hydrology for Small Watersheds; 1986. Technical Release 55

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. Geotextiles shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. Geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. Geotextile properties as described in Table 1.

Table 1. Geotextile for Temporary Silt Fence

Geotextile Property	ASTM Test Method	Geotextile Property Requirements	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D4751	U.S. No. 30 max. for silt wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.	
Water permittivity	D4491	0.2 sec^{-1} min.	
Grab tensile strength, in machine and x-machine direction	D4632/D4632M	180 lb. min. in machine direction, 100 lb. min. in x-machine direction	100 lb. min.
Grab failure strain, in machine and x-machine direction	D4632/D4632M	30% max. at 180 lb. or more	
Ultraviolet (UV) radiation stability	D4355	705 strength retained min., after 500 hours in xenon arc device	

2.02 SEDIMENT BARRIERS

A. Silt Fence
   1. Silt fence shall meet the requirements of Washington State and/or City of Vancouver, Washington Erosion Control Manual, latest edition.
   2. Reinforced silt fence is a combination of silt fence fabric with woven wire reinforcement. Reinforced silt fence woven wire reinforcement shall meet the requirements of Washington State and/or City of Vancouver, Washington Erosion Control Manual, latest edition.
   3. Silt fence fabric shall meet the requirements of Section 2.01, Geotextiles.

B. Wattles:
   1. The interior material shall be natural straw, coir (coconut), composted material, wood fibers, or a combination of; and wrapped in approved degradable netting made of plastic, natural fiber such as jute, sisal, cotton, hemp, or burlap.
   2. All material, including netting, shall have a life expectancy of approximately one year.
   3. The minimum diameter of 8 inches shall be used.
   4. Diameters ranging 8 inches to 11 inches shall have a minimum weight of one pound per linear foot.
   5. Diameters greater than 11 inches shall have a minimum weight of three pounds per linear foot.
   6. The ends shall be secured tightly with degradable twine.
   7. Stakes shall be Oak or Southern Yellow Pine untreated wood.

2.03 STABILIZED CONSTRUCTION ENTRANCE/EXIT

A. Stone: Use sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be in accordance with the NSSGA Size R-2 (1.5 to 3.5-inch stone).

B. Geotextile: The geotextile underliner must be placed the full length and width of the entrance. Geotextile selection shall be based on AASHTO M288-98 specification:
   1. For subgrades with a CBR greater than or equal to 3 or shear strength greater than 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.3, Separation Requirements.
   2. For subgrades with a CBR between 1 and 3 or sheer strength between 30 and 90 kPa, geotextile must meet requirements of section AASHTO M288-96 Section 7.4, Stabilization Requirements.

2.04 RIP RAP

A. See Section 31 23 00 - Excavation and Fill for the requirements for rip rap.

2.05 STORM DRAIN OUTLET PROTECTION

A. Stone size: Stone size as indicated for each outlet in the Storm Drain Outlet Protection detail shown in the Drawings.

B. Geotextile: Geotextiles shall be used as a separator between the graded stone, the soil base, and the abutments. The geotextile shall be specified in accordance with AASHTO M288-96 Section 7.5, Permanent Erosion Control Recommendations.

C. Stone quality: Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather resistant. The specific gravity of the individual stones should be at least 2.5.

2.06 SURFACE ROUGHENING

A. Stair-step grading: Shall be carried out on any material soft enough to be ripped with a bulldozer. The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the “step” shall slope toward the vertical wall. Individual vertical cuts shall not be more than 30 inches on soft soil material and not more than 40 inches in rocky materials.

B. Grooving: Shall be carried out using machinery to create a series of ridges and depressions which run perpendicular to the slope (on the contour). Grooves may be made with any appropriate implement which can be safely operated on the slope, and which will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a frontend loader bucket. Such grooves shall not be less than 3 inches deep nor further than 15 inches apart.

2.07 TOPSOILING

A. Topsoil should be friable and loamy, free of debris, objectionable weeds and stones and contain no toxic substance that may be harmful to plant growth. A pH range of 5.0-7.5 is acceptable. Soluble salts should not exceed 500 ppm.

B. Topsoil stockpiles shall be contained by sediment barriers to prevent sedimentation on adjacent areas. Stockpiles shall be stabilized in accordance with specifications for Temporary Mulching and Temporary Grassing, or Polyacrylamide (PAM), specified in this Part.

2.08 TEMPORARY MULCHING

A. Dry straw: Shall be applied at a depth of 2 to 4 inches providing complete soil coverage. Material shall be clean, seed-free cereal straw.

B. Wood waste (chips, sawdust, or bark): Shall be applied at a depth of 2 to 3 inches. Organic material from the clearing stage of development should remain on site, be chipped, and applied as mulch.

C. Mulch Binder: Mulch on slopes exceeding 3 (horizontal) to 1 (vertical) shall be held in place by the use of a mulch binder, as approved by the Engineer. The mulch binder shall be non-toxic to plant and animal life and shall be approved by the Engineer.

2.09 TEMPORARY GRASSING

A. Grassing materials shall meet the requirements of the Washington State and/or City of Vancouver, Washington Erosion Control Manual, latest edition.

B. Seed rate, fertilization, lime application and other requirements shall be provided as shown on the Drawings.

C. Water: Water shall be free of excess and harmful chemicals, organisms and substances which may be harmful to plant growth or obnoxious to traffic. Salt or brackish water shall not be used. Water shall be furnished by the Owner.

PART 3 EXECUTION

3.01 GENERAL

A. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.

B. All erosion and sedimentation control devices and structures shall be inspected by the ESC Qualified Personnel (CESCL), as defined by State and local regulations, whichever is more stringent. Frequency of all inspections shall be determined by NPDES and Washington State and/or City of Vancouver, Washington Erosion Control requirements as outlined in the prepared TESC, Stormwater Pollution Prevention Plan (SWPPP) and State and local permit regulations.

C. All erosion and sedimentation control measures and devices shall be constructed and maintained as indicated on the Drawings, in the prepared SWPPP, or specified herein until adequate permanent disturbed area stabilization has been provided and accepted by the Engineer. Once adequate permanent stabilization has been provided and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

D. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather.

E. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

F. Inspect BMPs in accordance with the schedule in the NPDES and Washington State and/or City of Vancouver, Washington Erosion Control or as directed by Engineer.

G. Complete an inspection report within 24 hours of an inspection. Each inspection report shall be signed and identify corrective actions. Document that corrective actions are performed within 7 days of identification. Keep a copy of all inspection reports at the site or at an easily accessible location.

H. Initiate repair or replacement of damaged erosion and sediment control BMPs immediately and work completed by end of next workday. Significant replacement or repair must be completed within 7 days, unless infeasible.

I. Within 24 hours, remediate any significant sediment that has left construction site. Investigate cause of the sediment release and implement steps to prevent a recurrence of discharge within same 24 hours. Perform in-stream cleanup of sediment according to applicable regulations.

J. At end of each workday, stabilize or cover soil stockpiles or implement other BMPs to prevent discharges to surface waters or conveyance systems leading to surface waters.

K. Temporarily stabilize soils at end of shift before holidays and weekends, if needed. Ensure soils are stable during rain events at all times of year.

L. Initiate stabilization by no later than end of next workday after construction work in an area has stopped permanently or temporarily.

M. Provide permanent erosion control measures on all exposed areas. Do not remove temporary sediment control practices until permanent vegetation or other cover of exposed areas is established. However, do remove all temporary erosion control measures as exposed areas become stabilized, unless doing so conflicts with local requirements. Properly dispose of construction materials and waste, including sediment retained by temporary BMPs.

3.02 INSTALLATION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS

A. Stabilized Construction Entrance/Exit

1. Construction exit(s) shall be placed as shown on the Drawings or as directed by the Engineer. A construction exit shall be located at any point traffic will be leaving a disturbed area to a public right-of-way, street, alley, sidewalk, or parking area.
2. Placement of Construction Exit Material: The ground surface upon which the construction exit material is to be placed shall be prepared to a smooth condition free from obstructions, depressions, or debris. The geotextile underliner shall be placed to provide a minimum number of overlaps and a minimum width of one foot of overlap at each joint. The stone shall be placed with its top elevation conforming to the surrounding roadway elevations. The stone shall be dropped no more than three feet during construction.
3. Construction Exit Maintenance: The Contractor shall regularly maintain the exit with the top dressing of stone to prevent tracking or flow of soil onto public rights-of-way and paved surfaces as directed by the Engineer. This shall require periodic top dressing with 1.5-3.5-inch stone, as conditions demand.
4. Construction Exit Removal: Construction exit(s) shall be removed and properly disposed of when the disturbed area has been properly stabilized, the tracking or flow of soil onto public rights-of-way or paved surfaces has ceased and as directed by the Engineer.

B. Storm Drain Outlet Protection

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.
2. The riprap and gravel filter must conform to the specified grading limits shown in the plans.
3. Geotextile must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter fabric over the damaged area. All connecting joints should overlap a minimum of 1 ft. If the damage is extensive, replace the entire filter fabric.
4. Riprap may be placed by equipment but take care to avoid damaging the filter.
5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.
6. Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.
7. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
8. Immediately after construction, stabilize all disturbed areas with vegetation.

9. Filter: Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth.
10. Maintenance: Inspect riprap outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

C. Surface Roughening
   1. Cut Slopes Steeper than 3:1: Cut slopes with a gradient steeper than 3:1 should not be mowed. They shall be stair-step graded or grooved.
   2. Fill Slopes Steeper than 3:1: Fill slopes with a gradient steeper than 3:1 should not be mowed. They shall be grooved or allowed to remain rough as they are constructed. Method (a) or (b) below may be used:
      a. Groove according to method described in Part 2.
      b. As lifts of the fill are constructed, soil and rock material may be allowed to fall naturally onto the slope surface.
   3. Colluvial materials (soil deposits at the base of slopes or from old stream beds) shall not be used in fills as they flow when saturated.
   4. Cuts, Fills, and Graded Areas Which Will Be Mowed (less than 3:1):
      a. Mowed slopes should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned.
      b. These areas may be roughened with shallow grooves such as remain after tilling, discing, harrowing, raking, or use of a multipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).
      c. Grooves formed by such implements shall be not less than one inch deep and not further than 12 inches apart.
      d. Fill slopes which are left rough as constructed may be smoothed with a dragline or pickchain to facilitate mowing.
   5. Roughening with Tracked Machinery:
      a. Roughening with tracked machinery on clayed soils is not recommended unless no alternatives are available. Sandy soils do not compact severely and may be tracked.
      b. When tracking is the chosen surface roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery as possible should be made to minimize compaction.
   6. Seeding: Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seeding growth.

D. Topsoiling
   1. Testing: Field exploration should be made to determine whether the quantity and quality of surface soil justifies stripping.
   2. Stripping: Stripping should be confined to the immediate construction area. A 4-to-6-inch stripping depth is common but may vary depending on the particular soil.
   3. Topsoil pH: If pH value is less than 6.0, lime shall be applied and incorporated with the topsoil to adjust the pH to 6.5 or higher.
   4. Stockpiles: The location of topsoil stockpiles should not obstruct natural drainage or cause off-site environmental damage.

5. Stabilization: Stockpiles shall be contained by sediment barriers to prevent sedimentation on adjacent areas. Stockpiles shall be stabilized in accordance with specifications Temporary Mulching and Grassing or PAM that are contained within this specification.
6. Liming: Soil tests should be used to determine the pH of the soil. Where the pH of the subsoil is 5.0 or less or composed of heavy clays, agricultural limestone shall be spread at the rate of 100 pounds per 1,000 square feet. Lime shall be distributed uniformly over designated areas and worked into the soil in conjunction with tillage operations.
7. Bonding: Use one of the following methods to insure bonding of topsoil and subsoil:
    a. Tilling: After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 3 inches to permit bonding of the topsoil to the subsoil.
    b. Tracking: Passing a bulldozer over the entire surface area of the slope to leave horizontal depressions.
8. Applying Topsoil:
    a. Topsoil should be handled only when it is dry enough to work without damaging soil structure.
    b. A uniform application of 5 inches (unsettled) is recommended but may be adjusted at the discretion of the Engineer.

E. Temporary Mulching
1. When mulch is used without seeding, mulch shall be applied to provide full coverage of the exposed area. Mulch shall be applied as follows:
    a. Dry straw or hay mulch and wood chips shall be applied uniformly by hand or by mechanical equipment.
    b. If the area will eventually be covered with perennial vegetation, 20-30 pounds of nitrogen per acre in addition to the normal amount shall be applied to offset the uptake of nitrogen caused by the decomposition of the organic mulches.
    c. Apply mulch binder on exposed areas, where indicated on the Drawings or as instructed by the Engineer.
2. Anchoring Mulch:
    a. Straw mulch can be pressed into the soil with a disk harrow with the disk set straight or with a special “packer disk.” Disks may be smooth or serrated and should be 20 inches or more in diameter and 8 to 12 inches apart. The edges of the disk should be dull enough not to cut the mulch but to press it into the soil leaving much of it in an erect position.
    b. Straw mulch shall be anchored immediately after application.
    c. Straw mulch spread with special blower-type equipment may be anchored with Grade SS-1 emulsified asphalt in accordance with ASTM D977. The asphalt emulsion shall be sprayed onto the mulch as it is ejected from the machine. Use 100 gallons of emulsified asphalt and 100 gallons of water per ton of mulch.
    d. For Straw mulch, plastic mesh or netting with mesh no larger than one inch by one inch shall be installed according to manufacturer’s specifications.
    e. Netting of the appropriate size shall be used to anchor wood waste. Openings of the netting shall not be larger than the average size of the wood waste chips.

F. Temporary Grassing

1. Seed Bed Preparation:
    a. When a hydraulic seeder is used, seedbed preparation is not required.
    b. When using conventional or hand seeding, seedbed preparation is not required if the soil material is loose and not sealed by rainfall.
    c. When soil has been sealed by rainfall or consists of smooth cut slopes, the soil shall be pitted, trenched, or otherwise scarified to provide a place for seed to lodge and germinate.
2. Select a grass or grass-legume mixture suitable to the area and season of the year.
3. Seed shall be applied uniformly by hand, cyclone seeder, drill, culti-packer- seeder, or hydraulic seeder (slurry including seed and fertilizer). Drill or cultipacker seeders should normally place seed one-quarter to one-half inch deep. Appropriate depth of planting is ten times the seed diameter.
4. Soil should be “raked” lightly to cover seed with soil if seeded by hand.
5. Irrigation: During times of drought, water shall be applied at a rate not causing runoff and erosion. The soil shall be thoroughly wetted to a depth that will insure germination of the seed. Subsequent applications should be made when needed.
6. Temporary Stabilization: Temporary stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Temporary stabilization shall be provided to any area which will not receive permanent stabilization within the next 14 calendar days.

3.03 CLEAN-UP

A. Dispose of all excess erosion and sedimentation control materials in a manner satisfactory to the Engineer.

B. All temporary erosion control measures shall be removed after final stabilization of the site has occurred, unless otherwise noted on the Drawings or instructed by the Engineer.

C. Final clean-up shall be performed in accordance with the requirements of Section 01 74 23 of these Specifications.

END OF SECTION

SECTION 01 58 13

TEMPORARY PROJECT SIGNAGE

PART 1 GENERAL

1.01 SIGNBOARD

A. The Contractor shall provide one 4-foot by 8-foot multicolored signboard with a multicolored "City of Vancouver" emblem. Signboard shall be provided with 1-1/4-inch by 4-inch edging, shall be constructed of exterior grade high density overlaid plywood, and shall be mounted and located in an acceptable manner which will permit public viewing. Sign shall list the following information:

1. "City of Vancouver" emblem
2. Project Title
3. City Project Number
4. Washington State DOH Drinking Water
5. Revolving Funds $_____
6. Total Project Cost $_____

B. Items 5 and 6 above reflect the total estimated cost for the several separate contracts to be let by the Owner. Amounts shall be adjusted to reflect actual bid costs to the nearest $100,000.

C. The final layout of the sign shall comply with the requirements of the City of Vancouver.

1. Contractor shall provide Owner with draft signage for review and approval. Owner must receive approval from DOH Contract Manager prior to displaying signage on site.

D. The Contractor shall erect the sign in accordance with the following specifications. The sign shall be maintained in good condition until completion of the contract, at which time the sign shall become the property of the Owner. The sign is to be painted white with lettering and emblem colors as indicated by the City. Sign support shall be 4-inch by 6-inch posts painted black, set a minimum 3 feet 6 inches in the ground. Paint shall be exterior type. The lettering shall be Arial or similar san serif style.

E. The Contractor and his subcontractors may erect signs for information and direction. No commercial or advertising signs will be allowed on the site of the work.

END OF SECTION

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SECTION 01 61 45

AREA EXPOSURE DESIGNATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. SCOPE:
   1. This section designates area exposure types for each location, room, area, or space at the site of the Work.
   2. Area exposures are used to specify materials based on the corrosion environment that the material is exposed to when the materials for the component are not scheduled or otherwise identified for each specific installation (e.g., pipe, anchor bolts, pipe supports, coatings, etc.). Where materials are scheduled for specific individual components (e.g., equipment, instruments, conduit, panels, etc.), furnish materials as specified.

1.02 RELATED SECTIONS:

1. Section 01 11 00 – Summary of Work

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Atmospheric: Air space surrounding a structure or process.
   2. Solution: Liquid or solid which may contain water or other free liquid.

B. EXPOSURE TYPE: Included as a supplement to this Section, the Area Exposure Table designates an Exposure Type for each room or area. Each Exposure Type, listed from least to most severe corrosion potential, is defined below:
   1. Indoor Dry: locations inside a building or other enclosed structure not subjected to wash down and not in contact with a liquid holding or earth retaining wall.
   2. Indoor Wet: locations inside a building or structure that are damp, subject to wash down, or surfaces of structures that are in contact with a liquid holding or earth retaining wall or slab.
   3. Outdoor: locations not protected from the weather, or only partly protected by a roof or open enclosure, and exposed to exterior ambient conditions. Local ambient conditions may be expected to vary.
   4. Buried: below grade wall or roofs; locations covered and in contact with earth/soil.
   5. Submerged: locations inside a covered liquid or solids holding structure that are below a plane located 12 inches below the minimum operating level of the liquid in the tank or structure.
   6. Head Space: locations inside a covered liquid or solids holding structure that are above a plane that starts 1-foot below the minimum operating liquid level in the structure.

C. ENVIRONMENTAL CONDITIONS: Environmental conditions for each Exposure Type are tabulated below:

Exposure Type	Environment	Chemical Exposure	Chemical Concentration
Indoor Dry	Atmospheric, Dry	None	Not Applicable
Indoor Wet	Atmospheric, Wet	None	Not Applicable
Outdoor	Atmospheric, Wet	None	Not Applicable
Buried	Solution	Earth/Soil	Not Applicable
Submerged	Solution	Various Chemicals	Dilute

D. AREA EXPOSURE TABLE: The Area Exposure Table schedules an Exposure Type for each location, room, area, or space at the site of the Work. The Area Exposure Table is provided in Part 4 of this Section.

PART 2 NOT USED

PART 3 EXECUTION

A. MATERIALSELECTION

1. Provide construction materials, coating systems, and lining systems consistent with materials requirements specified in individual equipment/material Specifications for the exposure assigned in the area exposure table. In the event of a conflict between the individual equipment/material specification and this Section, the individual equipment/material specification governs. In the event an area exposure is not designated for a particular location, the area exposure with the most severe corrosion potential from all area exposures for adjacent locations, rooms, areas, or spaces governs, and shall be the basis of the Contract Price.
2. Where components are assigned multiple area exposures, select the material and coating specified for the area exposure that has the most severe corrosion potential. When components cross, span, or straddle the boundary separating two or more area exposures, select materials specified for the area exposure that has the most severe corrosion potential. Where materials change at a boundary between exposures, change the material at the boundary or within the less severe exposure. At material transitions, separate dissimilar metals by a dielectric coupling or other suitable barrier.

PART 4 AREA EXPOSURE TABLE

Facility Number	Facility Name	Room Name / Delineation	Exposure Type	Notes
000	Site	Outside the perimeter of facilities, above grade	Outdoor	
000	Site	Outside the perimeter of facilities, below grade	Buried	
W01	Wellhouse 1	Interior of Wellhouse 1, above grade	Interior Dry	
W02	Wellhouse 2	Interior of Wellhouse 2, above grade	Interior Dry	
B01	Treatment Building	Interior of Treatment Building, above grade	Interior Dry	
B01	Treatment Building	Interior of Treatment Building, below grade wet well	Submerged	
B02	Restroom and Storage Building	Interior of Restroom and Storage Building, above grade	Interior Dry	
B02	Restroom and Storage Building	Interior of Restroom and Storage Building, below grade	Buried	
P01	PFAS Treatment	Process Area, outside above grade	Outdoor	
P01	PFAS Treatment	Process Area, outside below grade	Buried	
P02	Rinse Water Tank	Rinse Water Tank, outside above grade	Outdoor	
P02	Rinse Water Tank	Rinse Water Tank, outside below grade	Buried	
U01	Valve Vault 1	Interior of below grade vault	Submerged	
U02	Injection Vault	Interior of below grade vault	Submerged	
U03	Valve Vault 3	Interior of below grade vault	Submerged	
U04	Grinder Pump	Interior of below grade vault	Submerged	
U05	Grinder Pump Meter Vault	Interior of below grade vault	Submerged	
000	Site	Interior of manholes and hand holes	Submerged	
000	Exterior of Buildings	Exterior	Outdoor	

END OF SECTION

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SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 GENERAL

1.01 DAMAGE

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Construction Manager.

1.02 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.

PART 2 EQUIPMENT

2.01 PACKAGE AND MARKING:

A. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

B. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

2.02 IDENTIFICATION:

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

2.03 SHIPPING:

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

2.04 FACTORY APPLIED COATINGS:

A. Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09 90 00 . The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in Section 09 90 00.

2.05 STORAGE:

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

2.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION:

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.

END OF SECTION

SECTION 01 73 24

DESIGN REQUIREMENTS FOR
NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/HVAC/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in ASCE 7.

D. Design and conform to criteria and design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the Drawings or where the size of attachments, anchorage, or bracing is defined in specific technical specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.
   1. Components in Seismic Design Category A.
   2. Furniture (except permanent floor supported storage cabinets over 6 ft tall).
   3. Temporary or movable equipment.
   4. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, I_p, is equal to 1.0.
   5. Mechanical and electrical components in Seismic Design Category B.
   6. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.
   7. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
      a. The component importance factor, I_p, is equal to 1.0;
      b. The component is positively attached to the structure;
      c. Flexible connections are provided between the component and associated ductwork, piping, and conduit;
      d. And either:
         1) the component weighs 400 lb or less and has a center of mass located 4 ft or less above the adjacent floor level; or
         2) the component weighs 20 lb or less, or in the case of a distributed systems, 5 lb/ft or less.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.
   1. Section 05 05 20 Anchor Bolts
   2. Section 05 50 00 Metal Fabrications

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AAMA	American Architectural Manufacturer's Association
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures
AISC 341	Seismic Provisions for Structural Steel Buildings
ACI 360	Specification for Structural Steel Buildings
ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASTM C635	Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C636	Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
DOSH	WA Industrial Safety and Health Act administered by the Labor and Industries Division of Occupational Safety and Health
IBC	International Building Code with local amendments
NFPA-13	Installation of Sprinkler Systems
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
SMACNA	Seismic Restraint Manual Guidelines for Mechanical Systems

1.04 DEFINITIONS

A. Structure: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

B. Non-structural Components: Non-structural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist effects of wind, snow, impact, temperature and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: Self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide Drawings and design calculations stamped by a Washington licensed professional engineer qualified to perform structural engineering.
   5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
   6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
   7. Shop drawings showing plans, elevations, sections and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
   8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
   9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in design calculations.

10. Special Seismic Certification for non-structural components identified in article 1.07 of this section.

1.06 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector under contract with the Owner and in conformance with IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. For non-structural components requiring Special Seismic Certification, the Special Inspector shall verify that the label, anchorage, and mounting conform with the Special Seismic certificate of compliance.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

2.02 DESIGN CRITERIA

A. Design Codes

Design	Code
Buildings/Structures:	International Building Code 2021 and ASCE 7-16
Reinforced concrete:	ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, ACI 318-19 for all other reinforced concrete
Structural steel:	AISC 360-16 and AISC 341-16
Aluminum:	Aluminum Design Manual, Latest Edition
Welding:	AWS Welding Codes, Latest Edition
Occupational health and safety requirements:	OSHA and DOSH

Note: When conflicting requirements occur, the most stringent requirements will govern the design.

B. Design Loads
   1. Design non-structural components and non-building structures for the following minimum loads: (Do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
   2. Dead Loads:
      a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
      b. Typical allowance for piping and conduit: 20 psf

3. Uniform Live Loads:

Elevated grating floors:	100 psf
Columns:	No column live load reduction allowed
Exitways, stairs and landings:	100 psf
Equipment platforms, walkways/catwalks (other than exitways):	100 psf
Utility bridges:	75 psf per level

4. Snow Loads:

Code:	IBC 2021 & ASCE 7-16
Risk Category:	III (Wastewater Treatment facilities are Risk Category III) Exception: Rinse water tank and PFAS vessels and its components are Risk Category IV.
Ground Snow Load (p_g):	25 psf
Exposure Factor (C_e):	C
Thermal Factor (C_t):	1.0
Importance Factor (I_s):	1.1 for Risk Category III 1.2 for Risk Category IV
Flat Roof Snow Load (p_f):	25 psf
Drifting:	Per ASCE 7

5. Wind Loads:

Code:	IBC 2021 & ASCE 7-16
Risk Category:	III (Wastewater Treatment facilities are Risk Category III) Exception: Rinse water tank and PFAS vessels and its components are Risk Category IV.
Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above:	103 mph for Risk Category III 107 mph for Risk Category IV
Exposure:	C
Topographic Factor (K_{zt})	1.0

Note:

1. *Design exterior non-strutural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.*

6. Seismic Loads:

Code:	IBC 2021 & ASCE 7-16
Risk Category:	III (Wastewater Treatment facilities are Risk Category III) Exception: Rinse water tank and PFAS vessels and its components are Risk Category IV.
0.2 Sec. Mapped Spectral Response, S_S:	0.806 g
1.0 Sec. Mapped Spectral Response, S_1:	0.367 g
Site Class:	D
0.2 Sec. Design Spectral Response, S_{DS}:	0.633 g
1.0 Sec. Design Spectral Response, S_{D1}:	0.709 g
Importance Factor (I_e):	1.25 for Risk Category III 1.5 for Risk Category IV
Component Importance Factor (I_p):	1.0, except I_p=1.5 for components identified in Section 13.1.3 of ASCE 7
Seismic Design Category	D

Notes:

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*

7. Impact Loads:
   a. Consider impact loads in design of support systems.
   b. Use the following impact load factors unless recommendations of the equipment manufacturer will cause a more severe load case:

Rotating machinery:	20% of moving load
Reciprocating machinery:	50% of moving load
Monorail Hoists:	
• Vertical	25% of lifted load
• Longitudinal	10% of lifted load
Hangers supporting floors and platforms:	33% of live and dead load

8. Temperature:
   a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations
   1. Design non-structural components and non-building structures to withstand load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, ignore the load when evaluating that member.

D. Design Considerations
   1. Design non-structural components and non-building structures for the following conditions:
   2. Climatic Conditions:

Maximum design temperature:	90	degrees Fahrenheit
Minimum design temperature:	15	degrees Fahrenheit

   3. Foundations:
      a. Extend foundations supporting non-structural components and non-building structures below the frost line, or support on non-frost susceptible structural fill down to the frost line.

Frost line for foundations:	18 inches

Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.

E. Column Base Fixity
   1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
   2. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection
   1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
   2. Maximum total load deflection for equipment support: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Contractor.

B. Anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the Drawings or other specification sections. Contractor is responsible for remedial work or strengthening (of concrete elements because of superimposed seismic loading) if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to Owner.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. Contractor is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Owner.

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.01 STRUCTURES

A. The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Owner, remove such existing structures, including curbs, gutters, pipelines and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. He shall also repair existing structures which may be damaged as a result of the work under this contract.

1.02 ROADS AND STREETS

A. Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving specifications.

1.03 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

A. Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Construction Manager.

B. Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

1.04 PROTECTION OF EXISTING INSTALLATIONS

A. The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

END OF SECTION

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SECTION 01 74 10

CLEANING AND DISINFECTION OF TREATMENT FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall clean and disinfect treatment facilities, structures, piping, equipment and appurtenances in accordance with the Contract Documents.

B. The Contractor shall be responsible for obtaining permits for discharging cleaning and disinfection water and dechlorination of such water, if required, to satisfy permit limits.

C. Cleaning and Disinfection procedures shall comply with the requirements of C653 Disinfection of Water Treatment Plants. Also referenced from C651 are ANSI/AWWA C651 Disinfecting Water Mains, C652 Disinfection of Water Storage Facilities.

D. All chemicals used for cleaning and disinfection shall comply with NSF/ANSI 60 – Drinking Water Chemicals – Health Effects.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submittals shall include:
   1. A cleaning and disinfection plan and schedule, including methods for water conveyance, control, disposal, shall be submitted for approval.
   2. Disinfection Safety Plan for storage and handling of disinfecting and dechlorination chemicals including Engineering Controls and the use of Personal Protective Equipment.
   3. Resume of experienced technician.
   4. Record of compliance in accordance with the standards referenced in this section.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and choice of disinfectant shall be as determined by the Contractor. No materials shall be used which would be injurious to the Work or future contact with potable water.

B. Chlorine for disinfection may be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.
   1. Liquid chlorine shall be in accordance with ANSI/AWWA B301 - Liquid Chlorine.
   2. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300-Hypochlorite.

C. Dechlorination agents may be sodium bisulfite, sodium sulfate, calcium thiosulfate, or ascorbic acid.

PART 3 EXECUTION

3.01 GENERAL

A. Water for testing and disinfecting will be furnished by the Contractor and shall be conveyed from the Owner-designated source to the points of use and shall be delivered through an Owner approved backflow preventer provided by the Contractor.

B. All hydraulic structures, piping, equipment and appurtenances shall be cleaned.

C. Cleaning and Disinfection operations shall be under the direction of a qualified technician with not less than 10 years of experience in the disinfection of water treatment facilities and has directed the disinfection of at least four similar sized facilities within the recent 10 years.

D. Contractor shall use all appropriate storage, handling safety measures as required by local, state or federal regulations and as presented in the Disinfection Safety Plan.

E. Cleaning and disinfection operations shall be performed in the presence of the Owner's Representative.

F. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the Work is accepted by the Owner.

G. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the Washington Department of Health.

H. Release of water from structures after disinfection has been completed shall comply with federal, state, and local regulations. Chlorine shall be treated in accordance with permit requirements before discharge.

3.02 CLEANING AND FLUSHING

A. Clean all potable water hydraulic structures, piping, equipment, and appurtenances in accordance with the relevant standards AWWA/NSI C651, C652, and/or C653.

B. Clean the rinse water tank by thoroughly hosing down all surfaces with high pressure horse and nozzle of sufficient size to deliver a minimum flow of 50 gpm.

3.03 DISINFECTION OF STRUCTURES AND APPURTENANT PIPELINES

A. Structures, piping and equipment which store or convey potable water shall be disinfected by chlorination in accordance with the requirements of ANSI/AWWA C653 - Disinfection of Water Treatment Plants.

B. Disinfection of piping shall use one of the methods allowed under ANSI/AWWA C651 as referenced from ANSI/AWWA C653.

3.04 BACTERIOLOGICAL SAMPLING AND TESTING

A. Disinfected water treatment facilities shall be sampled and tested by a certified bacteriological laboratory for compliance in accordance with the referenced standards.

3.05 RE-DISINFECTION

A. If any of the samples for a given tank or piping segment between tanks show the presence of total coliform bacteria, the unit or segment shall be re-disinfected and re-test at no additional cost to the Owner until test results are satisfactory.

B. Any delay in placing a unit in operation from the time of bacteriologic verification shall be re-disinfected and retested at the Owner's option at no additional cost to the Owner if the delay is caused by the Contractor.

3.06 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

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SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

1.02 TYPES OF INFORMATION REQUIRED

A. General:
   1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions:
   1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
      a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
      b. Operator Prestart: Provide requirements to set up and prepare each system for use.
      c. Start-Up, Shutdown, And Postshutdown Procedures: Provide a control sequence for each of these operations.
      d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
      e. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
      f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
      g. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance:
   1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:
      a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02 Operator Service Requirements.
         1) A table showing recommended lubricants for specific temperature ranges and applications;
         2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and
         3) A lubrication schedule showing service interval frequency.
      b. Preventive Maintenance Plan And Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. Corrective Maintenance:
   1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.
      a. Troubleshooting Guides And Diagnostic Techniques: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
      b. Wiring Diagrams And Control Diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.
      c. Maintenance And Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.
      d. Removal And Replacement Instructions: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required including criteria for anchor and equipment baseplate bolt torque values. Instructions shall include a combination of test and illustrations.
      e. Spare Parts And Supply Lists: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.
      f. Corrective Maintenance Manhours: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices:

1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

    a. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

    b. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

    c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

    d. Testing Equipment And Special Tool Information: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.03 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00 accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 99 90. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

B. Three copies of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

1.04 PAYMENT

A. Acceptable O&M information for the project must be delivered to the Construction Manager prior to the project being 65 percent complete. Progress payments for work in excess of 65 percent completion will not be made until the specified acceptable O&M information has been delivered to the Construction Manager.

1.05 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

END OF SECTION

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 DRAWINGS

A. Record Documents refer to those documents maintained and annotated by the Contractor during construction and are defined as:
   1. A neatly and legibly marked set of Contract Drawings showing the final location of piping, appurtenances, equipment, electrical conduits, outlet boxes and cables;
   2. Additional documents such as schedules, lists, drawings, electrical and instrumentation diagrams included in the specifications;
   3. Contractor layout and installation drawings such as loop drawings, single line diagrams, control schematics/elementary diagrams, control panel drawings, and wiring drawings; and
   4. Three-dimensional database-driven models used in the development of drawings or schedules, if applicable.

B. Unless otherwise specified, record drawings shall be full size.

C. The Contractor must provide full access and the right to examine, copy, excerpt, or transcribe, at no additional cost and at all reasonable times, any pertinent documents, papers, records for DOH SRF review. Labor compliance documentation shall be maintained for the duration of construction and for a period of three years from the date of completion of the Contractor's work.

1.02 MODELS

A. The Contractor has the option of utilizing three-dimensional database driven models in the development of Project Record Documents.

B. The use of modeling software does not absolve the Contractor from meeting the other requirements of this Section.

C. If the Contractor uses modeling software in the development of record drawings and schedules, the following requirements apply:
   1. The modelling software used by the Contractor shall be the same as that used by the Engineer during design development.
   2. The model Level of Development (LOD) shall be the same as that employed by Engineer during design development, but no less than LOD 300.
   3. Contractor shall coordinate with Engineer and Construction Manager in the development of a BIM execution plan to provide continuity to the model structure.

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph checkmarked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. BIM execution plan outlining continuity with the model structure developed during the design phase.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 USE DURING CONSTRUCTION

A. Record Documents shall be maintained in a clean, dry, and legible condition.

B. Record Documents shall not be used for construction purposes and shall be available for review by the Construction Manager during normal working hours at the Contractor's field office.

3.02 UPDATES

A. Marking of the Record Documents shall be kept current and shall be done at the time the material and equipment are installed.

B. Annotations to the Record Documents shall be made with an erasable colored pencil conforming to the following color code:
   1. Additions – Red
   2. Deletions – Green
   3. Comments – Blue
   4. Dimensions – Graphite*

   **Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.*

C. Monthly Review Meetings:
   1. During the monthly project meetings, the Contractor and Construction Manager shall review the record documents.

2. At that time the Contractor and Construction Manager shall review the working set of record drawings and initial the accepted areas where everyone has agreed that the location, elevation and/or other construction modification is at the indicated final location.
3. At the conclusion of each meeting, the Contractor shall submit the up-to-date Record Drawings to the Construction Manager.

D. Underground Utilities:
1. Contractor shall provide digital photographs of underground piping and conduits, a fixed measurement on the record drawings, and/or GPS coordinates showing locations from buildings or structures prior to burying piping or electrical conduit.
2. Contractor shall note the depth of buried piping and electrical conduit.

E. Field Routed Utilities:
1. All field routed utilities shall have the full utility layout documented on the record documents as installed. All fittings, appurtenances, start and end points, connections shall be identified. All elevations shall be clearly noted. Additional sheets are to be added to the record drawings as needed to clearly depict the full routing of utilities If a sheet does not existing in the [Contract Documents] allowing space for this.

3.03 SUBMISSION

A. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Construction Manager.

B. The electrical and instrumentation record drawings are typically the last mark ups to be completed. Final payment shall be withheld until the Contractor, Construction Manager, and Engineer have reviewed, verified and agreed on the final electrical and instrumentation record drawings.

C. At the completion of the work, all models (if applicable) shall be submitted to the Construction Manager in NWD format or other format approved by the Construction Manager and Owner.

END OF SECTION

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SECTION 01 79 00

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

A. The following information shall be submitted to the Construction Manager in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Construction Manager as a condition precedent to receiving progress payments in excess of 50 percent of the contract amount and not less than 3 weeks prior to the provision of training.
   1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
   2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at the site of the work or at the Vancouver Engineering Services Department office at, depending upon training requirements and Owner preference, at 4500 SE Columbia Way, Vancouver, WA 98661.

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:
   1. Familiarization
      a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
      b. Check out the installation of the specific equipment items.
      c. Demonstrate the unit and indicate how all parts of the specifications are met.
      d. Answer questions.
   2. Safety
      a. Using material previously provided, review safety references.
      b. Discuss proper precautions around equipment.
   3. Operation
      a. Using material previously provided, review reference literature.
      b. Explain all modes of operation (including emergency).
      c. Check out Owner's personnel on proper use of the equipment.
   4. Preventive Maintenance
      a. Using material previously provided, review preventive maintenance (PM) lists including:
         1) Reference material.
         2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
      b. Show how to perform PM jobs.
      c. Show Owner's personnel what to look for as indicators of equipment problems.
   5. Corrective Maintenance
      a. List possible problems.
      b. Discuss repairs--point out special problems.
      c. Open up equipment and demonstrate procedures, where practical.
   6. Parts
      a. Show how to use previously provided parts list and order parts.
      b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives
    a. Where to order parts: name, address, telephone.
    b. Service problems:
        1) Who to call.
        2) How to get emergency help.
8. Operation and Maintenance Manuals
    a. Review any other material submitted.
    b. Update material, as required.

2.05 VIDEO RECORDING:

A. The Owner will retain the services of a commercial video taping service to record each training session. After taping, the material will be edited and supplemented with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the Owner's video taping contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 EXECUTION

3.01 SUMMARY

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.
    1. As a minimum classroom equipment training for operations personnel will include:
        a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
        b. Purpose and plant function of the equipment.
        c. A working knowledge of the operating theory of the equipment.
        d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
        e. Identify and discuss safety items and procedures.
        f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
        g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.
i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and round checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform start-up and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Start-up and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long-term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform start-up and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01 91 00

COMMISSIONING, TESTING AND START-UP

PART 1 GENERAL

1.01 SUMMARY

A. This Section establishes the Contractor's responsibilities for developing and conducting the complete commissioning, including testing and startup, of all equipment, systems, and facilities (new or existing) which are defined within the Contract Documents. This effort and the associated experience requirements are significant and critical to a safe and successful startup that meets the project schedule requirements.

B. This Section provides the overarching guidelines for commissioning but does not supersede specific testing requirements found elsewhere in the Contract Documents. Where there is any discrepancy, Contractor shall assume the more stringent requirements control unless confirmed otherwise by the Engineer. Refer to Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems. For pre-commissioning activities, refer to other technical specifications, including Division 03 for requirements for testing of concrete hydraulic structures and Section 40 05 01 for testing requirements of hydraulic structures and piping.

C. All commissioning activities must be coordinated early in the project to minimize interference with the operation of the existing facility, or delays to the project schedule; see Section 01 12 16 for project work sequence and constraints. Unless otherwise specified, or agreed to in advance by the Engineer, Owner and Construction Manager, no commissioning activities will be scheduled to take place on a weekend or holiday recognized by the Owner.

D. This Section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 00 Summary of Work
   2. Section 01 12 16 Work Sequence
   3. Section 01 32 16 Construction Progress Schedule
   4. Section 01 33 00 Submittal Procedures
   5. Section 01 45 23 Testing and Inspection Services
   6. Section 01 50 00 Temporary Facilities and Controls

E. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects of the commissioning efforts.

F. A representative or representatives of the equipment manufacturer(s) shall participate in the commissioning phases per the requirements of the Specifications.
    1. Commissioning Overview: The sequence of the commissioning shall proceed as follows. Variations to this sequence may be requested by the Contractor and may be authorized by the Engineer (with input from the Construction Manager) where necessary to meet other constraints described in these Contract Documents. Any requested changes to the extent of testing quality control checks, related sequencing, and/or level or frequency of documentation shall be considered a deviation from the accepted Commissioning Plan and require resubmittal. The equipment and facility startup is a bottom-up approach, where testing starts at the component level, which is then followed by testing at the system, and then facility level.
        a. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is comprised of the following three parts.
            1) Part 1 – Component Installation Review
            2) Part 2 – Component Operational Test
            3) Part 3 – Component Network Communications Test
        b. Phase 2 Commissioning: Functional Test Phase
            1) Part 1 – Functional Test of Individual Components and Independent Systems
            2) Part 2 – Comprehensive Functional Test of Integrated Systems
        c. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase is comprised of the following two parts.
            1) Part 1 – Walkdown
            2) Part 2 – Seven (7) Day Operations Test
        d. Phase 4 Commissioning: Acceptance Test Phase
        e. Optimization/Performance Commissioning Phase
    2. Unless otherwise specified or agreed to in writing by the Engineer (with input from the Construction Manager), all testing activities required as part of facility construction will occur prior to initiation of Phase 1 Commissioning. These include, but are not limited to, testing hydraulic structures for water tightness, pressure testing of piping systems, etc. Refer to applicable specification sections for specific requirements.

1.02 CONTRACTOR COMMISSIONING MANAGER RESPONSIBILITIES AND QUALIFICATIONS

A. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects the testing and startup efforts, including development of System Commissioning Plans. Refer to paragraph 1.02 Contractor Commissioning Manager Responsibilities and Qualifications for experience requirements.

B. At 90 days prior to the commencement of the first component testing, the Commissioning Manager shall be full time, working only on the testing and startup activities of this Work.

C. The Commissioning Manager's responsibilities shall include, but are not limited to, the following activities.
    1. Direct and oversee the development of all commissioning planning documents.
    2. Coordinate and be responsible for all testing and startup activities.

3. Coordinate activities with overall Contractor's project schedule, providing a schedule update at each meeting.
4. Serve as liaison between the Contractor and the Engineer/Construction Manager for all testing and startup activities. Coordinate directly with Owner's staff as directed by the Construction Manager.
5. Organize, lead, and provide minutes for Commissioning Meetings from the initial development of the System Commissioning Plans until the completion of all testing and startup activities.
6. Maintain the System Commissioning Plans and provide monthly updates to the Startup Team until the month prior to startup, then provide weekly updates until commissioning is complete.
7. Oversee and administer all testing activities, including either direct participation in the testing, and/or oversight and monitoring of all testing, and related documentation.
8. Assure that all tests have been successfully completed in accordance with the submitted testing procedures.
9. Develop, compile, review for completeness and compliance to the specifications, and submit all required completed test submittals and other related documentation in a timely manner.
10. Work with the Contractor's Safety Supervisor to provide safe work conditions during commissioning.
11. Prior to submittal, review and approve the content of all training sessions to assure that the training includes all applicable operation, maintenance, safety, and functional, operations, and acceptance testing information.

D. Commissioning Manager's Statement of Qualifications:
   1. Bachelor's degree in civil, mechanical, or electrical engineering with a minimum of 10 years of construction experience and 5 years of experience serving in a role with responsibilities similar to those described in this Section.
   2. Experience in the startup of similar systems on at least one completed drinking water facility, with a minimum construction cost of $5 million.

1.03 DEFINITIONS

A. Commissioning:
   1. The systematic process composed of all elements and requirements related to testing and startup of the Work.

B. Commissioning Hierarchy:
   1. Area
      a. A collection of systems usually constructed within or primarily within the confines of a single building or structure.
      b. Generally, the Drawings are compiled by Area number, in ascending order. Area numbers used in the Drawings correspond with the numbering system utilized during the last several facility upgrades.
      c. In most cases, Areas correspond with treatment processes. In some cases, however, multiple treatment processes are included in the same Area and/or a single treatment process is incorporated into multiple Areas.

2. System
    a. An arrangement of components or other systems so related or connected to perform a specific function and which form an identifiable, unified, functional, operational, safe, and independent part of the Owner's facility.
    b. A system may consist of solely new equipment installed as part of the Work, or as a combination of new equipment installed as part of the Work and existing equipment operating in conjunction with each other.
    c. A system may include equipment and facilities in more than one Area.
3. Component
    a. Components comprise every discrete item associated within the Work.
    b. Example components include but are not limited to the following:
        1) Structural system components include: buildings, tanks and elevated catwalks.
        2) Architectural system components include: floors, walls, doors, windows, ceilings and roofs.
        3) Process system components are usually discrete pieces of equipment and their respective motors and include: pumps, tanks, pressure vessels, and other types of treatment equipment.
        4) Piping system components include: the piping, the piping connections, and the valves, whether manual or powered.
        5) Electrical system components include: wiring, equipment including but not limited to panelboards and MCCs.
        6) Control system components include: Wiring, instruments, control panels, human-machine interfaces (HMIs'), computers, programmable logic controllers (PLCs), instrument networks, and process control networks.
        7) Heating, ventilation and air conditioning (HVAC) system components include: discrete pieces of HVAC equipment, and their respective motors and include: pumps, water quality systems, valves, fans, louvers and ductwork.
        8) Plumbing system components include: pumps, strainers, valves, water supply piping, and area collection/drainage for system.
        9) Fire alarm system components include: fire alarms, and network communication.
        10) Security system components include: video surveillance, locking systems, identification systems, access to existing or other systems, and security staffing.
        11) Communication systems, including internet connectivity devices, speakers, and receivers.
        12) Access control systems, including motorized gates and interface to existing and/or other systems.
        13) Indoor and outdoor lighting control systems and interface to other systems.

C. Summary of Test Phases. Reference paragraph 3.05 Testing for comprehensive test phase requirements.

1. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is intended to:
    a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
    b. Perform operational tests to prove that the components are operating as needed, intended, and specified.
    c. Perform component network communications tests to prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended and specified.
2. Phase 2 Commissioning: Functional Test Phase. The Functional Test Phase is performed on a system, multiple integrated systems and/or a facility to prove that they function as required in conformance with the performance requirements and as needed, intended and specified. Functional tests use plant water, non-potable water, air, or simulated signals, not the specified media. Note the specified media but must be coordinated with the cleaning and disinfection requirements in Section 01 74 10.
3. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase prepares a system, multiple integrated systems or a facility for the Acceptance Test Phase, proves that all systems are correctly set up and that the facility will reliably function over time in real world conditions. The Operations Test Phase is intended to:
    a. Provide for operations testing to prove compliance with performance requirements using either plant water, non-potable water, air, or the specified media, depending on the tests performed.
    b. Perform a complete inspection (walkdown) by the commissioning team to verify readiness for the 7-day operational test.
    c. Provide for 7-day operations test which shall consist of a continuous un-interrupted seven-day run period using the specified media.
4. Phase 4 Commissioning: Acceptance Test Phase. The Acceptance Test Phase operates a system, multiple integrated systems or a facility with the specified media, by the Owner (with assistance from the Contractor), for 30 days, without operational or performance failure to demonstrate satisfactory performance with the performance requirements specified. Performance tests, specified in individual specification sections to verify guaranteed performance, are performed during Phase 4 Commissioning.
5. Optimization Commissioning Phase: Some systems may be specified with Optimization Testing which is intended to provide the Manufacturer's services to optimize specific systems.

D. Other Key Terms:

1. Tests: Unless otherwise specified, denotes all field-testing including component tests, functional tests, operational tests, acceptance tests, and optimization/performance tests.
2. Startup Constraints: Startup constraints are identified throughout these Contract Documents with major construction constraints with reference to the effects on process startup are being discussed in Section 01 12 16.

3. Commissioning Team. Led by the Commissioning Manager, the Commissioning Team is comprised of key operations and maintenance personnel of the Owner, the Construction Manager, the Engineer and key representatives of the Suppliers.
4. Commissioning Manager: A testing and startup expert employed by the Contractor who is responsible for overseeing, organizing, administering, recording, and documenting all aspects the commissioning efforts.
5. Temporary Provision: Outages, re-routes, systems, components, materials, or equipment which is temporarily required to allow any test to occur.
6. Integrator: party responsible for control panel fabrication or alteration
7. Programmer: responsible for configuration of controllers (PLC, DCS, RTUs), HMI software. This may be separate from the party responsible for the control panel, fabrications or alternation, instrument installation and configuration.
8. Vendor Programmer: party responsible for controllers or local interface on vendor package equipment, defined as separate from plant or area SCADA systems.

1.04 SYSTEMS FOR PRE-COMMISSIONING AND COMMISSIONING

A. The following are list the major areas and systems within those areas to be commissioned as individual packages:
   1. Area P01:
      a. System 1: PFAS Treatment
         1) Pressure vessels
         2) Control valves
         3) Meters
         4) Heat tracing
   2. Area P02:
      a. System 1: Rinse Water Tank
         1) Concrete tank
         2) Floating decant
   3. Area U04:
      a. System 1: Grinder Pump
         1) Pump
         2) Heat tracing
   4. Area U05:
      a. System 1: Grinder Pump Meter Vault
         1) Meters
         2) Heat tracing
   5. Area B01:
      a. System 1: Treatment Building Booster Pumps
         1) Booster pumps
   6. Area B02:
      a. System 1: Restroom and Storage Building HVAC
         1) Exhaust fans and louvers
         2) Unit heaters

3) Cooling systems

b. System 2: Rinse Water Discharge Pumps

1) Pump

7. For all areas, facilities, equipment not explicitly included in the areas listed above, Contractor to provide listing of systems and equipment.

1.05 COMMISSIONING PLAN

A. A Master Commissioning Plan for the Work shall be prepared. The Master Commissioning Plan shall be divided into several sub-plans, the first of which is an overall Project Commissioning Plan for the Work, with more detailed System Startup Plans prepared for each system. The number of System Startup Plans is dependent on the number of facilities and systems involved in the Work, the minimum number of which is defined later in this Section.

1. Project Commissioning Plan. The Project Commissioning Plan shall provide an overview of the efforts related to the testing and startup for the Work. At a minimum this plan shall cover the following.
   a. An organizational chart of the Commissioning Team and a description of the roles and responsibilities for each member.
   b. A general approach, sequencing and analysis of major constraints at the facility and system level to performing the testing and startup for the Work.
   c. A listing and brief description of each system to be commissioned.
   d. Updated Construction progress schedule (see Section 01 32 16) which integrates the commissioning plan and schedule into the overall construction schedule. The updated schedule shall identify the schedule duration of each of the system commissioning activities specified in paragraph 1.05 B below; detailed schedule of each system commissioning activity can be provided with each system commissioning plan, as specified in paragraph 1.05 B.3 below.

B. System Commissioning Plans. A System Commissioning Plan shall be created for each system identified in paragraph 1.04 Systems for Pre-Commissioning and Commissioning. The System Commissioning Plan shall be kept updated as testing progresses. At a minimum these plans shall include the following.

1. System Description. Provide a description of the system and each facility and area(s) into which that the system extends.
2. Testing Descriptions and Sequencing
   a. Overall Testing Description
      1) Provide a summary of the testing activities to be performed for that system.
      2) Provide a summary of the media (potable water, non-potable, air, etc) to be used during testing.
      3) Provide a summary of the sequencing of the testing to be performed for the system.
      4) Provide a description of how signals from existing equipment not yet integrated into the work, or from new equipment that cannot yet be actuated, will be simulated or actuated in order to test the system.
   b. Component Testing
      1) Provide a listing, description and sequencing of each component test.

2) The sequencing of the component testing shall be optimized to minimize the length of the phase.
3) Record of field or factory calibration such as for instruments, or configuration specific to requirements specified such as VFD settings.
4) Instrumentation and control loop tests.
5) Electrical acceptance tests.
6) Arc flash hazard and protective device requirements of Division 26.

c. Functional Testing
1) For each system, or multiple integrated systems or facilities which will undergo functional testing, provide a list, description and sequencing of each functional test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.
a) Local control of all equipment and systems must be tested first. Successful testing of any field interlocks and hardwired controls before proceeding to remote control.
b) Local control and remote check out are to be structured around the submitted I/O list, as specified in Division 40.
c) All field terminations, loop checks, and modification within a control panel must be complete commencement of functional testing.
2) Project process and instrumentation diagrams (P&IDs) shall be marked-up and provided which schematically represent the process and controls of the final construction of the system and shall be marked up noting temporary features necessary for Functional testing.

d. Operations Testing
1) For the system, provide a description of the walkdown process.
2) For the system, provide a list, description and sequencing of each startup test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.
3) Project P&IDs shall be marked-up and provided that schematically represent the process and controls of the final construction and shall be marked up noting temporary features necessary for Operations Testing.
4) Plan drawings shall also be provided, marked up to show the final construction and temporary features required for Operations Testing.

e. Acceptance Testing
1) For the system, provide a list, description and sequencing of each acceptance test.

f. Optimization/Performance Testing
1) If required for the facility, provide a list, description and sequencing of each optimization/performance test.

3. Comprehensive Testing Schedule
a. For each System Commissioning Plan, list all equipment to be tested by specification section number and name, and provide a comprehensive schedule showing the following for each.
1) Section number and/or paragraph number within a section.
2) Forecasted installation completion dates.
3) Forecasted visit dates by the manufacturer.

4) The system within which each equipment item is included and will be tested.
5) Forecasted start and completion for each test (component, functional, operations, acceptance).
6) Forecasted submittal dates for test reports.

b. Update Comprehensive Testing Schedule monthly and coordinate it with the Overall Project Schedule.

4. Control Descriptions. Provide a listing of the control description(s) involved. Provide control descriptions as part of the System Commissioning Plan.
5. Drawings. Provide a listing of the following drawings.
   a. All drawings that are part of the Contract Documents and are directly related to the facility undergoing testing.
   b. Shop drawings including wiring diagrams relevant to the facility.
   c. List of package system PLCs and their I/O's and wire diagrams for the system.
6. Instruments. Provide a list of the instruments involved with an appendix which includes the correct set points and ranges for the instruments.
7. Testing Consumables. Provide tables with descriptions that describe the consumables and estimated quantities required during testing, including but not limited to potable water, plant water, chemicals, fuels, oils, lubricants and filters.
8. Testing Equipment Calibration. Provide a description of the measurement devices and the calibration method for the measurement devices which will be used to measure process performance characteristics.
9. Temporary Provisions
   a. Provide a listing and description of temporary provisions required to perform all tests, including calibration equipment.
   b. Where testing requires a source of water, gas or other medium other than the process fluid, identify the source of the water or fluid, the temporary provisions to employed to deliver the water or fluid to the testing location, the temporary provisions to circulate the water or fluid through the facilities to be tested.
   c. Identify the location and method of disposal of the test media (water or fluid, or specified media). Identify temporary provisions required to safely deliver spent media to point of disposal.
10. Hazard Analysis. Provide a description of each potential hazard during the testing activities in the facility and mitigation measures planned for each.
11. A listing of and a short resume for the Manufacturer's representatives who will be involved in testing.
12. Forms: Provide in an appendix with each form and checklist to be used. Starting with forms provided in Section 01 99 90, edit each form to make specific to the components included in each System to be commissioned. Provide additional forms as needed to fully document the commissioning activities specified.

1.06 MANUFACTURER'S FIELD SERVICES

A. Where manufacturer's services are specified in this Section or other specification sections, furnish an authorized representative of the manufacturer who is factory-trained, knowledgeable and experienced in the technical aspects of their products and systems supplied on the Project and qualified to provide these services. Manufacturer representatives shall be available during equipment installation, commissioning and training of Owner's personnel.

B. Manufacturer's representatives shall be subject to the acceptance of by the Construction Manager and Engineer as a submittal with each System Commissioning Plan. No substitute representatives will be allowed without prior written approval from the Construction Manager.

C. Manufacturer's Certifications:
   1. After equipment installation and before equipment energization, each manufacturer's representative shall prepare a written Manufacturer's Installation Certification Form, Form 43 05 11-A in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly installed and lubricated, has been properly maintained by the Contractor, is in accurate alignment, is free from any undue stress imposed by connecting piping and anchor bolts, and is in accordance with the manufacturer's installation instructions.
   2. During Phase 4 Commissioning, each manufacturer's representative shall prepare a written Manufacturer's Operation Certification Form, Form 43 05 11-D in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly lubricated; has been properly maintained by the Contractor; is in accurate alignment; is free from any undue stress imposed by connecting piping and anchor bolts; and has been operated under all design conditions and meets the performance criteria in accordance with the requirements in the applicable specification sections and the manufacturer's operating requirements.

D. The Manufacturer's authorized representative shall perform all services when Manufacturer's services are specified in the individual specification sections. The authorized representative shall be factory-trained and experienced in the technical applications, installation, operation and maintenance of the equipment, subsystem or system.

E. The scheduling of all visits to the site by the manufacturer's field services representative shall be determined by the Contractor and coordinated through the Commissioning Manager. The Contractor shall notify the Construction Manager a minimum of 7 days in advance of all visits.

F. The Manufacturer's authorized representative shall not independently determine any requirements can be omitted, reduced or otherwise change testing requirements, protocols, or required documentation without submitting a request for deviation to the accepted Commissioning Plan or other related submittals.

1.07 SUBMITTALS

A. Action Submittals: The following minimum submittals shall be submitted in accordance with Section 01 33 00.

1. Within 60 days following Notice to Proceed.
    a. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (") shall denote full compliance with a paragraph as a whole.
    b. If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.
    c. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
    d. Commissioning Manager qualifications and past work experience including contact names, addresses, and current telephone numbers that can be used to verify the accuracy of the provided information.
2. Within 120 days following Notice to Proceed.
    a. Master Commissioning Plan.
3. Not less than 120 days prior of the initiation of the first planned component testing in a system.
    a. System Commissioning Plan for the system within which the first components will be tested. Submit system test plans in two parts as described below:
        1) Submit the portion of the system commissioning plan for Component and Functional testing.
        2) After successful completion of the Component testing, submit the test plan for the remaining phases of testing and commissioning.
    b. Submit remaining System Commissioning Plans not less than 120 days prior to first planned component testing within each system, following the same two-part submittal process described above.
4. Qualifications of equipment manufacturer's representatives, to be submitted with each System Commissioning Plan.
5. Within 7 days following completion of each phase of Commissioning for each System Commissioning Plan, submit documentation demonstrating successful completion of the testing phase for that system. Any issues identified during the testing phase shall be identified along with the actions taken, or planned to be taken, to rectify the issue.
6. Certificates of instrument calibration, provided upon request from the Construction Manager or Engineer.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
   1. Updates to Comprehensive Testing Schedule.

C. Closeout Submittals: The following minimum closeout submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
   1. Manufacturer's Certificates of Proper Installation, Form 43 05 11-A in Section 01 99 90, or reference to completed certificates provided under separate submittals where specified.
   2. Test Reports, including completed test forms as specified in Section 01 99 90, and paragraph 1.05 Commissioning Plan, or reference to completed test forms provided under separate submittals where specified.
   3. Certificate of Testing and Commissioning
   4. Certificate of Training Completion, Form 43 05 11-B in Section 01 99 90, or reference to completed Certificates of Training Completion provided under separate submittals where specified.
   5. Manufacturer's Certificates of Proper Operation, Form 43 05 11-D in Section 01 99 90, or reference to completed Manufacturer's Certificate of Proper Operation provided under separate submittals where specified.

D. Samples:
   1. Reference the individual specifications within the Contract Documents for items requiring samples to be submitted.

E. Mock-ups:
   1. Reference the individual specifications within the Contract Documents for items requiring mock-ups to be submitted.

PART 2 PRODUCTS

2.01 TEST MATERIALS AND EQUIPMENT

A. Provide calibrated test gauges, meters, recorders and monitors, reagents and test gases and associated assemblies, as required, to supplement or augment the Work specified in the Contract Documents to facilitate compliance with requirements of the commissioning. Select devices designed to measure the performance of the specific equipment and systems incorporated into the Work.

B. When testing requires the use of temporary provisions such as, but not limited to equipment, power, compressed air, or instrumentation which have not yet been placed in service, provide substitute sources acceptable to both the Owner and Construction Manager, and capable of meeting the requirements needed to perform the testing.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall install all equipment in accordance with Manufacturer's requirements and the Contract Documents. Notify the Engineer/Construction Manager of any conflict between a manufacturer's installation recommendations and the Contract Documents.

B. The Contractor shall perform component testing, functional testing, and startup testing, of all installed component and systems. Unless specified otherwise, the Owner shall be responsible for operating the facility during acceptance testing, with assistance and support from the Contractor in performing specific testing activities.

C. The Contractor shall provide the services of all technical and craft personnel required to support the Work throughout the duration of all testing phases, except as otherwise noted in this Section.

D. The Contractor shall maintain the appropriate staff (either on-site or on-call) to be able to respond immediately (24-hours per day) to deficiencies discovered during the Operations Test Phase and the Acceptance Test Phase. The Contractor's qualified personnel must be capable of being on-site within a maximum of 2 hours of notice to correct any deficiencies.

E. Owner's Operations and Maintenance Responsibility during Testing:
   1. Systems, multiple integrated systems, or facilities in the Operations Test Phase which require wastewater to be treated and disposed of shall be operated by the Owner with guidance from the Commissioning Manager.
   2. Unless specified otherwise, systems, multiple integrated systems, or facilities in the Acceptance Test Phase shall be operated by the Owner with assistance and support from the Commissioning Manager.

F. Until completion of the Acceptance Test Phase, the Contractor shall maintain all facilities undergoing testing. This includes, but is not limited to, manufacturer recommended preventative maintenance, repairs as needed, consumables such as lubricants, coating touch-up, etc.

G. The Contractor shall provide temporary systems, piping, valving, drains, power, controls, etc. to facilitate any of the tests, as needed to cycle water or air through the facilities in a manner that simulates the ultimate operation of the system.

H. All testing that may affect the operation of the existing facilities shall be coordinated with the Owner, including the proper isolation (e.g., lock out/tag out) procedures and features prior to commencing Work.

I. Timing of Testing:
   1. No testing shall commence until the related specific System Commissioning Plan has been submitted, reviewed, and received a review action of No Exceptions Taken, or Make Corrections Noted.

2. No testing shall commence until the O&M Manual for the equipment involved has been reviewed and received a review action of No Exceptions Taken or Make Corrections Noted.
3. Progression from one test phase to the next shall only be allowed at the written approval of the Construction Manager, following submission of written documentation from the Contractor signifying that the intent of that testing phase has been met with satisfactory results. The written approval will include a listing of items still owed by the Contractor regarding the testing which has occurred.
4. Operations Testing shall not commence until all tagging and labeling including but not limited to piping, conduit, wires, panels, and equipment, have been completed.
5. Acceptance Testing shall not commence until training has been completed.
6. All life-safety systems, including but limited to ventilation, fire monitoring and alarms, hazard monitoring and alarms, communication systems, associated with a specific system, must have successfully completed operations testing prior to proceeding with Functional Testing of the system.

J. At the satisfactory conclusion of each test phase, the Contractor shall dismantle and remove all temporary valving, hoses, and other equipment used during the test, and return the facilities to conditions as existed before the test.

K. All deficiencies found during any test phase and subsequent correction thereof, must be inspected and approved by the Construction Manager prior to re-testing or continuation of testing. The contractor shall correct all noted deficiencies.

3.02 TESTING AND STARTUP MEETINGS AND WEEKLY REPORTS

A. The Commissioning Manager shall conduct regular commissioning meetings.

B. The first meeting shall be at least 4 months prior to submitting the Project Commissioning Plan and shall include preliminary discussions regarding this plan. Commissioning meetings shall then be held monthly until 60 days prior to the first planned Component Testing. Ongoing development of the individual System Commissioning Plans will be among the topics discussed in these meetings.

C. Commissioning meetings shall be attended by the Construction Manager, key members from the Contractor staff, Subcontractors, key representatives of the Manufacturers, along with representatives for the Owner and the Engineer.

D. The Commissioning Manager shall prepare meeting minutes from the Testing and Start-up and distribute to all attendees not later than 3 days prior to the next meeting, or within 5 working days of each meeting, whichever is sooner. These should be issued as draft with a request for comments within 3 business days, followed by a final issuance.

E. Weekly Test Reports:
1. During testing activities, submit weekly test reports describing the tests performed, test methods, test strategies implemented during the test, summary of successful testing completed, and specific highlight of any problems and/or deficiencies found during testing.
2. For all troubleshooting, describe the troubleshooting strategy, methods, and final resolution.

3.03 EQUIPMENT AND MATERIALS REQUIRED FOR TESTING

A. It shall be the Contractor's responsibility to ensure that all required materials and test and repair equipment are on hand during all planned testing activities. Spare parts, specified to be provided as part of the work, shall not be used for testing without the written approval of the Construction Manager.

B. All instruments used to measure performance shall be calibrated. Certificates of calibration shall be current (as required in Division 40), and shall be at the job site during testing, and provided upon request or when specified.

C. Contractor is required to provide all expendables during all tests (not including Acceptance Testing, unless otherwise specified), including but not limited to, chemicals, fuel, oil and filters (e.g., air, fuel, natural gas, oil, media, etc.). Upon completion of Operational Testing (or Acceptance Testing, where specified) all expendables shall be replaced with new.

3.04 TEMPORARY PROVISIONS

A. Maintain temporary provisions until the testing phase requiring the temporary facilities are complete, or until the permanent facilities are in service where specified.

3.05 TESTING

A. Phase 1 Commissioning: Component Test Phase: The Component Test Phase shall be comprised of the following three parts.
   1. Part 1 – Component Installation Review
      a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
      b. Perform all changes, adjustments, and replacements required to make the equipment operate properly.
      c. The Component Installation Review includes but is not limited to the following activities.
         1) Verification of adherence to manufacturer's installation and pre-startup requirements and procedures.
         2) For structures and tanks, perform and confirm compliance of structural leakage tests in accordance with Division 03 of these specifications.
         3) For piping, perform and confirm compliance of piping testing in accordance with Section 40 05 01.
         4) Verify wiring continuity for all components, equipment, instruments, panels, and devices. Check power, control, and monitoring circuits for continuity prior to connection to power source. Reference Division 26 and Division 40 for additional specifics regarding installation review of electrical and controls components including, but not limited to:
            a) Electrical acceptance tests per Section 26 08 00, complete.
            b) Arc flash hazard and coordination study, protective device settings, and labeling completed.
            c) Process control system component tests per Section 40 61 20.

5) Confirm cleanliness of connecting piping systems.
6) Confirm alignment of connected machinery.
7) Confirm correct lubrication.
8) Confirm valve orientation and position status for manual operating mode.
9) Confirm correct tagging and identification
10) Confirm proper functioning of all safety components.
11) Confirm proper connections, alignment, calibration and adjustment.
12) Manually rotate or move all moving parts to assure freedom of movement.
13) Confirm all safety equipment is installed per contract requirements, including but not limited to eye wash stations, warning signs, ventilation systems and equipment, etc.
14) Provide Manufacturer's Certificate of Proper Installation following the completion of this review.

2. Part 2 – Component Operations Test
   a. Perform testing showing that the component is operating as needed, intended, and specified for the Work including but not limited to the following.
      1) Bump electric motors to verify power and direction of rotation.
      2) Verify correct voltage and phase sequence of all circuits.
      3) Verify correct amperage.
      4) Pre-Loop and Loop tests per Section 40 61 21.
      5) Complete testing of all control circuits including interlocks.
      6) Verify that every component is operational through its entire range of operation.
   b. Reference Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems.
   c. Unless otherwise specified or allowed by the Construction Manager, the test media for component operational testing shall be plant water or non-potable water.
3. Part 3 – Component Network Communications Test
   a. The component network communication tests shall prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended, and specified.
   b. Perform network tests for all network panels, network hardware, network cables, and all other network systems that are required to be installed and operational for each component.
   c. Refer to Division 40 for specific execution requirements for the component network tests.

B. Phase 2 Commissioning: Functional Test Phase:
   1. Functional testing shall be performed on all components and systems as required to prove that they function as required in conformance with the performance requirements and as needed and intended to complete the Work. All components of a system shall be operated together during functional testing.
      a. The Functional Test Phase is required for all process equipment, HVAC equipment, other equipment, piping, electrical, instrumentation, controls, and package system equipment.
      b. Testing for all PLC controls associated with all components with OIT / SCADA HMI supervisory control, monitoring and alarming functions shall be performed. This test shall include testing of multiple components that have interfaces between them. For packaged equipment this shall include testing of interfaces and interlocks between equipment supplied by the Supplier of the packaged equipment and equipment supplied in other technical specification sections.
      c. When testing requires the use of auxiliary systems such as electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, provide acceptable substitute sources, capable of meeting the requirements of the component or system.
      d. Functionally test each system as an independent system.
         1) Tests shall include all the functional requirements provided in Division 26 and Division 40, within the individual requirements in the Specifications and as required by the Supplier.
         2) Demonstrate that each, and every, component within the system interacts and functionally operates as specified throughout its entire range of operation.
         3) Test each interlock for the system, all local controls, and all PLC controls.
      e. Functionally test multiple integrated systems. The testing shall include individual components and systems that were previously tested independently.
         1) Test in a step-by-step method to accomplish orderly and systematic testing of integrated systems to simulate the functionality of the completed Work.
         2) Tests shall be run through normal operating ranges and to prove specific performance requirements as required by the Specifications or otherwise needed to prove compliance with the Specifications.
         3) To the greatest extent practical, test at conditions which represent the full range of operating parameters (or specified test parameters if greater) as defined in the Contract Documents.
         4) The tests shall include all network controls, all network interlocks, all inter-process interlocks, and all operations interfaces.
         5) The tests shall be performed until the specified operating modes or performance has been accomplished without interruption for the specified duration as indicated in the Specifications or in no instance less than 4 hours.
         6) Should the functional testing of the integrated systems be halted for any reason, the testing shall be repeated until it has been accomplished without interruption.
         7) Coordinate with Construction Manager such that Construction Manager can witness each individual step in the procedures.

f. Following the testing perform the following.
    1) Check equipment for loose connections, unusual movement or other indications of improper operating characteristics.
    2) Disassemble and inspect equipment which exhibits unusual or unacceptable operating characteristics. Re-align machines identified as out of alignment. Repair, or remove and replace with new if unable to pass the requirement of the testing. Test until the equipment meets the requirements of the Specifications.

g. Unless otherwise specified or allowed by the Construction Manager and Engineer, the test media for functional testing shall be the water identified in the System Commissioning Plan (e.g., plant water, non-potable water, air, or specified media, depending on the system).

C. Phase 3 Commissioning: Operations Test Phase:
1. General Requirements of the Operations Test Phase
    a. Tests shall be performed using the specified media.
    b. Disposal of test media shall follow all laws and regulations and with proper permits.
    c. Unless otherwise indicated in these Contract Documents or permitted by the Construction Manager, training shall be performed during the Operations Test Phase.
    d. The Operations Test Phase shall be conducted at a time and date which is requested by the Contractor and agreed to by the Owner.
    e. Coordinate with the Owner for introduction of specified media, disposal (or return to treatment plant) of specified material, and operation of facilities with specified media.
    f. Prior to commencement of the Operations Test Phase, the facility shall be fully operational, capable of accepting design flows and performing functions as designed.
    g. The Operations Test Phase shall test for normal operational sequence as an integrated system conforming to the requirements of the Specifications through full specified operating range. Test network control logic across multiple systems.
    h. During the Operations Test Phase, tests shall be executed for all components. Tests shall include all the operations tests as specified in the individual equipment technical specification sections. This includes vibration tests where specified.
    i. Provide required support to the Owner such that the facility attains its fully operational mode.
2. Part 1 - Walkdown: After the completion of the functional testing, a complete inspection by the Startup Team shall be performed to determine if the facility is ready for the Seven (7) Day Operational Test.
    a. Walk through the facility with the Construction Manager, the Owner, and the Engineer to acknowledge facility is ready for the Seven (7) Day Operational Test.
    b. A working punch-list will be developed and provided by the Construction Manager.

c. The punch-list shall be identified by the following ranking criteria:
    1) Level 1: Significant impact item and no further tests shall be performed until resolved. Requires a signoff prior to proceeding.
    2) Level 2: Minimal impact item that can be corrected later and does not affect continuation of testing.

3. Part 2 - Seven (7) Day Operational Test. The Operations Test Phase shall consist of a continuous un-interrupted seven-day run period using the specified media.

D. Phase 4 Commissioning: Acceptance Test Phase:
1. The Acceptance Test Phase shall be a test of a system or multiple systems by the Owner using the specified media, without operational or performance failure to demonstrate conformance with the performance requirements specified. The minimum duration of the Acceptance Test Phase shall be 30 days, unless otherwise specified within individual equipment specifications. This is the final test to demonstrate the facility including new and existing processes operate together as needed, intended, and specified.
    a. During this test, vary operational parameters during the day, with steady state conditions overnight.
    b. Conduct performance testing where required in individual specification sections. Where practical, coordinate timing of performance testing to fall within the nominal 30 days allocated for Acceptance Testing; however, performance testing outside of this 30-day period may be required in order to fully comply with specified performance testing requirements.
    c. The Acceptance Test Phase shall be judged completed wholly at the discretion of the Engineer with input from the Construction Manager.
    d. This test may last significantly longer than the specified calendar days listed if deficiencies are found, and the test is restarted one or more times. The Contractor shall coordinate with the Owner and provide support as necessary.
    e. After satisfactory completion the facility shall be placed into normal operation.
    f. Provide documentation of successful performance testing where required in individual equipment specifications.
    g. Provide Manufacturer's Certificates of Proper Operation.

E. Optimization Testing:
1. Provide optimization testing as required in individual equipment specifications.

3.06 RETESTS

A. If any portion of a test does not pass, the Contractor shall correct the problem in a timely manner and repeat the test until it passes to the satisfaction of the Engineer and Owner.
1. Functional testing of equipment or a system shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, facility, or designated portion has operated in manner intended for (7) continuous days without significant interruption, unless otherwise agreed upon.
2. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, facility, or designated portion has operated in manner intended for (28) continuous days without significant interruption, unless otherwise agreed upon.

3. Significant Interruption: May include any of the following events:
    a. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
    b. Failure of any critical equipment or unit process that is not satisfactorily corrected within 6 hours after failure.
    c. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 24 hours after failure.
4. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer and Construction Manager, the system, all specified testing has been successfully completed, and all deficiencies have been corrected.

B. If a failure of any component or system occurs during any phase of commissioning, the entire phase shall be re-started. If the Commissioning Manager determines that the failure is minor and recommends continuation of the test rather than re-starting, then the Commissioning Manager shall request continuation in writing to the Construction Manager and Engineer, who, if in agreement, may permit continuation of testing.

C. If a failure of any component should occur during any phase of commissioning, the Contractor shall be responsible for the actual cost of any idle time due to such failure. Such costs of idle time shall include personnel costs of Owner's, Construction Manager's, and Engineer's staff who are assigned to coordinate, assist and witness the commissioning activities. This includes personnel costs, rental costs of equipment and any other incidental costs of the delay.

3.07 AFTER TESTS

A. Once testing has been completed, and until the Construction Manager has issued a certificate of Final Completion, all equipment shall be rechecked once by the Contractor (or more often if specified) for proper alignment and realigned, if necessary. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Construction Manager. All equipment or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled, inspected and shall then be repaired or removed from the Site and replaced at no cost to the Owner.

END OF SECTION

SECTION 01 99 90

REFERENCE FORMS

PART 1 FORMS

1.01 DESCRIPTION

A. The forms listed below and included in this section are referenced from other sections of the project manual:

Form No.	Title
01 33 00-A	Submittal Transmittal Form
01 45 20-A	Equipment Test Report Form
01 78 23-A	Operation and Maintenance Transmittal Form
01 78 23-B	Equipment Record Form
01 78 23-C	Equipment Record Form
09 90 00-A	Coating System Inspection Checklist
26 05 00-A	Wire and Cable Resistance Test Data Form
26 05 00-B	Installed Motor Test Data Form
26 05 00-C	Dry Transformer Test Data Form
26 05 00-D	Motor Control Center Test Form
40 61 13-G	Field Switch Calibration Test Data Form
40 61 13-H	Transmitter Calibration Test Data Form
40 61 13-I	Miscellaneous Instrument Calibration Test Data Form
40 61 13-J	Individual Loop Test Data Form
40 61 13-K	Loop Commissioning Test Data Form
43 05 11-A	Manufacturer's Installation Certification Form
43 05 11-B	Manufacturer's Instruction Certification Form
43 05 11-C	Unit Responsibility Certification Form
43 05 11-D	Manufacturer's Operation Certification Form
43 05 13-A	Rigid Equipment Mount Installation Inspection Checklist
43 05 21-A	Motor Data Form

01 33 00-A. SUBMITTAL TRANSMITTAL FORM

Submittal Transmittal

Submittal Description:	Submittal No:[1]	Spec Section:

	Routing	Sent	Received
Owner:	Contractor/CM		
Project:	CM/Engineer		
	Engineer/CM		
Contractor:	CM/Contractor		

We are sending you:
☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only
Remarks: _____

Item	Copies	Date	Section No.	Description	Review action[a]	Reviewer initials	Review comments attached

[a]*Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected*
Attach additional sheets if necessary.

Contractor

Certify either a or b:

a. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

b. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

No.	Deviation

Certified by: _____

Contractor's Signature: _____

[1]See *Section 01 33 00-1.04. A, Transmittal Procedure.*

01 45 20-A. EQUIPMENT TEST REPORT FORM

NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.

City Of Sample

Example Water Treatment Plant

Stage IV Expansion Project

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

Equipment Test Report

- Equipment Name: Sludge Pump 2
- Equipment Number: P25202
- Specification Ref: 11390
- Location: East Sedimentation Basin Gallery

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
A. Preoperational Checklist				
1. Mechanical				
a. Lubrication				
b. Alignment				
c. Anchor bolts				
d. Seal water system operational				
e. Equipment rotates freely				
f. Safety guards				
g. Valves operational				
h. Hopper purge systems operational				
i. Sedimentation tank/hopper clean				
j. O&M manual information complete				
k. Manufacturer's installation certificate complete				
2. Electrical (circuit ring-out and high-pot tests)				
a. Circuits:				
1) Power to MCC 5				
2) Control to HOA				
3) Indicators at MCC:				
a) Red (running)				
b) Green (power)				
c) Amber (auto)				
4) Indicators at local control panel				
b. Wiring labels complete				
c. Nameplates:				
1) MCC				
2) Control station				
3) Control panel				

	Contractor		Construction Manager	
	Verified	Date	Verified	Date
d. Equipment bumped for rotation				
3. Piping Systems				
a. Cleaned and flushed:				
1) Suction				
2) Discharge				
b. Pressure tests				
c. Temporary piping screens in place				
4. Instrumentation and Controls				
a. Flowmeter FE2502F calibration				
1) Calibration Report No.				
b. Flow recorder FR2502G calibrated against transmitter				
c. VFD speed indicator calibrated against independent reference				
d. Discharge overpressure shutdown switch calibration				
e. Simulate discharge overpressure Shutdown				
B. Functional Tests				
1. Mechanical				
a. Motor operation temperature satisfactory				
b. Pump operating temperature satisfactory				
c. Unusual noise, etc?				
d. Pump operation: 75 gpm/50 psig				
(1) Measurement:				
(a) Flow:				
(b) Pressure:				
(c) Test gage number:				
e. Alignment hot				
f. Dowelled in				
g. Remarks:				
2. Electrical				
a. Local switch function:				
1) Runs in HAND				
2) No control power in OFF				
3) Timer control in AUTO				
b. Overpressure protection switch PS2502C functional in both HAND and AUTO				
c. Overpressure protection switch PS2502C set at 75 psig				
d. PLC 2500 set at 24-hour cycle, 25 min ON				
C. Operational Test				
1. 48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional				

RECOMMENDED FOR BENEFICIAL OCCUPANCY:

Construction Manager	Date

ACCEPTED FOR BENEFICIAL OCCUPANCY

Owner's Representative	Date

01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

Date:	Submittal No:[2]
To:	Contract No:
	Spec. Section:
	Submittal Description:
Attention:	From:

Checklist	Contractor		Construction Manager	
	Satisfactory	N/A	Accept	Deficient
1. Table of contents				
2. Equipment record forms				
3. Manufacturer information				
4. Vendor information				
5. Safety precautions				
6. Operator prestart				
7. Start-up, shutdown, and postshutdown procedures				
8. Normal operations				
9. Emergency operations				
10. Operator service requirements				
11. Environmental conditions				
12. Lubrication data				
13. Preventive maintenance plan and schedule				
14. Troubleshooting guides and diagnostic techniques				
15. Wiring diagrams and control diagrams				
16. Maintenance and repair procedures				
17. Removal and replacement instructions				
18. Spare parts and supply list				
19. Corrective maintenance man-hours				
20. Parts identification				
21. Warranty information				
22. Personnel training requirements				
23. Testing equipment and special tool information				

Remarks:

Contractor's Signature :

[2] See Section 01 33 00-1.04.A, Transmittal Procedure.

01 78 23-B. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

Lubricants: Recommended:

Alternative:

Misc. Notes:

Recommended Spare Parts					Electrical Nameplate Data			
Part No	Quan	Part Name	Cost		Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	V	Amp	Hz
					Ph	Rpm	Sf	Duty
					Code	Insl. Cl	Des	Type
					Nema Des	C Amb	Temp Rise	Rating
					Misc.			
					Mechanical Nameplate Data			
					Equip			
					Make			
					Serial No.		Id No.	
					Model No.		Frame No.	
					Hp	Rpm	Cap	Size
					Tdh	Imp Sz	Belt No.	Cfm
					Psi	Assy No.	Case No.	
					Misc			

01 78 23-C. EQUIPMENT RECORD FORM

Equip Descrip		Equip Loc	
Equip No.	Shop Dwg No.	Date Inst	Cost
Mfgr		Mfgr Contact	
Mfgr Address			Phone
Vendor		Vendor Contact	
Vendor Address			Phone

Maintenance Requirements	D	W	M	Q	S	A	Hours

09 90 00-A COATING SYSTEM INSPECTION CHECKLIST

Project Name			
Owner		Coating System Manufacturer (CSM)	
General Contractor (GC)		Coating System Applicator (CSA)	
Area or Structure		Location within Structure	
Coating System (eg E-1)		Coating Type (eg Epoxy, etc.)	

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	GC QC			
		CSM QC			
		CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	GC QC			
		CSM QC			
		CSA QC			
3	Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	GC QC			
		CSM QC			
		CSA QC			
4	Completion of Surface Preparation for Substrates to Be Coated.	GC QC			
		CSM QC			
		CSA QC			
5	Completion of Primer Application.	GC QC			
		CSM QC			
		CSA QC			
6	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	GC QC			
		CSM QC			
		CSA QC			
7	Completion of Concrete Filler/ Surface Application to Concrete.	GC QC			
		CSM QC			
		CSA QC			
8	Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations.	GC QC			
		CSM QC			
		CSA QC			

Coating System Inspection Checklist

Step	Description		Name	Signature	Date
9	Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations.	GC QC			
		CSM QC			
		CSA QC			
10	Completion of Full and Proper Cure of Coating System.	GC QC			
		CSM QC			
		CSA QC			
11	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	GC QC			
		CSM QC			
		CSA QC			
12	Completion of Localized Repairs to Coating System Following Testing.	GC QC			
		CSM QC			
		CSA QC			
13	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements.	GC QC			
		CSM QC			
		CSA QC			

26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

Location of Test	Insulation resistance, megohms
1.	
2.	
3.	
4.	
5.	
6.	
7.	

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

						Ambient temp	°F
Resistance:							
Insulation resistance phase-to-ground megohms:							
Phase A		Phase B		Phase C			
Current at Full Load:							
Phase				Current, amps			
Phase				Current, amps			
Phase				Current, amps			
Thermal Overload Device:		Manufacturer/catalog #			Amperes		
Circuit breaker (MCP) setting:							

Motor Nameplate Markings:

Mfr		Mfr Model		Frame		HP	
Volts		Phase		RPM		Service factor**	
Amps		Freq		Ambient temp rating			°C
Time rating				Design letter**			
	(NEMA 1-10.35)				(NEMA MG-1.16)		
Code letter				Insulation class			

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

26 05 00-C. DRY TRANSFORMER TEST DATA FORM

(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: _____ Secondary Voltage: _____ Winding Connection: _____

A. VISUAL INSPECTION

Transformer Inspection	Pass	Fail	Note
1. Nameplate data as specified			
2. Mechanical condition			
a. Free of dents and scratches			
b. Anchored properly			
c. Shipping brackets removed			
d. Spacing from wall per nameplate			
3. Grounding *			
a. Equipment grounding			
b. System grounding			

B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

Test Group	Resistance between		30-second reading	60-second reading	Absorption Ratio Index 60-sec. / 30-sec.
Primary Winding to ground	A	GRD			
	B	GRD			
	C	GRD			
Secondary Winding to ground with * N-G Bond removed	a	GRD			
	b	GRD			
	c	GRD			
Primary Winding to Secondary Winding	A	a			
	B	b			
	C	c			

Submit resistance readings to the Construction Manager immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed:_____ Date _____

26 05 00-D. MOTOR CONTROL CENTER TEST FORM

Equipment No.: _____ Ambient room temperature: _____

Location: _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD		A-B	
B-GRD		B-C	
C-GRD		C-A	

2. Set the circuit breaker in the starter unit to comply with the requirements of NEC, Article 430-52 and Table 430-152.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				
			% Deviation Allowed:	

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:

(Attach test form 40 61 13-A)

b. Instrumentation tubing/piping tested:

(Attach test form 40 61 13-B)

c. Instruments calibrated:

(Attach test forms 40 61 13-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

43 05 11-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

Contract No:	Specification section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments:

Manufacturer	Contractor
Signature of Authorized Representative	Signature of Authorized Representative
Date	Date

43 05 11-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No:	Specification Section:
Equipment name:	
Contractor:	
Manufacturer of equipment item:	

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described greasing frequency	
Others:	

Manufacturer	Signature of Contractor Representative Date
Signature of Authorized Representative	
Date	Signature of Authorized Representative Date

43 05 11-C. UNIT RESPONSIBILITY CERTIFICATION FORM

[PROJECT TITLE]

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

_____

[SECTION TITLE]

In accordance with Section 43 05 11-1.02 **Unit Responsibility of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ , and for related equipment manufactured under** sections**_____, _____, and _____ .**

We have reviewed the requirements for sections 43 05 11 and 43 23 03 where applicable) and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.

Notary Public	Name of Corporation
Commission expiration date	Address
Seal:	By:
	Duly Authorized Official
	Legal Title of Official
	Date

43 05 11-D. MANUFACTURER'S OPERATION CERTIFICATION FORM

A. Contract No:	Specification section:

Equipment name:

Contractor:

Manufacturer of equipment item:

The undersigned manufacturer of the equipment item described above hereby certifies that he has witnessed and/or directed the testing of the equipment described above and confirms that the equipment operates within the manufacturer's guidelines for proper and reliable operation, and that the equipment will meet the specified performance requirements.

Comments:

Manufacturer	Contractor
Signature of Authorized Representative	Signature of Authorized Representative
Date	Date

43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION CHECKLIST

[CLIENT, PROJECT NAME]

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 3: Equipment Leveling		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Millwright		Date
Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 7: Epoxy Grout Installation		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 8: Completion of Full and Proper Cure of Epoxy Grout		
Name: Contractor Rep.		Date

Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 9: Completion of Localized Repair of Grout Voids		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date
Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements		
Name: Contractor Rep.		Date
Name: Construction Manager		Date
Name: Grouting Contractor Rep.		Date
Name: Grout Manufacturer's Technical Rep.		Date

43 05 21-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

Mfr:		Mfr Model:		Frame:		Horsepower:	
Volts:		Phase:		RPM:		Service Factor:	
FLA:		LRA:		Frequency:		Amb Temp Rating:	°C

Time rating:		Design Letter:	
	(NEMA MG1-10.35)		(NEMA MG-1.16)
KVA Code Letter:		Insulation Class:	

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____
B. UL frame temperature code ____ (NEC Tables 500-8B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____

(Section 43 05 21-2.04 Motor Efficiency)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure:			Enclosure Material:		
Temp Rise:		°C (NEMA MG1-12.41,42)			
Space Heater included?	☐ Yes	☐ No	If Yes:	Watts	Volts
Type of motor winding over-temperature protection, if specified:					

Provide information on other motor features specified:

_____

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SECTION 02 41 13

SELECTIVE SITE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Work described in this section includes demolition and removal of any existing built site construction, utilities, appurtenances; capping of existing utilities; and all incidental items necessary to provide a condition suitable to construct the full scope of improvements illustrated and/or implied on the Contract Documents.

B. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

C. The Contractor is solely responsible for the scope of Demolition required to build the entirety of new construction illustrated or implied on the Drawings. Specific items illustrated on the drawings could include, but not necessarily limited to; sidewalks, curbs, ramps, signs, driveways, fences, trees, landscape materials and subsurface pipes and structures. Verify the number, location and condition of items to be demolished, removed or modified.

D. Render all areas where improvements are illustrated or implied to be built, clear of debris and free of demolished remnants and debris and other items or conditions which might have a deleterious effect on the continued construction of the project.

E. Become thoroughly familiar with all existing conditions at the Project site, the drawings, specifications, as well as City, County and State Regulations and Ordinances to fully ascertain the scope of work illustrated and/or implied on the Drawings.

F. Visit the site to make an inspection of existing conditions in order to be informed of all the existing conditions on the Project site.

G. The Owner, and Owner's Representatives do not guarantee that all of the existing utilities are illustrated on the Drawings. The Contractor shall locate and verify all horizontal and vertical locations of all existing utilities at no expense to the Owner. In the event that there are, in the opinion of the Contractor, items for demolition not illustrated on the drawings, they shall notify the Owner's Representatives in writing during the Bid Phase of the Project. The Owner's Representatives shall evaluate any such information and shall respond as feasible during the Bid Phase of the Project.

1.02 PROJECT CONDITIONS

A. Traffic
   1. Conduct Demolition operations and removal of debris to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities.
   2. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Owner.
   3. Provide alternate routes around closed or obstructed vehicular or pedestrian traffic ways as required.

4. Submit a Traffic Control Plan for review.
5. Traffic Control Plan must coordinate all traffic control with the City of Vancouver, Washington Department of Transportation requirements, and/or other interested third parties.
6. Provide all temporary traffic control and traffic safety devices including but not limited to barricades, signage, signal lights, and/or flagmen to protect the public at large, and all Contractor's personnel while operating within public streets and/or rights-of-way.

B. Use of explosives will not be permitted, except with written permission of Owner.

C. Promptly repair damages caused to items to remain by Demolition operations at no additional cost to Owner.

D. Costs related to the removal, relocation, replacement and/or rerouting of any and all existing utilities or other built, stored, stockpiled items of any kind, surface or subsurface is the responsibility of the Contractor and will be included in the Contract Sum.

E. Site shall be rendered obstruction free, whether obstructions (utility poles, guy wires etc.,) are noted on the drawings or not.

1.03 EROSION, SEDIMENT AND POLLUTION CONTROLS

A. Furnish and install Erosion Sediment and Pollution Control Measures prior to Demolition operations.

B. Use water sprinkling, temporary enclosures and other suitable methods as necessary to limit the amount of dust and dirt rising and scattering in the air, to the lowest level of air pollution practical for the condition of work. Comply with the governing regulations.

C. Follow and implement all Local, State and Federal regulations pertinent to Demolition operations or any resultant erosion, sediment and pollution control measures.

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
      a. Copy of this Section, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
      b. Check-marks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation.
      c. Failure to include a copy of the marked-up specification sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.

B. Informational Submittals:
   1. Procedures: Section 01 33 00 and 01 78 23.

2. Submittal requirements for operation and maintenance manuals as per requirements of Section 01 78 23.

PART 2 PRODUCTS

2.01 MATERIALS TO BE REUSED

A. Materials to be disassembled and reused shall be handled and stored in a manner and placed so as to prevent damage. Damaged materials shall be repaired or replaced at no cost to Owner. Fasteners, fittings and brackets related to materials to be reused shall, if not salvageable in first-class condition, be replaced at no cost to Owner.

2.02 MATERIALS TO BE REMOVED

A. Materials to be disassembled and not reused shall be treated as "waste" and disposed of by Contractor. In addition:
   1. Burning of waste on site shall not be permitted.
   2. Waste materials shall become the property of the Contractor and shall be promptly removed from site. Storage or sale of salvageable items on site shall not be permitted. Disposal of said materials shall be done so legally.
   3. Do not store waste in planted or tree save areas or any area that can be damaged by storage operations.

PART 3 EXECUTION

3.01 EXTERIOR DEMOLITION

A. Structures
   1. Structures indicated to be removed shall be moved off Owner's property or demolished with debris removed from site.
   2. Owner assumes no responsibility for actual condition of existing structures.
   3. Scope of Demolition includes all coordination with Owner for removal of all incidental appurtenances found on the site.

B. Demolish and/or remove any encountered foundations, footings, asphalt pavement, walls, piping, concrete slabs, vaults and/or other below-grade construction interfering with new construction.

C. Any voids below grade caused by demolition of structures, or below-grade construction, including storm and sanitary sewer structure removal, shall be filled as specified in Division 31 – Earthwork. Consult the owner’s Geotechnical Testing Consultant for assessment of existing conditions and recommendations prior to proceeding and provide report to Owner’s Representatives prior to proceeding.

D. Utilities
   1. Disconnect and seal off utilities to be demolished prior to start of Demolition.
   2. Utilities shall be disconnected below existing grade level by representatives of public utility being disconnected.
   3. Do not interrupt utility service to existing adjacent occupied facilities except as required and approved by Public Utility Company and Owner.

E. Clearing and removal of trees to be completed in a manner to protect adjacent trees, and root systems of adjacent trees, not shown for removal.

3.02 PROTECTION

A. Limit Demolition operations to those items required to provide a condition suitable to construct the full scope of improvements illustrated and/or implied on the Drawings for new construction.

B. Protect and prevent damage to existing construction to remain. Repair and/or replace, at the expense of the Contractor, any and all damage to any of the Owner's property or any adjacent or nearby property Owner's possessions in kind that are to remain.

3.03 OTHER

A. See Mechanical, Civil, Plumbing and Electrical drawings and specifications for any additional utility demolition requirements.

END OF SECTION

SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 DESCRIPTION

A. Formwork requirements for concrete construction.

1.02 QUALITY ASSURANCE

A. References:

1. The references listed below are part of this section. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict, the requirements of this section shall prevail.

Reference	Title
ACI 117	Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.5	Specifications for Environmental Concrete Structures
DOC/NIST PS 1	Voluntary Product Standard, Structural Plywood

B. Design – General:

1. Provide design of formwork, shoring and reshoring systems by the Contractor's Professional Engineer currently registered in the State of Washington.
2. Design, engineering, and construction of formwork, shoring, and reshoring systems is the responsibility of the Contractor.
3. Develop a procedure and schedule for removal of shores (and installation of reshores).
4. Structural record calculations, signed and sealed by the Contractor's Engineer, are required to prove that all portions of the structure, in combination with the remaining forming and shoring systems, have sufficient strength to safely support their own weight plus the loads placed thereon.
5. When developing procedures, schedules, and structural calculations; consider the structural system that exists, effects of imposed loads, and the strength of concrete at each stage of construction.

C. Design Criteria:

1. Design formwork in accordance with ACI 301 and ACI 318 for building structures and ACI 350 and 350.5 for environmental structures to provide concrete finishes as specified in Section 033000.
2. Design systems for full height of wet concrete pressure.
3. Design formwork to limit maximum deflection of form facing materials, as reflected in concrete surfaces exposed to view, to 1/240 of span.

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturer's product data with installation instructions:
      a. Form materials.
      b. Form ties (with waterstops).
      c. Form release compound.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Letter of certification:
      a. Stating that formwork has been designed in accordance with this specification and referenced documents, sealed and stamped by the Contractor's registered design Engineer.

PART 2 PRODUCTS

2.01 FORMS

A. Wood Forms:
   1. Provide new and unused exterior grade plywood panels manufactured in accordance with American Plywood Association (APA) and bearing the trademark of that group.
      a. Forms for concrete surfaces exposed to view: use APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4".
      b. Forms for other concrete surfaces: use APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch.
   2. When approved, plywood may be reused.

B. Metal Forms:
   1. Do not use aluminum. Provide forms free of rust and straight without dents to provide members of uniform thickness.

2.02 FORM TIES

A. Commercially fabricated for use in form construction. Fabricated so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Cone on ends shall be 3/4 inch to 1 inch diameter. Provide embedded portion of tie not less than 1 1/2 inch from face of concrete after cone ends have been removed. Provide ties with integral waterstops at water-retaining and below grade structures.

B. Tapered through-bolts may be used when approved. Use 1-inch minimum diameter at the smallest end. Fill tapered tie holes after cleaning to produce watertight construction. Use a mechanical waterstop plug near the center of the wall and fill each side with non-shrink cement grout. Mechanical waterstop plug shall be Greenstreak Group, Inc. "X-Plug"; or equal.

2.03 FORM RELEASE COMPOUND

A. Coat form surfaces in contact with concrete using a non-staining, non-residual, water based, bond-breaking form coating. The form release agent must be NSF-60 approved for potable water containment structures.

PART 3 EXECUTION

3.01 PREPARATION

A. Cover surface of forms with form release compound prior to form installation in accordance with manufacturer's recommendations.

B. Do not permit excess form coating material to stand in puddles on forms or hardened concrete surfaces against which fresh concrete is to be placed.

C. Clean surfaces of forms, reinforcing steel and other embedded items of accumulated mortar, grout, or other foreign materials from previous concreting or construction activities before concrete is placed.

3.02 FORMWORK CONSTRUCTION

A. Form vertical surfaces of cast-in-place concrete including sides of footings.

B. Construct and place forms so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Brace or tie forms together to maintain position and shape under the load of freshly-placed concrete.

C. Tighten forms to prevent leakage.

D. Provide temporary openings(windows) at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

E. Provide temporary openings to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height, spaced no more than 8 feet on center measured horizontally and vertically.

F. Place a 3/4-inch chamfer strip at exposed to view corners of formed surfaces.

G. At construction joints, overlap hardened concrete surface by at least 1 inch. Brace forms against hardened concrete to prevent movement, offsets, or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place forms at architectural lines, control joints, or at other inconspicuous lines.

H. Where circular sections are formed using flat faced materials, use flat form lengths not exceeding 2 feet wide and the resulting deflection angles at the joints is not greater than 3-1/2 degrees.

I. Construct wood forms for openings to facilitate loosening. Anchor forms so that movement of any part of the formwork system is prevented during concrete placement.

J. At platforms constructed to move equipment over in-place reinforcement, provide beams, struts, and/or legs, supported directly on formwork or other structural members without resting on reinforcing steel.

K. Provide a positive means of adjustment (wedges or jacks) at shores and struts to take up settlement during concrete placement. Brace forms against lateral deflection. Fasten in-place wedges and shims used for final adjustment of forms prior to concrete placement.

L. Place tapered through-bolt form ties with the larger end on the side of the structure in contact with liquid.

3.03 TOLERANCES

A. Install formwork with tolerances in accordance with ACI 117 and the following (the more stringent requirement controls):

1. Install formwork in accordance with manufacturer's written instructions.
2. Vertical surface tolerance from plumb; walls, columns, piers, and risers:
   ± 1/2 inch for entire height ±
   1/4 inch in any 10 feet of height
3. Vertical surface tolerance from plumb; exposed wall corners, end columns, control-joint grooves, and other exposed to view vertical lines: ± 1/2 inch
   for entire height ± 1/4
   inch in any 20 feet of height
4. Horizontal variation from level or from grade; top of slabs, slab soffits, ceilings, and beam soffits, measured before removal of supporting shores: ± 3/4
   inch for entire length ± 3/8
   inch for any bay or 20 foot length ± 1/4
   inch in any 10 feet of length
5. Horizontal variation from level or from grade; exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view horizontal lines: ± 1/2 inch for
   entire length ± 1/4 inch in any
   20 feet of length.
6. Plan position variation; columns, walls, and partitions: ± 3/4
   inch for entire length ± 3/8
   inch for any bay or 20 foot length
7. Plan location and size; sleeves, floor openings, walls, wall openings, beams, and columns: ±
   1/2 inch
8. Cross sectional dimensions; columns and beams and thickness of slabs and walls: ± 3/8 inch
9. Plan dimensions; footings and foundations: minus
   1/2 inch + 2
   inches
10. Misplacement or eccentricity; footings and foundations: 2 percent
    of footing width in direction of misplacement not more than 2
    inches

11. Thickness; footings and foundations: minus 5 percent no limit on the maximum increase except that which may interfere with other construction.
12. Step variance in flight of stairs:
    Rise ± 1/16 inch
    Tread from level ± 1/8 inch

B. Use control points and benchmarks for reference purposes to check tolerances. Establish and maintain reference points in an undisturbed condition until final completion and acceptance of the work.

C. Regardless of tolerances listed, no portion of a structure shall extend beyond the legal boundary of work site.

D. Camber formwork to compensate for anticipated deflections in formwork under wet load of concrete. Adjust camber to maintain above specified tolerances in hardened concrete after forms and shoring are removed.

3.04 REMOVAL OF FORMS

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure in combination with remaining forming and shoring systems has sufficient strength to safely support its weight and loads placed thereon.

B. If forms are loosened and not removed, proceed same day with wet curing operations to soak surfaces of concrete where forms are loosened. When wet curing is not practical or not planned, loosen, remove, and start approved curing procedures on the same day.

C. When required for concrete curing in hot weather, required for repair of surface defects, or when required for finishing at an early age; remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

D. Remove top forms on sloping surfaces as soon as concrete has attained sufficient stiffness to prevent sagging. Make repairs or finishing treatment on such sloping surfaces immediately after form removal.

E. Remove wood forms for wall openings as soon as this can be accomplished without damage to concrete.

F. Remove formwork from columns, walls, sides of beams, and other parts not supporting weight of concrete as soon as concrete has hardened sufficiently to resist damage from removal.

G. When shores and supports are so arranged such that non-load-carrying form facing material can be removed without loosening or disturbing other shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

H. In all cases, proceed with curing same day as form removal.

I. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.

3.05 RESHORING

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure, in combination with remaining forming and shoring systems, has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads are 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 the structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete, but in no case later than the end of working day on which stripping occurs.

E. Place reshores to carry their required loads without overstressing.

F. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength specified by the formwork engineer's structural calculations and verified by field cured test cylinders or other approved method.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Reinforcing steel for use in reinforced concrete.

1.02 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements For Structural Concrete
ACI SP-66	ACI Detailing Manual
ASTM A615	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
AWS D1.4	Structural Welding Code - Reinforcing Steel
CRSI-PRB	Placing Reinforcing Bars
CRSI-MSP	Manual of Standard Practice
FEDSPEC QQ-W-461H	Wire, Steel, Carbon (Round, Bare, and Coated)

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.

5. Manufacturer and type of proprietary reinforcing steel splices. Submit a current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used.
6. Qualifications of welding operators, welding processes and procedures.
7. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. 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 reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

1.04 DELIVERY, STORAGE AND HANDLING

A. Ship reinforcing steel to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.

PART 2 PRODUCTS

2.01 BAR REINFORCEMENT

A. Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706. Where specified, reinforcing steel shall be epoxy-coated in conformance with ASTM A775.

2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A1064.

2.03 WIRE AND PLAIN BARS

A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A1064.

2.04 SMOOTH DOWEL BARS

A. Smooth dowel bars shall conform to ASTM A615, Grade 60, with a metal end cap at the greased or sliding end to allow longitudinal movement.

2.05 REINFORCING STEEL MECHANICAL SPLICES

A. Reinforcing steel mechanical splices shall be a positive connecting threaded type mechanical splice system manufactured by Erico, Inc., Dayton Superior, Williams Form Engineering Company, or approved equal.

B. Type 1 mechanical splices shall develop in tension or compression a strength of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcement and shall meet all other ACI 318 requirements. Where splices at the face of wall are shown or approved, form saver-type mechanical couplers may be used. Form-saver couplers shall have integral plates designed to positively connect coupler to formwork. Type 1 mechanical splices are typical except for locations noted below where Type 2 mechanical splices are required.

2.06 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

2.07 BAR SUPPORTS

A. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI-MSP and placed in accordance with CRSI-PRB. Plastic coating on legs shall extend at least 0.5-inch upward from form surface.

B. Provide precast concrete blocks, four inches square in plan, with embedded tie wires (wire dobies) as specified by CRSI 1 MSP for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

C. Provide stainless steel or plastic protected plain steel supports for other work.

2.08 FABRICATION:

A. Fabricate reinforcing steel bars in accordance with ACI 315 and the following tolerances:
   1. Sheared lengths: +/-1 inch.
   2. Overall dimensions of stirrups, ties, and spirals: +/-1/2 inch.
   3. All other bends: +0 inch, -1/2 inch
   4. Minimum diameter of bends of reinforcing steel bars: Per ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT TOLERANCE

A. Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:
   1. Reinforcing steel bar clear distance to formed surfaces shall be within +/-1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
   2. Reinforcing steel top bars in slabs and beams shall be placed +/-1/4 inch of specified depth in members 8 inches deep or less and -1/4", +1/2 inch of specified depth in members greater than 8 inches deep.
   3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.

4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 1/2 inches or 1.5 times the reinforcing steel bar diameter for columns.
5. Beam and slab reinforcing steel bars shall be threaded through column vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

3.02 CONCRETE COVER

A. Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:
   1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.
   2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.
   3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.
   4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

3.03 SPLICING

A. Reinforcing steel splicing shall conform to the following:
   1. Use Class B splice lengths in accordance with ACI 318 for all reinforcing steel bars unless shown otherwise on the drawings.
   2. Unless noted otherwise on the Drawings, splices in circumferential reinforcement in circular walls shall be Class B tension splices and shall be staggered. Adjacent hoop reinforcement splices shall be staggered horizontally by not less than one lap length (center of lap below to center of lap above) or 3 feet, whichever is greater, and shall not coincide in vertical arrays more frequently than every third bar.
   3. Splicing of reinforcing elements noted as “tension tie” members on the Drawings shall be avoided whenever possible. If splices cannot be avoided, the splices shall be made with full mechanical or full welded splice capable of developing at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be staggered at least 30 inches.
   4. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.
   5. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Owner’s Representative. Mechanical proprietary splice connections may be used when approved by the Owner’s Representative or as indicated on the drawings.
   6. Welding of reinforcing steel bars is not allowed unless approved by the Owner’s Representative.

3.04 CLEANING

A. Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

3.05 PLACEMENT

A. Reinforcing steel bar placement shall conform to the following:
   1. Uncoated reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.
   2. Fasten coated reinforcing steel bars together to prevent displacement. Use plastic or nylon ties to hold the coated reinforcing steel bars rigidly in place. Support coated reinforcing steel bars with plastic or plastic coated chairs, runners, bolsters, spacers and supports as required.
   3. Support reinforcing steel bars over cardboard void forms by means of concrete supports which will not puncture or damage the void forms nor impair the strength of the concrete member.
   4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Place spacer reinforcing steel bars at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
   5. Extend reinforcement to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
   6. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Owner's Representative.
   7. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
   8. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.
   9. Bars with kinks or with bends not shown shall not be used.
   10. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Owner's Representative. Bars shall not be welded at the bend.

3.06 FIELD QUALITY CONTROL

A. Field quality control shall include the following:

1. Notify the Owner's Representative whenever the specified clearances between the reinforcing steel bars cannot be met. The concrete shall not be placed until the Contractor submits a solution to the congestion problem and it has been approved by the Owner's Representative.
2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in this section. The Engineer's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the Owner's Representative.
3. Coated reinforcing steel bars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating. The Owner's Representative may defer final inspection of the coated reinforcing steel bars until bar erection and handling is complete. Repair coated areas as directed by the Owner's Representative and completed prior to concrete placement.
4. An independent laboratory shall be employed to review and approve Contractor welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete, which consists of providing material, mixing, transporting equipment, and labor for the proportioning, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete in the structure.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 11 00 Concrete Forming
   2. Section 03 20 00 Concrete Reinforcing
   3. Section 03 60 00 Grouting
   4. Section 05 50 00 Metal Fabrications
   5. Section 07 91 26 Joint Fillers
   6. Section 07 92 00 Joint Sealants
   7. Section 09 90 00 Painting and Coating

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	Guide to Evaluation of Strength Test Results in Concrete
ACI 301	Specifications for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 350.1	Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures
ACI 503.7	Specification for Crack Repair by Epoxy Injection
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM C31	Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregates
ASTM C39	Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

Reference	Title
ASTM C94	Ready-Mixed Concrete
ASTM C117	Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Slump of Hydraulic Cement Concrete
ASTM C150	Portland Cement
ASTM C157	Length Change of Hardened Hyraulic-Cement Mortar and Concrete
ASTM C172	Sampling Freshly Mixed Concrete
ASTM C192	Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete
ASTM C511	Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
ASTM C595	Blended Hydraulic Cements
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Slag Cement for use in Concrete and Mortars
ASTM C1059	Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1315	Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
ASTM C1567	Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Sampling Aggregates
ASTM D2419	Sand Equivalent Value of Soils and Fine Aggregate
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
CRD-C572	U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
4. Each proposed mix design showing:
    a. Expected strength at 7 and 28-days
    b. Slump, before and after introduction of high-range water-reducing admixture
    c. Water/cement ratio
    d. Weights and test results, certifications, and mill reports of the ingredients
    e. Chemical analysis report and report of other specified test analyses for supplementary cementitious material
    f. Aggregate gradation and documentation of test results classifying aggregate as non-potentially reactive
    g. Shrinkage test results for liquid containing structures
    h. Other physical properties necessary to review each mix design for conformance with these specifications
5. Mix designs proposed shall be sealed by a Professional Engineer registered in the state where the project is located.
6. Product literature and technical data for aggregates, cement, and pozzolan.
7. Product literature, technical data, and dosage of proposed admixtures including, but not limited to, air entraining, water reducing, retarding, shrinkage reducing, etc.
8. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. Owner's Representative reserves the right to accept or reject such proposed methods.
9. Lift Drawings: Submit shop drawings for concrete placements on the project before on-site construction begins. The drawings shall be organized by structure and submitted as a complete set for the Engineer's review. The drawings shall be drawn to scale and show dimensions, forming details, and placement volumes. Show location of construction joints, details of surface preparation, scheduled finish, embedments (including conduits, inserts, and anchor bolts), penetrations (including pipe sleeves), openings, keyways, blockouts, bulkheads, etc. The drawings shall clearly show the placement sequence and will be accompanied by a schedule that shows the schedule dates for forming, placement, and stripping for each section of concrete placed within each structure.
10. Curing program description in sufficient detail to demonstrate that the Contractor will provide acceptable strength, finish, and crack control within the completed structure. Detailed plan for curing and protection of concrete in cold and hot weather.
11. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, surface hardeners, epoxy and chemical grout for crack injection, retardant
12. Sample panels to demonstrate formed wall surface finishes as specified in Part 3.
13. Samples of concrete floor and slab finishes as specified in Part 3.

14. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

1.05 QUALITY ASSURANCE

A. Quality Control By Owner:
   1. Special Inspection of concrete work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspection of concrete is in addition to, not replacing, other inspections and quality control requirements specified herein. Where sampling and testing specified herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.
   3. Refer to Section 01 45 00 Quality Control, for Owner provided testing.

B. Quality Control By Contractor:
   1. Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 and ASTM C1077. The testing laboratory shall sample and test concrete materials as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.
   2. Concrete testing laboratory personnel shall be certified in accordance with the ACI Concrete Laboratory Testing Technician – Level 1 Certification Program or the ACI Concrete Strength Testing Technician Certification Program, or an equivalent program.
   3. Refer to Section 01 45 00 Contractor Quality Control.

C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.

D. Concrete Conference
   1. Contractor shall schedule and conduct a meeting to review the specification requirements and the proposed concrete design mixes, including procedures for producing proper concrete construction. Hold the meeting no later than 28 days after the Notice to Proceed.
   2. All parties involved in the concrete work shall be included to attend the conference, including the following: Contractor's representative, testing laboratory, concrete subcontractor, concrete supplier, reinforcing steel subcontractor, Owner’s Representative, and Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement shall be ASTM C150, Type II or Type V, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.
   2. If low alkali cement is not available, aggregates shall show an expansion of less than 0.1% when tested in accordance with ASTM C1260 or ASTM C1567 concrete mix test results shall be submitted verifying that the aggregates are not reactive per the criteria in this standard. ASTM C1260 and ASTM C1567 results shall be no older than 1 year.
   3. Portland-pozzolan cement shall be ASTM C595, Type IP (MS), interground, low alkali.
   4. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Change of Materials paragraph below.

B. Ground granulated blast-furnace slag (GGBFS), if used in conjunction with portland cement, shall be per ASTM C989.

C. Aggregates:
   1. General:
      a. Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.
      b. Check aggregates for alkali-silica reactive constituents per ASTM C1260. Aggregate shall have less than 0.1% expansion when tested in accordance with ASTM C1260. Aggregates having 0.1% or greater expansion may still be satisfactory provided ASTM C1567 concrete mix test results are submitted and show an expansion of less than 0.1% at 16 days. Test results shall be no older than 1 year.
      c. Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. Establish the final combined aggregate gradation during mix design.
      d. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Change of Materials paragraph below.
   2. Fine Aggregate:
      a. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.

b. Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

U.S. standard sieve size	Permissible variation in individual tests, percent
30 and coarser	2
50 and finer	0.5

c. Other tests shall be in accordance with the following specifications:

Test	Test method	Requirements
Amount of material	ASTM C117	3 percent passing No. 200 sieve maximum by weight
Sand equivalent	ASTM D2419	Minimum 70 percent

3. Coarse Aggregate:
   a. Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 4 for Class Designation 4S. Gradation of each coarse aggregate size specified shall conform to ASTM C33, Table 3.
   b. Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

D. Pozzolan:
   1. Pozzolan shall be Class N, natural pozzolan, or Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Change of Materials paragraph below.
   2. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.
   3. Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.
   4. The loss on ingnitition shall be a maximum of four percent.
   5. The maximum percent of sulfur trioxide (SO3) shall be 4.0

E. Admixtures:
   1. General:
      a. Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Use admixtures in accordance with the manufacturer's recommendations and add separately to the concrete mix. Water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with requirements specified in Part 3.
   2. Water Reducing Admixtures:
      a. Conform to ASTM C494, Type A. Acceptable products include: BASF Corporation “MasterPozzolith Series”; SIKA Chemical Corp. “Plastocrete 161”; Euclid Chemical Co. “Eucon WR 91”; or approved equal.

3. Water Reducing and Retarding Admixtures:
    a. Conform to ASTM C494, Type D. Acceptable products include: BASF Corporation "MasterSet R Series"; Sika Chemical Corp. "Plastiment"; Euclid Chemical Co. "Eucon Retarder 75"; or approved equal.
4. High Range Water Reducing (Superplasticizing) Admixtures:
    a. Conform to ASTM C494, Type F. Acceptable products include: BASF Corporation "MasterGlenium" Series; Sika Chemical Corp. "Viscocrete 2100" or "Viscocrete 2110" (Hot Weather) or "Viscocrete 6100" (Cold Weather); Euclid Chemical Co. "Eucon 37"; GCP Applied Technologies "ADVA 195"; or approved equal.
5. High Range Water Reducing And Retarding Admixtures:
    a. Conform to ASTM C494, Type G. Acceptable products include: GCP Applied Technologies "Daracem 100"; Sika Chemical Corp. "Sikaplast 200" ; Euclid Chemical Co. "Eucon 537"; or approved equal.
6. Air Entraining Agent:
    a. Conform to ASTM C260 and produce air entrained concrete as specified in the Mix Proportioning table below. Acceptable products include: BASF Corporation "MasterAir Series"; Sika Chemical Corp. "Sika AEA-14" or "Sika AIR" ; Euclid Chemical Co. "Eucon AEA-92"; or approved equal.

F. Water:
1. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

G. Change of Materials:
1. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the Engineer. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the Engineer before use in concrete.

2.02 CONCRETE CHARACTERISTICS

A. Mix Proportioning:
1. Concrete shall be normal weight concrete composed of cement, pozzolan, admixtures, aggregates, and water; proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. It is acceptable to substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan.

2. Provide concrete mix designs in accordance with the following guidlines:

Concrete class	Minimum[a] 28-day compressive strength, psi	ASTM coarse aggregate size	Maximum water-cementitious materials (w/cm) ratio	Minimum cementitious materials content (pounds/CY)	Pozzolan, percent by weight of cementitious materials	Air content (percent)	Slump range[d] (inches)
B	3000	57 or 67	0.45	560	15-20[c]	4-6	3-5
C-1	4500	57 or 67	0.40	560	15-20	4-6	3-5
C-2	5000	57 or 67	0.42	560	15-25	4-6	3-5
E[b]	2000	57	--	-	15-20[c]	Not Required	4-8

[a] *Determine compressive strength at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.*

[b] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[c] *Pozzolan use is optional for this class of concrete.*

[d] *Slump before addition of high range water reducing admixture (superplasticizer). Maximum slump after addition of high range water reducing admixture shall be 8".*

B. Use:

1. Provide concrete by class for the uses listed below.

Concrete class	Type of use
B	Non-structural concrete (sidewalks, curbs, pavers, etc.)
C-1	Typical cast-in-place structural concrete
C-2	Precast concrete
E[a]	Pipe bedding and encasement, electrical conduit encasement (duct banks) and concrete fill

[a] *Contractor's option to use the same concrete mix for pipe encasement as the concrete slab above.*

C. Control Tests:

1. General:
   a. Select and adjust proportions of ingredients in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the Trial Mix Design method or Field Experience Data method. Do not place concrete prior to submittal and acceptance of proposed mix.
2. Trial Mix Design:
   a. Mixes verified by this method shall have the samples produced for testing, manufactured at the batch plant which will supply concrete to the project, using materials proposed for the Work and material combinations listed above. Testing, data, and reporting shall conform to ACI 318 and the following:
      1) Required compressive strength used as the basis for selecting concrete proportions (f'cr) shall be the specified concrete strength (f'c) + 1000 psi for specified concrete strengths less than 3,000 psi and f'c + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.

2) Make at least three different trial mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing f'cr.
3) Design trial mixtures to produce a slump within ¾ inch of the maximum specified and an air content within 0.5 percent of the maximum specified.
4) For each w/cm ratio or cementitious materials content, cast and cure at least twelve standard test cylinders in accordance with ASTM C192. Four cylinders from each batch tested at age 7-days, 14-days, and 28-days or as required to comply with ACI 318.
5) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.
6) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce f'cr. This is the maximum w/cm ratio to be used unless a lower w/cm ratio is specified above.

3. Field Experience Data:
   a. When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use, Contractor may substitute use of this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318, except as modified herein.
      1) Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits:
         a) f'c as specified or up to 500 psi above
         b) w/cm ratio as specified or lower
         c) pozzolan content within 5 percent of that specified
         d) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary
         e) slump after introduction of admixtures +0/-1 inch.
   b. Use of historical Field Experience Data does not allow modification of the project mix specifications herein without review and acceptance by the Engineer.
4. Shrinkage:
   a. Liquid containing structures using Class C-1 concrete mix are intended to be watertight. Provide test results for Class C-1 concrete mix meeting the following requirement: drying shrinkage limit of 0.032 percent in the laboratory at 35-days (7-days moist cure and 28-days drying) as tested in accordance with ASTM C157 and the following modifications:
      1) Wet cure specimens for a period of 7-days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.
      2) Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.
      3) Report results in accordance with ASTM C 157 at 0, 7, 14 & 28-days of drying.
   b. Concrete shall not be placed in the field prior to acceptance of the concrete mix. To meet the drying shrinkage limit, it is recommended that a shrinkage reducing admixture be considered for use in concrete for liquid containing structures.

2.03 WATERSTOPS

A. Polyvinyl Chloride (PVC):
   1. Manufacture PVC waterstops from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572. Use 6-inch flat center/ribbed sides/0.375 inch thick less waterstops in construction joints. Acceptable products include: Greenstreak Group, Inc. “Model 679”; Vinylex Waterstops and Accessories “Model R638”; or approved equal. Use 9 inch center-bulb/ribbed sides/0.375 inch thick waterstops in expansion joints. Acceptable products include: Greenstreak Group, Inc. “Model 696”; Vinylex Waterstops and Accessories Model “RLB938”; or approved equal.
   2. Use molded crosses, tees, and other shapes for changes of direction, intersections, and transitions as recommended by the manufacturer.

B. Expanding (Hydrophilic) Waterstops:
   1. Expanding waterstops shall be bentonite-free and made from unvulcanized rubber. Acceptable products include: Adeka Corporation “Ultra Seal MC-2010MN”; Greenstreak Group, Inc. “Hydrotite CJ-1020-2K”; or approved equal. These are allowable for use only where indicated on the drawings or accepted in writing by the Engineer. Provide adhesive approved by the waterstop manufacturer plus concrete nails and fender washers to secure waterstop material in-place during concrete placement. The waterstop MUST be placed between two mats or curtains of steel reinforcement.
   2. For limited cover applications or where only one mat or curtain of reinforcement is present, use Adeka Corporation “Ultra Seal KBA-1510FP”or approved equal.

2.04 SEALANTS AND JOINT FILLERS

A. Sealants and preformed joint fillers are specified in Sections 07 92 00 and 07 91 26.

2.05 BONDING COMPOUNDS

A. Epoxy resin bonding compounds for use in wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use. Acceptable products include: BASF Corporation “MasterEmaco ADH 327RS”; Sika Chemical Corporation “Sikadur 32”; or approved equal.

B. Non-epoxy bonding compounds for use in dry areas for non-structural bonding or as noted on the drawings shall conform to ASTM C1059 Type II. Acceptable products include: Penetron Specialty Products “Acrylic Bondcrete”; ChemMasters “Cretelox”; or approved equal.

C. Apply bonding compounds in accordance with the manufacturer’s instructions.

2.06 EPOXY FOR CRACK INJECTION

A. Use a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, epoxy-resin blend. Consistency as required to achieve complete penetration into cracks. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include: Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or approved equal.

B. Use epoxy injection for structural crack repairs except as noted below for non-structural cracks in liquid-containing concrete structures. The Engineer shall determine whether a crack is classified as structural or non-structural.

2.07 CHEMICAL GROUT FOR CRACK INJECTION

A. Use hydrophobic polyurethane grout at the Engineer's discretion as an alternative for sealing non-structural cracks in concrete structures intended to be watertight. Acceptable products for sealing hairline cracks include: GCP Applied Technologies "DE NEEF Flex SLV PURe" (must be used with DE NEEF Flex Cat PURe); or Sika Corporation "SikaFix HH LV" as appropriate for crack width; or approved equal. Coordinate with product supplier to verify and select appropriate product for crack widths to be injected.

2.08 SURFACE RETARDANT

A. Retardant for exposing aggregate for unformed surfaces in construction joints shall be Sika Corporation"Rugasol-S"; GCP Applied Technologies "Top-Cast"; or approved equal.

B. Apply retardant in accordance with manufacturer's instructions sufficient to assure a minimum penetration of 1/4 inch.

2.09 SURFACE HARDENER

A. Moderate Duty Hardener:
   1. Use a premixed, non-colored, and non-metallic hardener. Acceptable products include: BASF Corporation "MasterTop 100"; or approved equal.
   2. Apply hardener in accordance with manufacturer's instructions, in an amount of at least 0.75 pounds per square foot for commercial, light duty traffic and 1.25 pounds per square foot for heavy duty traffic and process spaces. Product and/or application procedure shall be coordinated with air content of concrete being placed.

B. Heavy Duty Hardener:
   1. Use an emery aggregate dry shake applied during slab finishing. Acceptable products include: L&M Construction Chemicals "Emeryplate FF"; or approved equal.
   2. Apply in accordance with manufacturer's recommendations at a minimum rate of 1.5 pounds per square foot; adjust for the specific floor traffic and use anticipated. Product and/or application procedure shall be coordinated with air content of concrete being placed.

C. Hardener For Existing Concrete:
   1. Use an alkaline siliconate solution to harden, densify, and seal the surface. Acceptable products include: L&M Construction Chemicals "Seal Hard"; or approved equal.
   2. Proposed product shall be approved by Owner after review of similar floors so-treated for at least 2 years.

2.10 CURING AND SEALING COMPOUNDS

A. Acceptable products include: BASF Corporation "MasterKure CC 250SB"; Dayton Superior "Cure & Seal 25% J22UV"; or approved equal, conforming to ASTM C1315.

B. Compound shall be clear and applied in accordance with the manufacturer's instructions.

C. Curing and sealing compound shall be certified compliant with final finish system if applicable, including compatibility with floor hardeners in areas where floor hardeners are specified to be used.

PART 3 EXECUTION

3.01 GENERAL

A. Use only truck-mixed, ready-mixed concrete conforming to ASTM C94. Proportion materials by weighing.

B. Introduce pozzolan into the mixer with cement and other components of the concrete mix; do not introduce pozzolan into a wet mixer ahead of other materials or with mixing water.

C. Introduce water at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified w/c ration and slump is not exceeded and the maximum total water per the approved mix design is not exceeded.

D. Arrange with the testing laboratory for inspection as required to comply with these specifications.

E. Deliver concrete to the site and complete discharge within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a Contractor proposed remedial action plan to be reviewed and accepted by the Owner's Representative.

3.02 CONVEYING AND PLACING CONCRETE

A. Convey concrete from the mixer to the forms in accordance with ACI 301. Remove concrete that has segregated in conveying from the site of the work.

B. Placing Concrete:
   1. General:
      a. Place concrete in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft (6-ft when superplasticizer is used).
   2. Placing Concrete By Pumping:
      a. Concrete placed by pumping is at Contractor's discretion and shall not be the cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.
      b. Measure slump at the hose discharge, except as follows: Initial slump testing in each placement shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.

c. Measure air content at the hose discharge, except as follows: Initial air content testing shall occur at both the pumping unit inlet hopper and the hose discharge. Loss of air content shall be measured between the inlet hopper and the hose discharge. Increase the air content of the delivered concrete at the inlet hopper to provide the specified air content at the hose discharge. After these criteria have been satisfied, air content may be measured at the inlet hopper.

d. Before starting each pumping operation, prime the pump and line with a cement slurry to lubricate the system. Waste cement slurry outside the forms. Equip hose tip with a safety chain for recovery in case of hose blowout during pumping. Hose or accessories shall not remain in the freshly placed concrete.

e. Use tremie placing techniques and equipment for pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times. Concrete pumping shall not occur until Owner's Representative has verified equipment including the tremie plug. Should the discharge line become open, with zones empty of concrete, cease pumping and re-primed with tremie plug installed before continuing.

3. Placing Concrete In Hot Weather:
   a. In temperatures above 80 degrees F, place concrete in accordance with ACI 305.1.
4. Placing Concrete In Cold Weather:
   a. In temperatures below 40 degrees F, place concrete in accordance with ACI 306.1.

3.03 CONSOLIDATING CONCRETE:

A. Consolidate concrete in accordance with ACI 301. If evidence of inadequate consolidation is observed, concrete placement will be suspended until Contractor provides a revised plan to achieve proper consolidation.

3.04 CURING AND SEALING

A. General:
   1. Cure concrete using water (including form curing and use of moister retaining covers), a clear membrane curing compound, or by a combination of both methods. Coordinate repairs or treatment of concrete surfaces so that interruption of curing will not be necessary.
   2. Maintain concrete surface temperature between 50 degrees F and 80 degrees F for at least 5 days. Cure concrete in hot weather (above 80 degrees F) in accordance with ACI 305.1. Cure concrete in cold weather (below 45 degrees F) in accordance with ACI 306.1.

B. Water Curing:
   1. Keep concrete continuously wet for a minimum of 10-days after placement (14 days after placement for sections over 3-feet thick). Absorptive mats or fabric may be used to retain moisture during the curing period. Absorptive covers shall comply with AASHTO M182, Class 3, and moisture retaining covers shall comply with ASTM C171.

2. Use water curing in hot weather for liquid containment structures. Cover forms and keep moist. Loosen forms as soon as possible without damage to the concrete, and make provisions for curing water to run down inside them. During form removal, take care to provide continuously wet cover to newly exposed surfaces.

C. Curing Compound:
   1. When curing compound is allowed, apply it as soon as the concrete has set sufficiently so as not to be marred by the application or apply it immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall follow manufacturer's instructions. For liquid containing structures, apply curing compound at twice the manufacturer's recommended dosage rate, applied in two coats perpendicular to each other.
   2. Do not use curing compound on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded. In these cases, use water curing unless the curing compound is first removed or is compatible with the final finish covering.

3.05 PROTECTION

A. Protect concrete from injurious action by sun, rain, wind, flowing water, frost, excessive vibration and mechanical means.

B. Loading green concrete is not permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing strutures to the satisfaction of the Owner's Representative.

D. Arrangements for covering, insulating, heating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

3.06 CONSTRUCTION JOINTS

A. General:
   1. Place concrete in each unit of construction continuously. Before new concrete is placed on or against concrete which has set, retighten forms and clean foreign matter from the surface of the set concrete. Provide waterstops as specified.

B. Construction:
   1. Form construction joints by producing a rough surface of exposed aggregates using a surface retardant; include joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, remove retarded surface mortar either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and expose coarse aggregate to ensure adequate bond and watertightness at the construction joints.

C. Locations:
   1. Provide construction joint locations as follows:
      a. Cast walls exceeding 50 feet in length in panels not to exceed 30 feet in length. Cast adjoining panels only after 5-days have elapsed. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from a corner unless specifically detailed thus on the drawings.
      b. Locate joints in beams or girders at or near the quarter point between supports.
      c. Make joints in the members of a floor system at or near the quarterpoint of the span.
      d. Make joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs.
      e. Cast slab panels in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, with maximum 1 ½ to 1 ratio of side lengths. Minimum lapsed time between placing adjacent panels shall be 3-days. The requirements for size of slab panel is waived if joints are located on the Drawings.
   2. Vertical construction joints shall have edges grooved or beveled at faces exposed to view including interior faces of basins and tanks. Seal grooves subjected to wetting or weather with joint sealant.
   3. Continue reinforcing steel and welded wire reinforcement through construction joints. Beams, girders, and floor slabs shall not be constructed over columns or walls until at least one day has elapsed to allow for initial shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder unless otherwise shown. Joints shall be perpendicular to the main reinforcement. Provide waterstops in construction joints as specified.

3.07 INSERTS AND EMBEDMENTS

A. Inserts:
   1. Where pipes, castings, or conduits are to pass through structures, position in forms before placing concrete; or where shown on Drawings or approved by the Owner's Representative, provide openings in the concrete for subsequent insertion of such pipes, castings, or conduits. Provide waterstops and a slight flare in the form to facilitate grouting and permit the escape of entrained air during grouting.
   2. Provide additional reinforcement around openings. Use non-shrink grout to infill around inserts.
   3. Place horizontal conduits and pipes, in slabs and beams, between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318.
   4. Conduits and pipes shall not run directly beneath a column or base plate.
   5. Position conduit, pipe, and other ferrous items such that there will be a minimum of 2-inches clearance between said item and concrete reinforcement. Welding inserts to reinforcement is not permitted.
   6. The outside diameter of conduit or pipe shall not exceed one-fourth the slab or beam thickness.

B. Embedments:
   1. Gate frames, gate thimbles, special castings, channels, grating frames, or other miscellaneous metal parts to be embedded in concrete shall be secured in the forms prior to concrete placement.
   2. Embed anchor bolts and inserts in concrete as shown. Provide inserts, anchors, or other bolts necessary for the attachment of piping, valves, metal parts, and equipment.
   3. Provide nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent entry of concrete. Do not use continuouse anchor slots or strips in concrete intended to be watertight.
   4. Positon operators or sleeves for gate or valve stems to clear reinforcing steel, conduit, and other embedments, and to align accurately with equipment.

3.08 EXPANSION JOINTS

A. Expansion joints shall be as shown. Do not extend reinforcement or other embedded metal items through expansion joints. Provide waterstops where indicated.

3.09 WATERSTOPS

A. Waterstops shall conform to ACI 301. Tie waterstops in position prior to placement of concrete to prevent movement and deformation.

B. Provide waterstops in construction and expansion joints as follows:
   1. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
   2. Wall and slab joints of tanks and channels subject to water pressure.
   3. Waterstops shall be provided for the full height of the walls.
   4. Provide at other locations shown on the Drawings.

C. Field splices shall be at straight sections using heat fused welded, butt splices only. Lapping of splices or joining by means other than heat fused welding is not allowed.

D. Install hydrophilic waterstops according to manuacturer’s recommendations. Surfaces of concrete shall be prepared level/plumb and to the smoothness required by manufacturer. Grind surface as necessary. Provide bonding adhesive and concrete nails with fender washers to hold waterstop in position during concrete placment.

3.10 MODIFICATION OF EXISTING CONCRETE

A. General:
   1. Verify structural dimensions related to or controlled by previously constructed or existing structures prior to concrete work.

B. Cutting or Coring Concrete:
   1. Saw cut concrete to a depth of 1 inch to form straight outlines of concrete areas to be removed. Where reinforcement is exposed due to saw cutting or core drilling and no new material is to be placed on the cut surface, provide a protective epoxy coating to the entire cut surface.
   2. Coat surfaces of oversized openings with an epoxy bonding compound prior to re-finishing with profiling mortar to the required opening size.
   3. Grind existing joint edges to create a chamfer matching those used on adjacent construction.
   4. Investigate concrete to be drilled, cored, or sawcut to determine location of reinforcing steel. Locate penetrations to clear existing reinforcing steel. Where not possible to avoid reinforcing steel, consult the Engineer as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed.
   5. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be by the Contractor.

C. Joining New Concrete To Existing:
   1. Existing concrete surfaces to be joined with new concrete shall be cleaned and roughened by abrasive blasting, bush hammering, or other method to achieve ¼-inch amplitude surface. Remove existing metalwork, embeds, or other interfering items. Coat existing surface with epoxy bonding compound prior to placement of new concrete.

D. Post-Installed Anchors and Dowels:
   1. Use non-destructive methods for locating reinforcement prior to drilling operations. For anchor and dowel locations that interfere with reinforcement, attempt to relocate to avoid drilling through the reinforcement if possible.
   2. For situations that do not allow relocation, cutting of reinforcement for installation is subject to the following:
      a. Prior to drilling through reinforcement, the Contractor shall consult the Owner's Representative or Engineer.
      b. Drill holes with a hammer drill and carbide bit (core drilled holes are not allowed), followed by brushing and air-cleaning with oil-free compressed air.
      c. Holes drilled through reinforcement must be in compliance with adhesive anchor assumptions for roughened hole surface typical of a hammer drill and carbide bit. No smooth hole surfaces are allowed.
      d. Do not cut slab rebar within 24 inches of a supporting wall, column, or an opening in the slab.
      e. No cutting of rebar is allowed in the middle third of slab spans for anchors with diameters equal to or greater than 3/4 inch.
      f. Maximum of two rebar may be cut in any 10 foot width of slab.
      g. Maximum of two rebar may be cut within any 10 foot width of concrete wall.
      h. Maximum of one rebar may be cut within any 8 foot width of CMU wall.
   3. For anchors that cannot be moved and that conflict with the above requirements, consult Engineer for direction. It is not acceptable to cut reinforcement in beams, columns, precast members, or stairs.

4. Use a pre-manufactured, self-mixing, injectable, two-component, epoxy adhesive, as per Section 03 60 00. Follow manufacturer's recommendations and ICC Evaluation Report for installation.

E. Waterstops:
   1. Where a waterstop between new and existing concrete is required, install a hydrophilic waterstop, or a retrofit waterstop where indicated on the design drawings for the specific location.

3.11 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
   1. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete in accordance with ACI 301. Clean areas to be repaired. Cut and chip out honeycombed or otherwise defective areas to solid concrete, to a depth of at least 1-inch. If defective area includes exposed reinforcing steel, correct by removing concrete a minimum of 1-inch beyond the reinforcing. Make edges of the cut perpendicular to the surface of the concrete in a neat rectangular patern.
   2. Joints shall be grooved to a radius or bevel of ¾-inch depth.
   3. Finish patches on exposed surfaces to match and blend with adjoining work. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions.

B. Formed Surface Finishes:
   1. Finish A - Grout Rubbed Finish
      a. After repair of surface defects, apply a grout rubbed finish in accordance with ACI 301 except that all form fins and other protrusions shall be completely removed. Lightly sandblast surfaces prior to sacking. Sandblasting shall occur after the specified curing period.
      b. Add a PVA bonding compound to the mix water used in sacking mortar; as recommended by the manufacturer.
      c. Provide Finish A at uncoated surfaces of stair wells, at interior surfaces of equipment rooms, galleries, tunnels, operations areas, exposed channels and tanks from 1 foot below minimum water surfaces and up, at exposed exterior surfaces to 1 foot below grade, and at permanently exposed vertical and sloped surfaces such as pipe chases.
      d. Do not provide Finish A at concrete surfaces receiving a coating.
   2. Finish B - Smooth Surface Finish
      a. Initial surface preparation is the same as Finish A; repair surface defects and remove all form fins.
      b. Provide Finish B at surfaces to be coated, at interior surfaces of exposed channels and tanks from 1 foot below minimum water surfaces and down (Finish A applied above this level), and full height at surfaces of wet wells, tanks, and channels not exposed to view. See Section 09 90 00 for additional concrete surface preparation, including filling of bug holes, and coating requirements.

3. Finish C - Rough Form Finish
    a. Repair surface defects and imperfections greater than 3/8 inch in any dimension. Remove form fins and protrusions down to less than 3/8 inch projection.
    b. Provide Finish C or smoother at exterior surfaces from 1 foot below grade and down, at other vertical surfaces not exposed to view and not specified above to receive Finish A or B.
    c. Also apply Finish C to unoccupied interior areas not otherwise specified.
4. Finish D – Unfinished Surface
    a. Repair surface defects and otherwise leave the surfaces as they come from the forms, except plug tie holes and repair or remove defects greater than 1/2 inch in any dimension.

C. Sample Of Formed Surface Finish A:
1. Provide a sample concrete panel, minimum 4 feet by 4 feet; representative of formed surface Finish A. The panel shall be representative of the workmanship and finish required, including repair of defects, filling of tie holes, sandblasting, and rubbing.
2. The sample shall be approved by the Owner's Representative prior to the start of production work. The sample shall be on display at the job site, and finished surfaces shall match sample.

3.12 SLAB FINISHES

A. General:
1. The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Do not use dry cement on new concrete surfaces to absorb excess moisture. Round edges to a radius of 1/2 inch.
2. Slope floors to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Restrict use of floor drains with only locally depressed slabs to locations specifically noted.
3. Immediately after final finish is applied, the surface shall be cured and protected as specified in Curing, Sealing, and Protection paragraphs above.
4. Where finish is not specified, floor slabs shall receive a Steel Trowel Finish.

B. Float Finish:
1. Perform floating with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently. Float as required to meet tolerance requirements of ACI 117 for a conventional surface.
2. Floating shall close cracks and checks plus compact and smooth the surface. Refloat the slab to a uniform texture.
3. Applly float finish to surfaces of channels, tank bottom slabs, exterior below grade horizontal surfaces, incuding tops of footings, and surfaces to receive insulation or roofing.

C. Steel Trowel Finish:
1. Float the concrete surface as indicated above and then trowel in accordance with ACI 301.

2. Provide Steel Trowel Finish on interior exposed floors and slabs that will receive resilient fooring, carpet or ceramic tile, unless specified otherwise.

D. Broom Finish:
   1. Float the concrete surface as indicated above, then immediately give the concrete a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301.
   2. Provide a Broom Finish for steps and ramps, exterior exposed horizontal surfaces, and where otherwise indicated.

E. Samples Of Concrete Slab Finishes:
   1. Provide a sample concrete slab, minimum 4 feet by 4 feet, representative of workmanship and each specified finish.
   2. Samples shall be approved by the Owner's Representative prior to the start of production work. The samples shall be on display at the job site, and finished surfaces shall match samples.

3.13 RELATED SURFACES

A. Stair Treads:
   1. Construct stair treads with a nonskid nosing as specified in Section 05 50 00.
   2. Treads shall have a Float Finish followed by a Steel Trowel Finish with a slope of 1/8 inch toward the front.

B. Finishing of Unformed Surfaces:
   1. Adjacent Unformed Surfaces:
      a. Tops of walls, buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be Float Finished to a texture reasonably consistent with that of the adjacent formed surface.
      b. Continue final treatment of formed surface uniformly across the top of the unformed surface.
   2. Pavements and Sidewalks:
      a. The surface of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall be Float Finished followed by a Broom Finish.
      b. Round edges and expansion joints to a radius of 1/2 inch. Control joints shall be grooved or sawcut to a minimum depth of 1/4 the slab thickness.

3.14 FIELD SAMPLING AND TESTS

A. General:
   1. Field sampling and tests shall be performed by an independent testing laboratory. Samples of aggregates and concrete will be obtained at such times to represent the quality of the materials and work throughout the project.
   2. The laboratory shall provide necessary labor, materials and facilities for sampling aggregate and for casting, handling, and initially storing the concrete samples at the work site.
   3. The minimum number of samples and tests are specified in Testing paragraph below.

B. Sampling:
   1. Aggregates:
      a. General:
         1) Sample fine and coarse aggregates in accordance with ASTM D75 not less than 30 days prior to the use of such aggregates in the work.
         2) Take samples at the discharge gates of the bins feeding the weigh hopper. Repeat sampling when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found.
         3) Aggregate samples shall be tagged and their sources idenified.
      b. Coarse Aggregate:
         1) Take a sample weighing between 50 and 60 pounds after the batch plant is brought up to full operation.
         2) Take samples to obtain a uniform cross section, accurately representing the materials on the belt or in the bins for sieve analysis.
      c. Fine Aggregate:
         1) Take samples as specified for coarse aggregate.
         2) Take samples of sand when the sand is moist for sieve analysis and specific gravity tests.
   2. Concrete:
      a. Take samples of plastic concrete in accordance with ASTM C172.
      b. Take samples at the hopper of mixing equipment or transit mix truck, except as noted in the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

C. Testing:
   1. Aggregate:
      a. A minimum of one test of coarse aggregate per 400 cubic yards of concrete used and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent.
      b. A maximum of one test per day of each aggregate is required.
      c. Repeat of the entire concrete mix design test program is required before source changes will be accepted.
   2. Concrete:
      a. Strength Tests:
         1) The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 by 8 inch or 6 x 12 inch.
         2) Concrete samples shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less, or for each 5,000 square feet of slab or wall surface area placed per day. Provide additional cylinders when an error in batching is suspected. Each set of cylinders are cast from material taken from a single load of concrete.

3) Casting, handling and curing of cylinders shall be in accordance with ASTM C31. For the first 24 hours after casting, keep cylinders moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the testing laboratory will transport the cylinders to their laboratory.

4) Testing of specimens for compressive strength shall be in accordance with ASTM C39. Each test shall consist of two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) specimens. Test at the end of 7 days and at the end of 28 days. The remaining cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification.

5) A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8). If one cylinder shows evidence of low strength due to improper sampling, casting, handling, or curing, the result of the remaining cylinders may be used if approved by the Owner's Representative.

6) The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength. Not more than 10 percent of the individual strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.

7) Provide certified reports of the test results directly to the Owner's Representative and the Engineer. Test reports shall include sufficient information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, water/cement ratio, air content, temperature of concrete, and ambient temperature shall be noted.

8) The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in accordance with ACI 214R. Quality control charts shall be maintained throughout the entire project and shall be available for the Owner's Representative's inspection at any time.

9) If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Report changes and adjustments in writing to the Owner's Representative.

10) If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Engineer. Costs of such tests and/or anlysis shall be borne by the Contractor.

b. Tests for Consistency of Concrete:

1) Measure slump in accordance with ASTM C143. Take samples for slump determination from concrete during placement. Tests shall be made at the beginning of concrete placement operation, whenever test cylinders are cast, and at subsequent intervals to ensure that the specification requirements are met.

2) For pumped concrete, measure slump in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

3) When high range water reducer is added at the site, slump tests shall be taken before and after addition of the admixture.

c. Tests for Temperature and Air Content:

1) Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Perform temperature tests whenever test cylinders are cast.

2) Measure air content in accordance with ASTM C231 whenever test cylinders are cast. For pumped concrete, measure air content in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

D. Final Laboratory Report:

1. The testing laboratory shall provid a final report at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure.
2. Include final quality control charts for compressive strength tests for classes of concrete specified in each major structure. Also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

3.15 REPAIR OF DAMAGED AND CRACKED CONCRETE:

A. Acceptance Of Concrete:

1. Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet these requirements shall be repaired, as approved by the Engineer, to bring the concrete into compliance. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Engineer.
2. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Remove and replace rejected concrete work.
3. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. Repair Methods:

1. Damaged/defective concrete or concrete with crack widths exceeding 0.004 inches at liquid-containing and conveying structures or crack widths exceeding 0.006 inches for other structures shall be repaired by one of the following methods (only the Engineer may determine that a defect or crack does not require repair):
   a. Perform watertightness testing and repair as needed to meet leakage criteria in this specification even when liquid-containing and conveying structures meet the crack width criteria defined above.

b. Damaged or defective concrete includes surface defects, honeycomb, rock pockets, indentations greater than 3/16 inch, spalls, chips, air bubbles greater than 1/2 inch diameter, pinholes, bugholes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, projections, form popouts, texture irregularities, and stains or other color variation that cannot be removed by cleaning.

1) Damaged or defective concrete is repaired according to procedures outlined above under finish requirements, Repair of Surface Defects.

2. Crack Repair Method 1:
   a. Fill the joint or crack by drilling holes to the affected area (following the product manufacturer's details), install injection ports, and force epoxy or chemical grout (expanding urethane) into the joint under pressure.
   b. Material type and repair proceedures shall be approved by Engineer.
   c. After injection and curing; ports, sealing mix, and surface shall be cleaned and worked to match the adjacent specified finish.
3. Crack Repair Method 2:
   a. Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations.
   b. At a minimum, prepare surface to be clean and dry with no visible detrimental material in cracks to be filled. Conform to temperature limitations of epoxy. Clean and refinish to match adjacent surfaces.
4. Crack Repair Method 3:
   a. Cut a bevel groove 3/8 to 1/2 inch in width and depth, use backer rod or tape, and fill with sealant in accordance with manufacturer's instructions.
   b. This repair method is only used where approved by Engineer.
   c. Groove and sealant shall be applied on wet or hydrostatic pressure side of surface.

C. Repair Method Use:
1. Repair Method 1: For cracks in walls, surfaces sloped 1:1 or greater, beams, columns, structural slabs, overhead surfaces, and liquid retaining surfaces. Need for repair depends upon crack width, location, and leakage.
2. Epoxy grout is used for repair of structural cracks and chemical grout (expanding urethane) for repair of non-structural cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural or non-structural.
3. Repair Method 2: Utilized in lieu of Method 1 for slabs when approved by Owner's Representative. Final finish shall match adjacent surfaces.
4. Repair Method 3: Limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as approved by Engineer. Repair Method 3 is not an equivalent repair method to Repair Methods 1 or 2, which shall be considered the standards.

3.16 WATERTIGHTNESS TESTING AND REPAIR

A. Liquid Containing Concrete Tanks And Channels:
1. Watertightness testing shall comply with ACI 350.1 and the following requirements.

2. Concrete tanks, basins, reservoirs and channels which have walls or slabs subjected to hydrostatic pressure shall be tested for watertightness. The tests shall be made after the structure is complete and the concrete has achieved its specified 28-day strength, but prior to application of waterproof coating or backfill.
3. Filling of the tank for watertightness testing shall not exceed a rate of 4 feet/hour. Fill with water to the maximum operating water surface. Keep water at this level for at least 72 hours prior to start of test.
4. Testing includes visual inspection of the dry sides of all walls, wall base construction joint at top of the slab, and the soffit of elevated slabs for evidence of leakage. Damp spots, leakage, or seepage revealed by the test, including those caused by shrinkage of concrete, honeycombed areas, construction joints, or other sources shall be repaired by Repair Method 1 (see Repair Methods paragraph in the Repair of Damaged Concrete and Cracking article above).
5. Damp spots are defined as areas from which water that can be picked up on dry hand and smeared across the dry concrete surface.
6. Re-test tanks or channels which have been repaired to check the suitability of repairs.
7. Provide water required for testing and re-testing and dispose of in an approved manner.
8. After repair of visual leakage, liquid containing or conveying concrete structures supported on soil must also meet maximum leakage criteria into the soil through their base slab or mat foundation as follows:

Structure Type	Tightness Criterion
Containment structures fully lined prior to hydrostatic test	No measurable loss
Cylindrical water and wastewater storage tanks and reservoirs other than digesters	0.050 percent per day

Note: All damp spots and/or leakage through walls, wall-to-slab joints, and elevated slabs shall first be repaired as described above.

9. Record volume loss by measuring the vertical distance from the water surface to a fixed point on the tank above the water surface. Account for evaporation from open surfaces.
10. If the drop in water surface during the test period exceeds the values given in the table above, exclusive of evaporation, the leakage is considered excessive and shall be remedied. The test period shall be per ACI 350.1.

3.17 CLEANUP

A. Upon completion of the work and prior to final inspection, clean all concrete surfaces as follows: Sweep with a broom to remove loose dirt, then mop and/or flush with clean water. Scrub by hand or machine as required to remove and blend stains or discolored areas .

B. Clean floors that have curing and sealing compound as stated above, followed by the final application of curing and sealing compound.

END OF SECTION

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SECTION 03 48 11

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Factory design and manufacture of precast concrete vault sections and accessories.

B. Quality assurance and control.

C. Field installation of vaults.

D. Waterproofing and epoxy coating of vaults.

E. Installation of frames, hatches, and fall protection.

F. Ladders and safety devices.

G. Vault schedule.

1.02 RELATED SECTIONS

A. Section 01 73 24 - Design Requirements Non-structural Components and Non-building Structures.

B. Section 03 11 00 - Concrete Forming

C. Section 03 20 00 - Concrete Reinforcement

D. Section 03 30 00 - Cast-In-Place Concrete

1.03 REFERENCES

Reference	Title
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C478	Precast Reinforced Manhole Sections
ASTM C858	Underground Precast Concrete Utility Structures
ASTM C913	Precast Concrete, Water, and Wastewater Structures
ACI 301	Specifications for Structural Concrete Buildings
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 315R	Manual of Engineering and Placing Drawings for Reinforced Concrete Structures
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Environmental Engineering Concrete Structures
CRSI 63	Recommended Practice for Placing Reinforcing Bars

1.04 DESIGN

A. All vaults shall be designed by a licensed professional engineer registered in the State of Washington and engaged by the manufacturer. All dead loads, live loads, flotation, erection, temperature, and anchorage stresses shall be considered.

B. The calculations and drawings shall be prepared in a neat and legible manner, sealed by the licensed Professional Engineer performing the calculations.

C. The sealed calculations shall include a summary page to list all design loads, material specifications, and design criterion used in the calculations.

D. For design, groundwater shall be assumed at the top of the vault and the design shall provide for a 125 percent factor of safety against floatation.

E. Vaults shall be designed for H-20 wheel load on top slab and hatches. Structural calculations shall demonstrate adequate strength to resist in service and installation loadings including:
   1. AASHTO H20 wheel loading with applicable impact factors in accordance with ASTM C857.
   2. Surcharge load should be the weight of a minimum of 2 ft of embankment.
   3. Lateral earth pressures. Soil properties should follow the geotechnical engineering study report and its amendments.
   4. Any loads imposed by the supported pipeline and appurtenances.

1.05 SUBMITTALS

A. Submit evidence that shows current PCI, NPCA, and/or Washington DOT certification.

B. Submit shop drawings of wall sections and bases proposed for this project, include joint design and related details for field assembly as applicable.

C. Submit certification of conformance with Contract Documents and ASTM C478, C858, C913.

D. Submit catalog cut and installation details for aluminum hatches with fall protection grates, and ladders with safety devices.

E. Submit catalog cut for epoxy coating system used at interior surfaces and waterproofing system used on exterior surfaces.

F. Under a separate submittal, provide two file copies of calculations for each vault indicating all loads and load combinations. Other than the summary page, calculations will not be reviewed; calculations will not be returned to Contractor.

1.06 QUALITY ASSURANCE

A. Manufacturer shall be a PCI, NPCA, and/or Washington DOT-certified plant for production of precast vaults as specified herein.

B. Aggregate used in producing concrete shall be from Washington DOT approved sources.

1.07 QUALITY CONTROL INSPECTION

A. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection by Engineer. Such inspection may be made at the place of manufacture and/or at the Site after delivery.

B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close-textured and free of honeycomb, cracks, roughness, exposure of reinforcement, damaged joints, or other irregularities.

C. All sections which have been damaged after delivery will be rejected, or if already installed, shall be repaired or removed and replaced entirely at Contractor's expense.

D. Rejected sections shall be tagged as such, segregated from other sections, and removed from the Site.

PART 2 PRODUCTS

2.01 CONCRETE

A. Minimum 28-Day Compressive Strength - 4500 psi.

2.02 REINFORCEMENT

A. Reference Section 03 20 00.

2.03 PRECAST OR CAST-IN-PLACE CONCRETE BASES

A. Design and manufacture of precast concrete bases shall conform to the requirements of this section and ASTM C478, C858, C913. Cast-in-place concrete bases shall conform to Section 03 11 00 and Section 03 30 00.

B. Bases shall conform to the dimensions indicated on the Drawings or as required by design. The horizontal joint at the top of the base shall be compatible with that of the precast wall section.

C. Sumps shall be field constructed where shown on the Drawings. Walking surfaces shall be sloped to the sump, have a non-slip broom finish, and be sealed with a penetrating concrete sealer. Minimum concrete fill thickness at sumps shall be two inches.

2.04 PRECAST CONCRETE WALLS

A. Design and manufacture of precast concrete walls shall conform to the requirements of this section and ASTM C478, C858, C913.

B. All tongue-and-groove joints in the precast wall, including the joint at the top of the base, shall be made up using gaskets.

C. The precast sections shall be provided with a special groove to receive and hold the gasket in position during joint assembly.

D. After joint assembly, the gap between sections shall be packed on the inside and outside with “Masterflow 713” by Master Builder; “Five Star Grout” by U.S. Grout Corp.; or equal, and shall be troweled smooth so that no projections remain on the inside. There shall be concrete to concrete bearing between the various sections. The gasket shall not support the weight of the section.

2.05 PRECAST CONCRETE SLAB TOPS

A. Precast reinforced concrete slab tops shall be manufactured in accordance with ASTM C478, C858, C913. Openings and frames shall be provided for hatches where shown on the Drawings. Slab tops shall be set in a full bed of mortar.

B. Slab tops shall be crowned or sloped to drain, minimum 1/4 inch per foot.

C. Concrete slab tops shall receive a non-slip broom finish and a penetrating concrete sealer per Section 03 30 00.

2.06 GRATING TOPS

A. Where grated tops are shown on the Drawings, the Contractor shall supply fabricated grating frames to the precast manufacturer and coordinate the grating installation for a complete Project.

2.07 PIPE SEALS

A. Where polyethylene, plastic or PVC pipe is utilized, connections between vault and pipes shall be made with flexible rubber sleeves with stainless steel straps and bolts. Provide an elastomeric waterstop gasket where sleeve sizes are not commercially available.

B. The annular space around the pipe wall or sleeve shall be packed with “Masterflow 713” by Master Builders, “Five Star Grout” by U.S. Grout Corp.; or equal. Before the grout has set, Contractor shall recheck invert elevations of the pipe.

C. For steel or ductile iron pipe, provide a pipe sleeve sized to accept the pipe plus a modular mechanical seal such as Link Seal or equal.

2.08 HATCHES

A. Hatches shall be of the size and type shown on the Drawings and as described in Section 08 31 20.
   1. Aluminum single leaf, watertight gasketed floor hatch. Floor hatch shall be furnished with flush stainless steel hinges, aluminum stiffeners, and lockable slam latch. Hatches shall have extended aluminum frame to match concrete thickness with continuous anchor and shall be constructed of 1/4 inch minimum aluminum diamond pattern plate design.
   2. Hatches shall be provided with an auto-lock, hold-open device and torsion spring assembly. All hardware, including all parts of the latch and lifting mechanism assemblies, hold-open arms and guides, and all brackets, hinges, pins and fasteners shall be stainless steel or bronze.

3. The hatches shall be designed for an H-20 wheel load. A 1-inch drain coupling shall be provided in hatch frame. Contractor to extend drain to exterior of structure or to sump pit at vaults intended to remain dry.
4. At all hatches, provide a hinged aluminum grate fall-through protection system.
5. Aluminum hatches shall be Bilco "PCM" or as manufactured by Washington Aluminum Company or equal.

2.09 LADDER

A. Where shown on the Drawings, provide ladders as specified in Section 05 50 00.

B. Where shown on Drawings, provide ladder rungs made of cast iron or polypropylene with steel reinforcement. Rungs shall be either cast in place or drilled and adhesive grouted in the shop. Rungs are equally spaced at a maximum 12-inch spacing from the top of the base slab to the top of the top slab.

C. Install ladder rungs so that the distance from the rungs to the finished wall is 7 inches.

D. Provide aluminum ladder access safety post as specified in Section 05 50 00 by Bilco, U.S.F. Fabrications, or equal.

2.10 OPENINGS AND INSERTS

A. All openings required in the concrete shall be reinforced with additional diagonal bars tied to each layer of wall or slab reinforcement.

B. Any required pipe sleeves, inserts, and wall openings shall be coordinated with mechanical requirements prior to casting the units.

2.11 WATERPROOFING

A. Around the exterior of all wall joints, apply the "Bituthene" primer and membrane waterproofing system by W.R. Grace Company, or equal.

B. Exterior wall surfaces shall be waterproofed using manufacturer's standard two-coat system, specifically designed to waterproof the exterior of concrete surfaces in a below-grade submerged condition.

C. For the top slab and above-grade exposed side walls, the concrete shall be sealed with two coats of a penetrating concrete slab sealer per Section 03 30 00.

2.12 EPOXY COATING

A. The interior surface of the wet well shall receive a factory applied epoxy coating. Apply at wall surfaces (full height) and ceiling.

B. Surfaces shall be abrasive blasted and allowed to cure a minimum of 28 days prior to application of epoxy coating system. Follow manufacture's instructions for primer, application temperatures, etc. Use Sika Corporation "Sikagard 62", Euclid Chemical Company "Duraltex 1707", or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade elevations for vault base is correct, excavation is dewatered, and subgrade is pre-compacted.

B. Verify that rejected units have been removed from Site.

3.02 PREPARATION

A. Provide foundation mat of run-of-crusher stone to support base. Mat shall be 6 inches minimum depth and shall bear on sound undisturbed earth; excavate and remove subgrade material as necessary to reach sound subgrade.

B. Stone foundation mat shall be a minimum of 1 foot greater than the footprint of the vault base, and shall be compacted to a uniform, level surface.

3.03 INSTALLATION

A. Vault shall be accurately located and uniformly supported on the foundation mat in a level position.

B. Install wall sections in properly oriented position; follow manufacturer's instructions for joining together each section using the gaskets. Pack joints with grout.

C. Units shall be laid-up plumb and level.

D. Contractor is responsible for the integrity of all materials and protection against flotation during the installation and backfilling process.

3.04 COATINGS

A. All exterior below-grade wall joints shall be sealed using a membrane waterproofing system. Next, all below-grade wall surfaces shall be waterproofed, applied per manufacturer's instructions.

B. After installation is complete, the cover slab and interior walking surfaces shall be sealed as specified above.

C. After installation of mechanical equipment, provide touch-up painting of damaged epoxy wall finish.

3.05 BACKFILLING

A. Backfill using well compacted structural fill material, being careful to not damage exterior waterproof coating while providing full support under connecting pipes using compacted bedding material.

B. During the one year warranty period, all visible leaks shall be sealed in an approved manner.

3.06 SCHEDULE OF VAULTS

Vault Identification	Reference Drawing
U03 Valve Vault 3	D-P02-102
U05 Flow Meter Vault 5	C-000-411

END OF SECTION

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SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Grout for masonry is specified in Section 04 22 00. Adhesive anchor bolt grouting is specified in Section 05 05 20. Topping concrete over precast elements and clarifier topping concrete is specified in Section 03 30 00.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete
   2. Section 04 22 00 Concrete Unit Masonry
   3. Section 05 05 20 Anchor Bolts
   4. Section 43 05 13 Rigid Equipment Mounts

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm Cube Specimens)
ASTM C230	Flow Table for Use in Tests of Hydraulic Cement
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C939	Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C942	Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
ASTM C1181	Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts

Reference	Title
ASTM E329	Agencies Engaged in Construction Inspection, Testing, or Special Inspection
COE CRD-C611	Flow of Grout for Preplaced Aggregate Concrete
COE CRD-C621	Non-shrink Grout
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Complete product literature, including mixing, handling and placement instructions for the following: Cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement in accordance with Section 03 30 00.
   6. Current ICC Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with Section 01 45 23.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
      a. The Special Inspector shall furnish a report to the Engineer, Owner's Representative and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Quality Control by Contractor
   1. Provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 if a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.

C. Certifications
   1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.

D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications.
   1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
   2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

E. Manufacturer Qualifications
   1. Manufacturer shall have a minimum of five years experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
   2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.

PART 2 PRODUCTS

2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved ready to use mixture requiring only water for use at the job site. The 2-inch cubes shall have a minimum compressive strength of 3,000 psi at 7 days and 7,000 psi at 28 days.

B. Cementitious non-shrink non-metallic aggregate grout shall be:
   1. BASF, Masterflow 928
   2. Euclid Chemical Company, Hi-Flow Grout
   3. Five Star Products, Inc., Five Star Grout
   4. Sika Corporation, SikaGrout 212
   5. Approved Equal

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45 degrees Fahrenheit and 90 degrees Fahrenheit and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.

B. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be:
   1. BASF, Masterflow 648
   2. Euclid Chemical Company, E3-G
   3. Sika Corporation, Sikadur 42
   4. Approved Equal.

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer.
   1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
   2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
   3. Minimum seven-day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
   4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
   5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.

2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:
   1. Hilti, HIT-RE 500v3
   2. Simpson Strong Tie, SET XP
   3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or IAPMO Report. Adhesive shall be:
   1. Hilti, HIT-HY 270
   2. Simpson Strong Tie, SET XP

3. Approved Equal acceptable per ICC Report or IAPMO Report for resisting earthquake loads.

2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Repair mortars shall be:
   1. BASF, MasterEmaco S 466CI
   2. Sika Corporation, SikaTop 111 Plus
   3. Approved Equal

B. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF, MasterEmaco 1500HCR Vertical Overhead
   2. Sika Corporation, SikaTop 123 Plus
   3. Approved Equal

2.05 CEMENT GROUT

A. Cement grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
   1. Minimum Compressive Strength: 4,500 psi at 28 days.
   2. Maximum Water Cement Ratio: 0.42 by weight.
   3. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
   4. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
   5. Air Content: Five percent (plus or minus one percent).
   6. Minimum Cement Content: 564 pounds per cubic yard.
   7. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term “non-shrink grout” is indicated on the Drawings. Use of this grout to support the bearing surfaces of machinery shall be as specified in Section 43 05 13 or as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with the manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

3.03 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of Section 43 05 13, details on the Drawings, and in conformance with manufacturer's recommendations.

3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer's instructions.

3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Owner's Representative and shall be accepted prior to commencement of the work.

3.06 CEMENT GROUT

A. Cement grout shall be used for grout toppings less than four inches thick and for patching of fresh concrete.

B. Grouting shall comply with temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.

C. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 30 00, Cast-In-Place Concrete, for non-prepackaged cement grout.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Section includes: Reinforced concrete masonry constructed from concrete masonry units, reinforcing steel, mortar, and grout.

B. Concrete unit masonry materials and construction: Conform to TMS 602, except where noted otherwise in this Section.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 45 23 Testing and Inspection Services.
   2. Section 03 20 00 Concrete Reinforcing.
   3. Section 03 60 00 Grouting.

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI SP-66	ACI Detailing Manual
TMS 602	Specification for Masonry Structures
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A580	Stainless Steel Wire
ASTM A951	Steel Wire for Masonry Joint Reinforcement
ASTM A1064	Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C90	Loadbearing Concrete Masonry Units
ASTM C144	Aggregate for Masonry Mortar
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C270	Mortar for Unit Masonry
ASTM C404	Aggregates for Masonry Grout
ASTM C476	Grout for Masonry
ASTM C979	Pigments for Integrally Colored Concrete
ASTM C1314	Compressive Strength of Masonry Prisms
IBC	International Building Code

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mix design for grout.
   5. Product Data
      a. Masonry unit certificates: Show compliance with the specifications for each type of masonry unit.
      b. Reinforcing certificates: Showing compliance with the specifications for reinforcing steel as specified herein and in Section 03 20 00.
      c. Manufacturer's data and descriptive literature for each type of masonry accessory (anchors, wall ties, positioning devices, etc.), joint reinforcement, premixed mortar, grout admixtures, and flashing. Clearly mark the data to indicate which type, size, or item will be provided.
   6. Shop Drawings
      a. Reinforcing Steel: Detail bending and placement of masonry reinforcing bars. Comply with ACI SP-66.
      b. Masonry Units: Details of all types of CMU units including, but not limited to, corners, jamb units, lintels and bond beams.
      c. Anchors, wall ties, positioning devices, and other accessories, including locations.
   7. Samples for Verification: Full size units for each different exposed masonry unit.
   8. Test Reports
      a. Provide tests from an independent testing agency.
      b. Concrete Masonry Compressive Strength (f'm): Prism tests in accordance with ASTM C1314.
      c. Material Test Reports: Masonry units and grout.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner
   1. The Owner will provide the services of a qualified Special Inspector in accordance with IBC and Section 01 45 23.

B. Sample Panel: Construct a sample masonry panel for each type of masonry, approximately 6 feet long by 4 feet high, on site for approval by the Owner. Each panel shall show the workmanship, coursing, bond, anchors, tooling of joints, range of color, texture of masonry, and mortar color. Finished work shall match the approved sample panel.

C. Do not change source or supply of materials after the work has started.

D. Determine compressive strength of concrete masonry (f'm) by the prism test method in accordance with TMS 602 and ASTM C1314. Use the same materials and workmanship to construct the prisms as those to be used in the structures. Submit prism test results verifying required compressive strength (f'm) prior to beginning construction of masonry walls.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Cementitious materials shall be delivered to the site in unbroken containers, plainly marked and labeled with manufacturers' names and brands, stored in dry, weathertight enclosures to prevent entry of foreign materials and damage by water or dampness. Masonry units shall be stored off the ground and handled with care to avoid chipping and breakage. Materials shall be protected from damage and, except for sand, kept dry until used. Sand shall be covered to prevent intrusion of water and foreign materials and to prevent drying. Materials containing frost or ice shall not be used.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. General: Provide air, water, or steam cured concrete masonry units with modular dimensions. Texture and color masonry units per the Drawings and Specifications.

B. Concrete Masonry Units (CMU): For hollow concrete masonry units at both load-bearing and non-load-bearing walls, conform to ASTM C90, medium weight, with concrete masonry unit compressive strength as required to result in a concrete masonry compressive strength (f'm) of 2,000 psi. Concrete masonry units shall contain "DRY BLOCK" admixture by WR Grace Co. or "RainBloc" admixture by ACM Chemistries, Inc., amount per manufacturer's recommendation.

C. CMU shall be colored as per architectural drawings. Use iron oxide based colorant conforming to ASTM C979/C979M.

D. Special Shapes: Provide special shapes such as closures, header units, and jamb units as necessary to complete the work. Conform to the requirements for the units with which they are used.

2.02 MORTAR

A. Mortar: Conform to ASTM C270, Type S.

B. Cement:

1. Cement shall be Portland cement conforming to ASTM C150, Type II, low alkali containing less than 0.60 percent alkalies.

C. Hydrated Lime:
   1. Hydrated lime shall conform to ASTM C207, Type S.

D. Masonry Cement: Do not use masonry cement.

E. Sand:
   1. Aggregate for mortar shall be sand conforming to ASTM C144.

F. Water:
   1. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

G. Waterproofing Compound: Mortar shall contain "DRY BLOCK" admixture by WR Grace Co. or "RainBloc" admixture by ACM Chemistries, Inc., amount per manufacturer's recommendation.

H. Colored Mortar: Provide colored mortar to match the masonry units. Use iron oxide based colorant conforming to ASTM C979/C979M.

I. Admixtures: Admixtures may be used in mortar to retard curing and improve workability, provided that the admixture does not adversely affect bonding or compressive strength.

J. Mortar air content shall not exceed 12 percent. Do not use air-entraining admixtures.

2.03 GROUT

A. General: Conform to ASTM C476. Use Type II cement, minimum 28-day compressive strength of 2,000 psi or specified concrete masonry compressive strength (f'm), whichever is greater. Grout shall have sufficient water added to produce a consistency for pouring without segregation.

B. Aggregate: Conform to ASTM C404.

C. Fine Grout: Composed of one part cement, not more than 1/10 part lime, and 2 1/4 to 3 parts (by volume) fine aggregate.

D. Coarse Grout: Composed of one part cement, not more than 1/10 part lime, 2 to 3 parts (by volume) fine aggregate, and not more than 2 parts (by volume) coarse aggregate.

2.04 REINFORCING

A. Reinforcing Bars: See Section 03 20 00 Concrete Reinforcing.

B. Joint Reinforcing: Ladder type wire reinforcing with 9-gauge side and cross wires conforming to ASTM A951 and ASTM A1064, and hot-dip galvanized per ASTM A153 Class B-2.

2.05 ACCESSORIES

A. Horizontal Joint Reinforcement:
   1. Horizontal joint reinforcement shall be fabricated from cold drawn steel wire, ASTM A82. Wire shall be hot-dipped galvanized after fabrication in accordance with ASTM A153. Reinforcement shall be truss type with two or more longitudinal wires welded to a continuous diagonal cross wire, or ladder type with perpendicular cross wires not more than 16 inches o.c. Reinforcement shall be provided in flat sections 10 feet long, and preformed corners and tees approximately 30 inches long. Overall width shall be approximately 2-inches less than nominal thickness of wall.
   2. For single-wythe walls and partitions, two 9-gage longitudinal wires and 9-gage cross wires shall be provided.

B. Anchors And Ties:
   1. General:
      a. Anchors and ties shall be approved designs of stainless steel, zinc-coated steel, or noncorrosive metal having the equivalent total strength of steel types. Zinc-coated steel shall be coated by the hot-dip process after fabrication to a minimum of 1.25 ounces of zinc per square foot of surface when tested in accordance with ASTM A90.
   2. Corrugated Metal Ties:
      a. Metal ties shall be not less than 7/8-inch wide by approximately 7 inches long and not lighter than 22 gage.
   3. Rigid Steel Anchors:
      a. Rigid steel anchors shall be not less than 1 inch wide, 1/4 inch thick, and 24 inches long with each end bent not less than 2 inches.
   4. Dovetail Flat Bar Or Wire Anchors:
      a. Flat bar anchors shall be sheet steel, not lighter than 16 gage, and 7/8-inch wide, with end turned up 1/4 inch. Wire anchors shall be not lighter than 6 gage, 7/8-inch wide with wire looped and closed.
   5. Dovetail Anchor Slots:
      a. Unless otherwise specified, Dovetail slots shall be made of galvanized steel with minimum dimensions of 1 inch wide back by 1 inch deep by 5/8-inch throat.

C. Through-Wall Flashing:
   1. Flashing, where specified, shall be 5-ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory applied coating shall weigh not less than 6 ounces per square foot (approximately 3 ounces per square foot on each side).

2.06 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00. Information shall be received by the Construction Manager at least 14 days prior to the beginning of masonry work.
   1. Masonry unit certificates showing compliance to the specifications shall be submitted for each type of masonry unit.

2. Reinforcing certificates showing compliance to the specifications shall be submitted for reinforcing steel, including reinforcing steel wire and joint reinforcing, as specified herein and in Section 03 20 00.
3. Certified efflorescence test reports specified in paragraph 1.02 Efflorescence Testing.
4. Shop drawings showing details of anchors, adjustable wall ties, positioning devices, and other accessories.
5. Manufacturer's data and descriptive literature for each type of masonry accessory, premixed mortar, masonry cement, grout admixtures, and flashing. Clearly mark the data to indicate which type, size, or item the Contractor intends to provide. Data shall show conformance to specified requirements and Contractor's proposed usage details.

PART 3 EXECUTION

3.01 PREPARATION

A. General:
   1. Foundations for masonry work shall be straight, on-line, and level. All surfaces to be bonded with masonry shall be clean and free from laitance or foreign materials. Reinforcing dowels shall be in the correct location as specified. The placement and location of anchor ties, inserts, and other embedded items in concrete or other adjoining work shall be coordinated by the Contractor to suit the masonry work.

B. Protection:
   1. Exposed surfaces shall be protected from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Base of walls shall be protected from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.
   2. Uniform loads shall not be applied for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed.
   3. Temporary bracing shall be provided as required to prevent damage during construction.
   4. Protective boards for polyester film shall be provided during job installation to ensure no damage from building debris.

3.02 WORKMANSHIP

A. Masonry shall be level and plumb. Story poles or gage rods shall be used throughout the work. Changes in coursing or bonding after the work is started will not be permitted; neither will carrying one section of the walls up in advance of the others be permitted. Unfinished work shall be stepped back for joining with new work; toothing will not be permitted. Heights of masonry at each floor and at sills and heads of openings shall be checked with an instrument to maintain the level of the walls. Door and window frames, louvered openings, anchors, pipes, ducts, and conduits shall be built in as the masonry work progresses. Spaces around metal door frames shall be filled solidly with mortar. Drilling, cutting, fitting, and patching to accommodate the work of others shall be performed by masonry mechanics. Masonry shall be cut with masonry saws for exposed work. Structural steelwork, bolts, anchors, inserts, plugs, ties, lintels, and miscellaneous metalwork shall be placed in position as the work progresses. Chases of approved dimensions for pipes and other purposes shall be provided where specified and necessary. Tops of exposed walls and partitions not being worked on shall be covered with a waterproof membrane secured in place and extended down at least 2 feet on both sides.

3.03 MORTAR MIXING

A. Mortar materials shall be measured in 1 cubic foot containers to maintain control and accuracy of proportions; measuring materials with shovels is not permitted. Mortar shall be mixed in a mechanical batch mixer for not less than 3 nor more than 5 minutes after all ingredients are in so as to produce a uniform mixture. Water shall be added gradually as required to produce a workable consistency. Mortar not formulated to include retarding admixtures, which has not been placed in final position within 2-1/2 hours after the initial mixing, shall not be retempered and used. Use of antifreeze compounds, salts, or other substances to lower the freezing point of mortar is prohibited.

B. Mortar shall be mixed in accordance with ASTM C270 to obtain type mortar required. Where colored mortars are required, pigments may be added at the site or provided as part of prepackaged mortar mix. When masonry cement is used, mixing shall conform to printed instructions of the masonry cement manufacturer.

3.04 MORTAR JOINTS

A. Mortar joints shall be a uniform thickness of 3/8-inch unless otherwise specified. Exposed joints shall be tooled slightly concave with a round or other suitable jointer when the mortar is thumbprint hard except where otherwise required to match existing construction. For horizontal joints, jointers shall be at least 12 inches long for brickwork and 16 inches long for concrete masonry. Jointers shall be slightly larger than the width of the joint so that complete contact is made along the edges of the units, compressing and sealing the surface of the joint. Joints that will not be exposed shall be struck flush. Vertical joints shall be tooled first. Horizontal joints shall be level; vertical joints shall be plumb and in alignment from top to bottom of wall within a tolerance of plus or minus 1/2 inch in 40 feet.

B. Weep holes shall be placed at a maximum spacing of 48 inches at the base of cavity walls or veneer walls and in the course bearing on through-wall flashing.

3.05 TOLERANCES

A. Masonry work shall be within the following limits:
   1. Pilasters and Columns: 1/4 inch from true line.
   2. Face of Brick: 1/32 inch from face of adjacent brick.
   3. Face of Concrete Masonry Unit: 1/16 inch from face of adjacent unit.
   4. Variation from True Plane: 1/4 inch in 10 feet and 1/2 inch maximum in 20 feet or more.
   5. Variation from Plumb: 1/4 inch in each story, noncumulative and 1/2 inch maximum in two stories or more.
   6. Variation from Level: 1/8 inch in 3 feet, 1/4 inch in 10 feet, and 1/2 inch maximum.
   7. Variation in Wall Thickness: Plus or minus 1/4 inch.

3.06 CONCRETE MASONRY UNIT WORK

A. General:
   1. The first course shall be laid in a full bed of mortar for the full width of the unit. Succeeding courses shall be laid in running bond unless otherwise specified. Bed-joints shall be formed by applying the mortar to the entire top surfaces of the inner and outer face shells and to head joints by applying the mortar for a width of about 1 inch to the ends of the adjoining units. The mortar shall be of such thickness that it will be forced out of the joints as the units are placed in position. Where anchors, bolts, and ties occur within the cells of the units, metal lath shall be placed in the joint at the bottom of such cells and the cells filled with mortar or grout as the work progresses. Except at grouted or reinforced masonry, concrete brick shall be used for bonding walls, working out the coursing, topping out walls under sloping slabs, distributing concentrated loads, backing brick headers, and elsewhere as required. Concrete masonry units shall not be dampened before or during laying.

B. Special Concrete Masonry Unit Work:
   1. Where exposed concrete masonry unit walls and partitions are specified, special concrete masonry unit work shall be provided. Units shall be selected for uniformity of size, texture, true plane, and undamaged edges and ends of exposed surfaces. Units shall be placed plumb, parallel, and with properly tooled joints of maximum 3/8-inch thickness, and exposed surfaces kept clean and free from blemishes or defects.

C. Reinforced Concrete Masonry Unit Walls:
   1. Where vertical reinforcement occurs, cores shall be filled solid with grout, and units laid in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Adjacent webs shall be embedded in mortar to prevent leakage of grout, and mortar fins protruding from joints removed before grout is placed. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Reinforcing shall be positioned and held accurately before placing grout by tying or by using bar positioners at maximum 8-foot intervals. Vibrator shall be used to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be 1/2 inch. Unless otherwise specified, splices shall be formed by lapping bars not less than 40 bar diameters.

3.07 BONDING AND ANCHORING

A. Unless otherwise specified, partitions shall extend from the floor to the bottom of the construction above. Walls and partitions shall be structurally bonded and anchored to each other and to concrete walls and beams. Unless otherwise specified, non-load-bearing partitions and interior walls shall be securely anchored to the construction above in a manner that provides lateral stability while permitting unrestricted deflection of construction above. Anchors shall be completely embedded in mortar joints.

B. In addition, bonding and anchoring shall comply with the following procedures unless otherwise specified.
   1. At corners of load-bearing walls, provide a true masonry bond in each course.
   2. At intersections of load-bearing walls, provide a true masonry bond in each course, or anchor with rigid steel anchors not more than 2 feet apart vertically.
   3. At intersections of non-load-bearing partitions with other walls or partitions, tie with wire mesh ties at vertical intervals of not more than 2 feet or with masonry bonding in alternate courses.
   4. At masonry walls facing or abutting new concrete members, anchor masonry to the concrete with dovetail or wire-type anchors inserted in slots or inserts built into the concrete. To anchor masonry walls to existing concrete members, use corrugated metal ties anchored by drive pins to the concrete. Locate anchors not more than 18 inches o.c. vertically and not more than 24 inches o.c. horizontally.

3.08 HORIZONTAL JOINT REINFORCEMENT

A. Unless otherwise specified, reinforcement shall be provided at 16-inch spacing in all masonry walls. Reinforcement shall be continuous except at control joints and expansion joints. Reinforcement above and below openings shall extend not less than 24 inches beyond each side of openings. Reinforcement shall be provided in the longest available lengths, utilizing the minimum number of splices. Welded L-shaped assemblies and welded T-shaped assemblies to match the straight reinforcement shall be provided at corners and intersections of walls and partitions.

3.09 CONCRETE MASONRY UNIT LINTELS AND BOND BEAMS

A. Special units, lintels, and bond beams shall have cells filled solidly with grout or concrete, and provided with not less than two No. 5 reinforcing bars, unless otherwise specified. Reinforcing shall overlap a minimum of 40 bar diameters at splices. Bond beams and reinforcing shall terminate on each side of expansion joints. Concrete masonry units used for lintels and bond beams shall have exposed surfaces of the same material and texture as the adjoining masonry units. Bond beam units shall be produced from standard vertically-voided units with precut knock-out cross walls. Lintels shall be straight and true and shall have at least 8 inches of bearing at each end. Lintels shall set at least 6 days before shoring is removed.

3.10 GROUT

A. General:
   1. Fine grout shall be provided in grout spaces which are less than 2 inches in any horizontal dimension after deducting the thickness of horizontal reinforcing or in which clearance between reinforcing and masonry is less than 3/4 inch. Coarse grout shall be provided in grout spaces which are 2 inches or greater in all horizontal dimensions after deducting the thickness of horizontal reinforcing provided the clearance between reinforcing and masonry is not less than 3/4 inch. For a coarse grout pour over 6 feet high, increase grout space minimum horizontal dimension to 3 inches.

B. Placement:
   1. Grout shall be placed from the interior side of walls, except as approved otherwise. Sills, ledges, offsets, and other surfaces shall be protected from grout droppings. Prior to grouting, the grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings, or other foreign material. Grout shall be well mixed to prevent segregation, shall be sufficiently fluid to flow into joints and around reinforcing without leaving voids, and shall be placed by pumping or pouring from buckets equipped with spouts. Grout shall be placed in a continuous pour in grout lifts not exceeding 6 feet. At grout pours exceeding 6 feet, cleanouts shall be provided in the bottom course at every vertical bar but shall not be spaced more than 32 inches on center for solidly grouted masonry. Pours shall be 1-1/2 inches below the top of masonry units in top course, except at the finish course. Grout shall be agitated thoroughly to eliminate voids. Masonry displaced by grouting operation shall be removed and relaid in alignment with fresh mortar.

3.11 FORMS AND SHORING

A. Contractor shall construct forms to the shape, lines, and dimensions of members indicated and make sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry. Forms shall not be removed until members have cured.

3.12 CONTROL JOINTS

A. Unless shown otherwise on the design drawings, provide control joints in reinforced concrete masonry walls at a spacing equal to 1.5 times the wall height, not to exceed 25 feet. Control joints shall be located a minimum of 32 inches beyond the face of an opening. Control joint detail shall be as shown on the Drawings.

3.13 CLEANING

A. Contractor shall protect work which may be damaged, stained, or discolored during cleaning operations.

B. Exposed masonry surfaces shall be cleaned with clear water and stiff fiber brushes and rinsed with clear water. Where stains, mortar, or other soil remain, scrubbing shall continue with warm water and detergent. Immediately after cleaning, each area shall be rinsed thoroughly with clear water. Damaged, stained, and discolored work shall be restored to original condition or replaced with new work.

3.14 PROJECT CONDITIONS

A. Cold Weather Construction: Follow procedures specified in TMS 602.

B. Hot Weather Construction: Follow procedures specified in TMS 602.

END OF SECTION

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SECTION 05 05 14

HOT-DIP GALVANIZING

PART 1 GENERAL

1.01 DESCRIPTION

A. Section includes: Hot-dip galvanizing of steel materials.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 09 90 00 Painting and Coating

1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A780	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B6	Zinc
ASTM D6386	Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM E536	Test Methods for Chemical Analysis of Zinc and Zinc Alloys
DOD-P-21035A	Paint, High Zinc Dust Content, Galvanizing Repair

1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Coating applicator's Certificate of Compliance that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A123 or A153, as applicable.
5. Evidence that the galvanized coating applicator is a member of the American Galvanizing Association.

1.05 QUALITY ASSURANCE

A. Hot-dip galvanized coating applicator shall be a member of the American Galvanizing Association.

PART 2 PRODUCTS

2.01 MATERIALS

A. Zinc used for galvanizing shall conform to ASTM B6, and shall be at least equal to the grade designated as Prime Western.

B. Maximum amount of aluminum added to a galvanizing bath shall not exceed 0.01 percent.

C. Hot-Dip Galvanized Coating: Conform to ASTM A123 and A153, as applicable.

D. Repair: Zinc dust-zinc oxide coating conforming to MIL-P-21035B and achieving at least 93 percent zinc in the dry film. Acceptable products:
   1. ZRC Cold Galvanizing Compound by ZRC Worldwide
   2. 7000 System Cold Galvanizing Compound by Rustoleum
   3. Crown Cold Galvanize Coating 93% Zinc Rich by Aervoe Industries
   4. or approved equal.

2.02 FABRICATION REQUIREMENTS

A. Fabrication practices for products to be galvanized: In accordance with applicable portions of ASTM A143, A384 and A385. Avoid fabrication techniques that could cause steel distortion or embrittlement.

B. Coordinate with steel detailer to provide vent and drain holes of sufficient size and quantity to achieve specified galvanized coating.

PART 3 EXECUTION

3.01 PREPARATION

A. Casting surfaces to be galvanized shall be sand blasted or ground smooth. When a smooth cast is required, castings shall be tumbled and all high spots ground flush. Castings shall be normalized to prevent cracking. Malleable iron shall be safeguarded against embrittlement by pre-annealing.

B. Steel work shall be precleaned utilizing a caustic bath, acid pickle and flux or shall be blast cleaned and fluxed to obtain an acceptable surface for quality hot dip galvanizing.

3.02 APPLICATION

A. Steel Members, Fabrications, and Assemblies: Hot-dip galvanize after fabrication in accordance with ASTM A123.

B. Steel Bolts, Screws, Nuts, Washers and Hardware Components: Hot-dip galvanize in accordance with ASTM A153.

3.03 COATING REQUIREMENTS

A. Hot-dip Coating Thickness: Conform to ASTM A123 or ASTM A153, as applicable.

3.04 TESTING

A. Chemical analysis for impurities in the bath shall be made in conformity with ASTM E536.

B. Test Requirements and Methods: In accordance with ASTM A123 or ASTMA153, as applicable.

3.05 GALVANIZED SURFACES TO BE PAINTED

A. Where galvanized surfaces are specified to be painted in Section 09 90 00 or elsewhere in the Project Manual, conform to ASTM D6386.

3.06 REPAIR OF DEFECTIVE GALVANIZED COATING

A. Where zinc coating has been damaged after installation, clean substrate surface and repair with zinc dust-zinc oxide coating in accordance with ASTM A780. Apply zinc dust-zinc oxide coating in accordance with manufacturer's recommendation. Apply multiple coats to achieve a minimum film thickness of 8 mils.

B. Remove items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, from the project site for repair by the hot-dip zinc coating method.

END OF SECTION

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SECTION 05 05 20

ANCHOR BOLTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. Included are cast-in-place and post-installed anchors (adhesive systems and wedge type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

1.01 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 03 30 00 Cast-In-Place Concrete
   3. Section 03 60 00 Grouting
   4. Section 43 05 13 Rigid Equipment Mounts

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 318	Building Code Requirements for Structural Concrete
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
ASTM A563	Carbon and Alloy Steel Nuts
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength
IBC	International Building Code with local amendments

1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Anchor bolt placement plans.
   5. Anchor bolt, nut, and washer material information, including material certifications.
   6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Washington. Calculations shall comply with the provisions of ACI 318-19. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 psi unless otherwise noted.
   7. Product Data:
      a. ICC Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
      b. Product data indicating load capacity charts/calculations.
      c. Chemical resistance.
      d. Temperature limitations.
      e. Manufacturers written installation instructions.
   8. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program.

1.04 QUALITY ASSURANCE

A. Quality Assurance By Owner
   1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Owner and in accordance with IBC Chapter 17.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.

3. The Special Inspector shall furnish a report to the Engineer, Owner's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

PART 2 PRODUCTS

2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Sections 43 05 13 and 43 05 18, respectively.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

Material	Specification
Stainless Steel Anchor Bolts	ASTM A193 or A320, Type 316
Stainless Steel Threaded Rods	ASTM F593, Type 316
Stainless Steel Nuts	ASTM A194 Heavy Hex Nuts, Type 316 ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316
Stainless Steel Washers	Type 316 to match bolt material
Carbon Steel Anchor Bolts	ASTM F1554, Grade 36, Hot Dip Galvanized
High-Strength Carbon Steel Anchor Bolts	ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot Dip Galvanized
Carbon Steel Nuts and Washers	ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized
Concrete Adhesive Anchors	Hilti "HIT-RE 500v3", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods

Material	Specification
Concrete Masonry Adhesive Anchors	Hilti "HIT-HY 70", Simpson Strong-Tie “SET-XP”, or approved equal, with Type 316 Stainless Steel threaded rods
Concrete Masonry Expansion (wedge) Anchors*	Hilti "KWIK BOLT 3", or approved equal, Type 316 Stainless Steel
Concrete Expansion (wedge) Anchors *	Hilti “KWIK BOLT TZ”, or approved equal, Type 316 Stainless Steel

**Post installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Suitable for potable water supply.
   2. Formulated to resist washout.
   3. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on design drawings and as required by equipment manufacturer’s design.
   1. Provide high density polyethylene plastic sleeves of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:
   1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
      a. Acid concentrations higher than 10 percent
      b. Chlorine gas
      c. Machine or diesel oils
   2. Limit to applications where exposure to the following is extremely unlikely:
      a. Fire
      b. Concrete or rod temperature above 120 degrees F
   3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an Installer specially certified for overhead applications.
   4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
   5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
   6. Embedment depth shall be as specified or as required by the equipment manufacturer.
   7. Follow the anchor system manufacturer's installation instructions.
   8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core drilled holes are not allowed.
   9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
   10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25 degrees F.
   11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.

3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

B. Where slanting the drill does not resolve the conflict, notify the Owner's Representative and resolve the conflict to the satisfaction of the Owner's Representative in consultation with the Engineer.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Owner.

E. Reinforcing steel in masonry shall not be damaged.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the state of Washingtons.
   2. Calculations and details for redesign shall be submitted.

END OF SECTION

SECTION 05 10 00

STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural metals consisting of standard shapes, hollow sections, fasteners, and plates that are used in structural framing and connections.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 Submittal Procedures
   2. Section 05 05 20 Anchor Bolts
   3. Section 05 05 14 Hot Dip Galvanizing
   4. Section 09 90 00 Painting

1.03 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. For questions, refer to Engineer.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AISC 201	AISC Certification Program for Structural Steel Fabricators
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings
AISC 810	Erection Bracing of Low-Rise Structural Steel Frames
ASTM A6	General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36	Carbon Structural Steel
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

Reference	Title
ASTM A193	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A320	Alloy-Steel and Stainless Steel Bolting for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A384	Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A992	Structural Steel Shapes
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM F436	Hardened Steel Washers
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS-B3.0	Welding Procedures and Performance Qualifications
AWS-D1.1	Structural Welding Code--Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
ASW D1.8	Structural Welding Code – Seismic Supplement
IBC	International Building Code
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction

1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. Shop drawings for approval prior to fabrication. Shop drawings shall not be reproductions of the Drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, coatings, connection details, blocks, copes, and cuts. Substitutions of details shown on the Drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the Drawings.
5. Certification that steel Fabricator is approved to perform steel fabrication without special inspection.
6. AISC quality certification: Evidence that steel Fabricator has AISC 207 Certification as a AISC Certified Plant, Category BU (Certified Building Fabricator). Certificate to show name and address of certified firm, effective date, and category of certification.
7. Welding procedures, qualifications, and inspection report.
8. Certified mill test reports for structural steel and high-strength bolts and nuts.
9. In accordance with IBC Chapter 17, Fabricator at the completion of fabrication to submit Certification of Compliance stating that the fabrication was performed in accordance with the design documents.
10. Certified copies of all surveys conducted by a registered professional engineer or surveyor showing elevations and locations of base plates and anchor bolts to receive structural steel or aluminum, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.

1.05 QUALITY ASSURANCE

A. Quality Control by Owner:
   1. Special Inspection of structural metals work shall be performed by the Special Inspector under contract with the Owner and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection of structural metals is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural steel work shall receive Special Inspection in accordance with IBC, Chapter 17. Structural steel includes all steel elements that resist code-defined loads and whose failure would affect life safety. Items to be inspected include, but are not limited to, mechanical / electrical supports, beams, stringers, columns, access walkways, and stairways.

B. Fabricator Qualifications:
   1. A qualified Fabricator must participate in the AISC 207 Certification program and be designated an AISC Certified Plant, Category BU (Certified Building Fabricator).

PART 2 PRODUCTSMATERIALS

A. Steel:
   1. Materials for structural steel shall be as specified in Table A.

Table A - Steel Materials

Material	Specification

Table A - Steel Materials

Material	Specification
Channels	ASTM A36
Angles	ASTM A36
Plates	ASTM A36
Rolled wide-flange sections (W-shapes) and WTs	ASTM A992
Pipe sections	ASTM A53, Type E or S, Grade B (Fy = 35 ksi)
Round Hollow Structural Sections (HSS)	ASTM A500, Grade C (Fy=46 ksi min)
Square and Rectangular Hollow Structural Sections (HSS)	ASTM A500, Grade C (Fy = 50 ksi min)
Stainless steel bolts (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F593, Type 316
Stainless steel nuts and washers (used at stainless steel and aluminum framing unless noted otherwise)	ASTM F594, Type 316
Steel bolts (used at galvanized and painted steel framing)	Galvanized ASTM F3125 Gr. A325
Carbon steel nuts and washers	Galvanized ASTM A563 nuts and galvanized ASTM F436 washers
Anchor bolts	Refer to Section 05 05 20

B. Aluminum:
   1. Materials for structural aluminum shall be as specified in Table C.

Table C - Aluminum Materials

Material	Specification
Structural shapes	Alloy 6061-T6 per ASTM B308
Bolts	Use stainless steel bolts for aluminum framing (see Table A above)
Guardrail and handrail pipe	Alloy 6061-T6 or 6063-T6 per ASTM B241
Plates	Alloy 6061-T6 per ASTM B209
Anchor bolts	Refer to Section 05 05 20

PART 3 EXECUTION

3.01 GOVERNING DOCUMENTS

A. The following paragraphs are primarily written to be applicable to structural steel. Where stainless steel or aluminum are utilized the applicable governing document(s) for that material shall be adhered to as necessary.

3.02 EXAMINATION

A. Examine and accept conditions before beginning work.

3.03 FABRICATION

A. Fabrication of steel shall be in accordance with the applicable provisions of the AISC Steel Construction Manual and AISC 360. Fabrication of stainless steel shall be in accordance with the applicable provisions of AISC 313 and AISC 370. Fabrication of aluminum shall be in accordance with Aluminum Design Manual. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under AISC 207 for Category BU.

B. Compression joints depending on contact bearing shall have a surface roughness not more than 500 micro-inches and ends shall be square within the tolerances for milled ends specified in ASTM A6.

C. Shop splices of members will be permitted only where indicated on the Drawings. Splices not indicated require the approval of the Owner's Representative.

D. Verify measurements at the job site prior to fabrication. Fabricate to match job site measurements.

E. Provide bolt holes as indicated for securing other work to structural framing. Conform to AISC 325 and AISC 360 guidelines or contact Owner's Representative for approval for bolt holes not indicated on drawings.

F. Other work shall be routed around structural steel framing members to the extent possible. Where not indicated on the design drawings, additional cuts, alterations, and holes for the passage of other work through steel framing members require the approval of the Owner's Representative and shall be addressed in accordance with AISC 303.

3.04 INSTALLATION

A. General:
   1. Erection of structural steel shall be in accordance with the applicable provisions of AISC Steel Construction Manual (AISC 325). Erection plan shall conform to AISC 303. For low-rise structural steel buildings, 60 feet tall or less and a maximum of 2 stories, the structure shall be erected in accordance with AISC Design Guide 10.
   2. Coordinate installation of anchor bolts and other connectors required for securing structural steel in place. Refer to Section 05 05 20 for additional information regarding anchor bolts.
   3. Employ a registered professional engineer or surveyor for accurate erection of the structural framing. Check elevations of concrete and locations of anchor bolts before erection proceeds and report discrepancies to the Owner's Representative.
   4. Placement tolerances shall be in accordance with AISC 303 and AISC 360
   5. After final positioning of members, provide full bearing under base plates and bearing plates using non-shrink grout. Place non-shrink grout in accordance with the Manufacturer's instructions. Grout shall be cured prior to loading of the structure.
   6. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Protect aluminum in contact with concrete or grout with a heavy coat of bituminous paint.

7. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned without damaging any metalwork coatings (if applied).
8. Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete.
9. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced at the Contractor's expense.

B. Welding:
1. Welding shall be done by welders, welding operators, and tackers who have been qualified by tests as prescribed by AWS to perform the type of work required. The quality of welding shall conform to AWS Codes.
2. Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures.
3. Provide continuous seal welds for plates or structural shapes that are exposed to or submerged in water or wastewater.

C. Bolted Connections:
1. Bolted connections, unless noted otherwise, shall conform to AISC 360 and shall be bearing type connections with bolts fully tensioned unless connecting HSS shapes. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation. No drifting of bolts or enlargement of holes will be allowed to correct misalignment. Holes shall not be cut or enlarged by burning. Mismatched holes shall be corrected with new material.

3.05 CORROSION PROTECTION

A. Unless otherwise specified, carbon structural steel shall be galvanized. If coatings are indicated on the Drawings or elsewhere in the Specifications, coat in accordance with Section 09 90 00. Coating surface preparation shall be as specified in Section 09 90 00 and shall include the following operations:
1. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.
2. Grind all sharp edges from sheared plates and punched holes.
3. Grind uneven or rough welds with high beads to a smooth finish.

3.06 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired as specified in Section 05 05 14.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be provided under work of other specification sections.
   2. Fall arrest anchors
   3. Iron castings
   4. Ladders, ladder cages, and safety posts
   5. Ladder Rail Fall Protection System
   6. Ship's ladders
   7. U-channel concrete inserts
   8. Cover plates and frames
   9. Pipe sleeves
   10. Bollards
   11. Safety nosings at concrete stairs
   12. Miscellaneous metal fabrications not covered elsewhere

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 05 14 Hot-Dip Zinc Coating
   3. Section 05 05 20 Anchor Bolts
   4. Section 05 10 00 Structural Metal Framing
   5. Section 05 52 10 Aluminum Railings
   6. Section 09 90 00 Painting and Coating

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Specification for Structural Steel Buildings

Reference	Title
AISC Steel Construction Manual	American Institute of Steel Construction, Manual of Steel Construction
ANSI A14.3	Standard for Ladders - Fixed - Safety Requirements
ASTM A36	Carbon Structural Steel
ASTM A48	Gray-Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123	Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A240	Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276	Stainless Steel Bars and Shapes
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength
ASTM A312	Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A320	Alloy-Steel Bolting Materials for Low Temperature Service
ASTM A325	Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A489	Carbon Steel Lifting Eyes
ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A554	Welded Stainless Steel Mechanical Tubing
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process
ASTM A780	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
ASTM A786	Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Rolled Floor Plate, Stainless Steel
ASTM A924	Steel Sheet, Metallic-Coated by Hot-Dip Process
ASTM A992	Structural Steel Shapes
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B211	Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B241	Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B308	Aluminum-Alloy 6061-T6 Standard Structural Profiles

Reference	Title
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Hardened Steel Washers
ASTM F468	Nonferrous Bolts, Hex Cap Screws, SocketHead Cap Screws and Studs for General Use
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
OSHA 29 CFR 1910.27	Fixed Ladders
OSHA 29 CFR 1926.502	Fall Protection Systems Criteria and Practices
SSPC SP5	White Metal Blast Cleaning
IBC	International Building Code

1.04 DEFINITIONS

A. Galvanize: Hot-dip galvanize per ASTM A123 or ASTM A153, per Section 05 05 14.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration
   4. Manufacturer's product data.
   5. Detailed Shop Drawings:
      a. Fabrication drawings showing layouts, connections to structural system, and anchoring details.
      b. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions.
      c. Construction details, reinforcement, anchorage, and installation with relation to the building construction.
   6. Welding procedures and welder certificates and qualifications.
   7. U-Channel Concrete Inserts: Manufacturer’s product description and allowable load tables.

8. Passivation method for stainless steel fabrications.
9. Fall Arrest Anchor Certificate:
    a. Certify fall arrest system is designed to meet OSHA 29 CFR 1926.502 specified performance requirements.
    b. Signed and sealed by a Professional Engineer licensed in the state in which the project is located.

1.06 QUALITY ASSURANCE

A. Qualifications
    1. Fabricator shall have a minimum of five years experience in fabrication of metal specified.

B. Certificates
    1. Certified welding procedures and welding operators in accordance with AWS. Welding operator certificates shall be no more than one-year old and the welder shall have used the welding process to be performed within the last six months.

C. The use of salvaged, reprocessed or scrap materials will not be permitted.

D. Shop Assembly: Items in the shop shall be preassembled to the greatest extent possible, so as to minimize field splicing and assembly of units. Units shall be disassembled only to the extent necessary for shipping and handling limitations. Units shall be clearly marked for reassembly and coordinated installation.

1.07 DELIVERY, STORAGE AND HANDLING

A. Avoid damage during delivery and handling of fabrications.

B. Store off the ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for miscellaneous metalwork are specified in the following table.

Material	Specification
Steel	
Sheets, plates and shapes (except W shapes)	ASTM A36
W shapes	ASTM A992
Pipe	ASTM A53, Grade B
Square/rectangular tubing	ASTM A500, Grade B
Headed Anchor Studs	ASTM A108
Carbon steel bolts	ASTM A307, Grade A
High strength bolts	ASTM A325 (Type 1)

Material	Specification
Nuts	ASTM A563
Washers	ASTM F436
Stainless Steel	
Sheet and Plates	ASTM A240, Type 316 or 316L
Shapes, bars, and similar items	ASTM A276, Type 316 or 316L
Pipe	ASTM A312, Type 316 or 316L
Headed Anchor Studs	ASTM A276, Type 316L
Bolts	ASTM F593, Type 316
Nuts	ASTM F594, Type 316
Aluminum	
Sheets and plates	ASTM B209, Type 6061-T6
Bars, flats and similar items	ASTM B211 or B221, Type 6061-T6
Shapes	ASTM B308, Type 6061-T6
Round tubing and pipe	ASTM B241, Type 6061-T6
Square and rectangular tubing	ASTM B221, Type 6063-T52
Pipe	ASTM B211 or B241, Type 6061-T6
Bolts, Stainless Steel	ASTM F593, Type 316
Nuts, Stainless Steel	ASTM F594, Type 316
Checker Plate	
Steel	ASTM A786
Stainless steel	ASTM A793, Type 304
Aluminum	ASTM B632, Type 6061-T6
Other steel items	
Iron castings	ASTM A48
Eyebolts	ASTM A489
Threaded rods	ASTM A36

2.02 FABRICATION

A. General

1. Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.
2. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.
4. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.

5. Fabrication, including cutting, drilling, punching, threading and tapping required for fabrications or adjacent work, shall be performed prior to galvanizing.

B. Fall Arrest Anchors
   1. Fall arrest anchors shall meet requirements of OSHA 29 CFR 1926.502. Anchorages attached to personal fall arrest equipment shall be capable of supporting at least 5,000 pounds per employee attached, or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of at least two. Type of anchor shall fit the application and substrate material.
   2. Fall arrest anchors shall be manufactured by:
      a. Thaler Metal Industries
      b. DBI-SALA
      c. Approved Equal

C. Iron Castings
   1. Castings shall be as specified on the Drawings. Castings weighing less than 100 pounds shall be galvanized after machining. Castings weighing greater than 100 pounds shall be galvanized where specified.

D. Ladders
   1. Aluminum Ladders: Ladders shall be vendor supplied pre-engineered aluminum ladders. Ladders shall be fabricated of alloy 6063-T6. Rungs shall have non-slip grip surface. Finish shall be anodized. Fabricate ladders with rails, rungs, landings and cages to meet applicable requirements of OSHA 29 CFR 1910.27. Rungs shall be a minimum clear length of 16 inches, uniformly spaced at a maximum of 12 inches and plug welded into side rails. Install ladders so that the distance from the centerline of rungs to the finished wall surface is not less than 7 inches nor more than 12 inches. Provide clip angle supports bolted to the side rail at the top. Provide intermediate clip angle lateral supports at a maximum of 10 feet on center.
   2. Ladder Safety Post:
      a. Provide a telescoping ladder safety post at ladders below all floor and roof hatches, and other coverings.
      b. The ladder safety post shall be pre-assembled from the manufacturer.
      c. Performance characteristics:
         1) Post shall lock automatically when fully extended.
         2) Post shall have controlled upward and downward movement.
         3) Release lever shall disengage the post to allow it to be returned to its lowered position.
         4) Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14” on center and clamp brackets to accommodate ladder rungs up to 1-3/4” in diameter.
         5) Post: Manufactured of high strength square tubing with a pull up loop provided at the upper end of the post to facilitate raising the post.
         6) Material of construction: Stainless steel Type 316.
         7) Balancing spring: Stainless steel spring balancing mechanism to provide smooth, easy, controlled operation when raising and lowering the safety post.

d. Furnish and install climb prevention shield. The shield shall be lockable and hinged and when opened shall allow a user to climb up the ladder unimpeded. When closed the shield shall completely enclose all elements of the ladder at the base to eliminate any potential for unwanted climbing. Field verify the tank and foundation elements prior to creating shop drawings and fabrication.

e. Acceptable products include:

1) LadderUp Safety Post by Bilco

2) Ladder Safety Post Model SP by Nystrom Inc.

3) Approved equal

3. Ladder Cages:

a. Provide ladder cages when ladders are greater than 20 feet tall between floor/landing surfaces. Conform to OSHA 29 CFR 1910.27.

b. Furnish ladder shroud around the cage. The shroud shall be manufactured from minimum 16 gauge sheet steel, formed to fit around the ladder cage, and secured to the tank and the cage with welded or bolted connections. The shroud shall be integrated with the climb prevention shield below it and shall completely enclose all elements of the ladder to eliminate any potential for unwanted climbing.

4. Ladder Rail Fall Protection System:

a. System shall consist of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to harness belt can be attached.

b. Rail:

1) Notched at six-inch intervals and constructed of stainless steel Type 316.

2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.

3) For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.

4) Ladders Below Hatches: Rail for ladder shall extend from bottom of ladder to top of ladder. Provide telescopic safety post.

5) Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder. Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness.

c. Accessories: Provide with each ladder the following, all furnished by the fall prevention system Supplier:

1) One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.

2) One safety harness that attaches to sleeve. Harness shall be of woven high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.

3) One shock adsorbing lanyard no longer than six-feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double locking hooks at each end.

d. Acceptable ladder rail fall protection systems include:
   1) Miller Saf-T-Climb as manufactured by Honeywell
   2) Vertical Rigid Track Fall Arrest System as manufactured by Diversified Fall Protection
   3) Approved equal

E. Cover Plates and Frames

Fabricate aluminum cover plates weighing not more than 80 pounds per cover with a raised pattern nonslip top surface conforming to ASTM B632. Reinforce to sustain a live load of 100 pounds per square foot (foot traffic only) or as indicated on the Drawings. Frames shall be stainless steel angles and plates, with stainless steel

headed anchors welded to frame for anchoring to concrete. Miter and weld corners and butt joint straight runs. Provide flush drop handles for removal. Remove sharp edges and burrs from cover plates and exposed edges of frames. Weld connections and grind top surface smooth. Provide 1/8 inch clearance at edges.

F. Pipe Sleeves

1. Unless otherwise indicated on the Drawings, fabricate pipe sleeves from schedule 40 steel pipe with 3/16 inch thick by 3 feet wide seep ring continuously seal welded to the outside of the pipe. Galvanize after fabrication in accordance with ASTM A123.

G. Bollards

1. Provide minimum 6 inch galvanized standard weight steel pipe or as indicated on the Drawings. Pipe to be in accordance with ASTM A53. Anchor posts in concrete and fill solidly with concrete of a minimum compressive strength of 2500 psi. Coat galvanized pipe above grade in accordance with Section 09 90 00. Top coat cover color shall be safety yellow.

H. Safety Nosings at Concrete Stairs

1. Safety stair treads shall be 4 inches wide and manufactured by:
   a. Safe T Metal Company Incorporated, Style AX;
   b. Wooster Products Incorporated, Alumogrit, Type 101;
   c. Approved Equal.

I. Other Miscellaneous Steel Metalwork

1. Other miscellaneous steel metalwork including embedded and non-embedded steel metalwork, hangers and inserts shall be as specified or shown on the Drawings, and shall be galvanized after fabrication unless otherwise noted.

2.03 FINISHES

A. Galvanizing

1. Galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing in accordance with ASTM A123, ASTM A153, ASTM A653 or ASTM A924, Z275 G90, as applicable. Galvanize anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2. Repair damaged Zinc-Coated surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Owner's Representative.
3. Safeguard against warpage and distortion during galvanizing of steel in accordance with ASTM A384. Straighten items after galvanizing so that they are straight, free of racking and distortion.

B. Shop Painting
1. Prepare and coat surfaces in accordance with Section 09 90 00.
2. Steel to be embedded in concrete shall be free of dirt and grease.

C. Aluminum Surfaces
1. Surface condition aluminum before finishes are applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.
2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.
3. Provide other aluminum items with a standard mill finish.
4. Provide a coating thickness not less than that specified for protection.
5. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations.
6. Provide a polished satin finish on items to be anodized.

D. Stainless Steel Passivation
1. Stainless steel to be cleaned, descaled, and passivated after fabrication in accordance with ASTM A380. Passivate to remove iron compounds from the surface of the stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

3.02 PREPARATION

A. Make provisions for erection loads with temporary bracing. Keep work in alignment.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates.

3.03 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.

E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.

F. Seat angles, supports and guides: Set seat angles for grating and supports for floor plates so that they maintain the grating and floor plates flush with the floor.

G. Ladder Safety Post: Comply with manufacturer's installation instructions.

H. Pipe Sleeves: Provide where pipes pass through concrete or masonry. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls. Provide a center flange for water stoppage on sleeves in exterior or water bearing walls. Provide a rubber caulking sealant or a modular mechanical unit to form a watertight seal in the annular space between pipes and sleeves.

I. U-Channel Concrete Inserts: Provide as indicated for pipe supports and where otherwise specified or shown on Drawings.

J. Safety Nosings: Unless otherwise specified, safety stair nosing shall be installed on concrete stairs. Nosing shall be secured to concrete with suitable anchors at 15 inches on center and not more than 4 inches from the ends. 1/8 inch thick rubber tape shall be provided at both ends and cut to fit shape of nosing prior to concrete placement.

K. Concrete: Pan-filled stairs to be constructed in accordance with Section 03 30 00. Finish concrete with a "nonslip" finish with "very flat" tolerance as specified in ACI 301.

L. Fastening to Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.

M. Set steel stair baseplates on wedges, or shims. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

N. Railing: Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing required by design loads and as limited on Drawings. Plumb posts in each direction.

3.04 REPAIR/RESTORATION

A. Galvanized
   1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area or 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.
   2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.
   3. Use zinc-rich repair paint. Acceptable manufacturers:
      a. LPS, Cold Galvanize
      b. ZRC Worldwide, ZRC Galvilite
      c. Approved Equal

B. Painted
   1. After installation, clean and touch up damaged areas with the same materials used for the shop coat.

3.05 FIELD QUALITY CONTROL

A. Electrolytic Protection

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Stainless Steel
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
   3. Remove contamination in accordance with requirements of ASTM A380.
   4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

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SECTION 05 52 10

ALUMINUM RAILINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Prefabricated anodized aluminum component type guardrail and handrail systems; herein referred to as railing.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-in-Place Concrete.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
Aluminum Design Manual	The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures
ASTM B209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B210	Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B429	Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B483	Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AWS D1.2	Structural Welding Code, Aluminum
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration
IBC	International Building Code with local amendments

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Layout, installation, and detail shop drawings for railing.
5. Design calculations stamped and signed by a licensed professional engineer in the State of Washington. Railing and base support connections to be designed by the Contractor incorporating specified criteria and provisions in the current building code with local governing amendments.

B. Informational Submittals:
1. Material certification for compliance with this specification for aluminum and stainless steel materials.

1.05 QUALITY ASSURANCE

A. General:
1. Railing shall conform to the standards of the Occupational Safety and Health Administration (OSHA) and International Building Code.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cushion wrap complete rails, modules and components to prevent scratching and denting during shipment, storage, and installation.

B. Leave wrap intact, insofar as possible, until railing is completely installed.

PART 2 PRODUCTS

2.01 PERFORMANCE/DESIGN CRITERIA

A. Railing assembly and attachments shall resist a minimum uniform load of 50 pounds per linear foot on the top rail and a concentrated load of 200 pounds (not acting concurrently with the uniform load) applied in any direction. Contractor's supplier and engineer are responsible for designing the guardrail/handrail system along with its base support and anchor bolt size and embedment depth into concrete, or connection to metal framing, to resist the above loading condition taking into account anchor edge distances and concrete strengths at the point of attachment. Contractor shall submit calculations signed and sealed by a professional engineer in the State of Washington.

B. Thermal Movements: Provide railing that allow for thermal movements resulting from the project site maximum range in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

2.02 MANUFACTURERS

A. Julius Blum & Co., Inc.

B. Golden Railing Inc.

C. Moultrie Manufacturing.

D. American Railing Systems, Inc.

E. Approved equal.

2.03 MATERIALS

Component	Material
Aluminum pipe	ASTM B210 Alloy 65060-T832; ASTM B 221 Alloy 6063-T5/T52; ASTM B 429, Alloy 6063-T832; ASTM B483, Alloy T832
Aluminum plate	ASTM B209, Alloy 6061-T6
Stainless steel bolts	ASTM A593, Type 316
Stainless steel nuts and washers	ASTM A594, Type316

2.04 CONFIGURATION/COMPONENTS

A. Guard Top Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

B. Intermediate Rails: Minimum 1 1/2 inch nominal diameter pipe, Schedule 40.

C. Handrails: 1 1/2 inch nominal diameter pipe, Schedule 40.

D. Posts: Minimum 1 1/2 inch nominal diameter pipe, Schedule 80.

E. Provide manufacturer’s heavy-duty base fitting with stainless steel set screws.

F. Provide aluminum toe boards at guardrails, except where concrete curbs are indicated. Aluminum toe boards shall be minimum 3/16-inch thick plate, connected to the posts.

G. Bolts, including anchor bolts, shall be Type 316 stainless steel.

H. Fittings:
   1. Fittings shall be cast aluminum elbows, T-shapes, post brackets and escutcheons. Provide adapter and anchor plugs as required for a complete installation.
   2. Floor sleeves for removable railing shall be stainless steel, embedded in concrete.

2.05 ASSEMBLY/FABRICATION

A. Pipe cuts shall be clean, straight, square and accurate for minimum joint gap. Work shall be done in conformance with the guardrail and handrail manufacturer's instructions. Work shall be free from blemishes, defects, and misfits of any type which can affect durability, strength, or appearance.

B. Guardrailing and handrailing shall be connected by screws or bolts or welding. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Wherever needed because of the thickness of the metal, holes shall be subpunched and reamed or drilled. Components with mismatched holes shall be replaced. No drifting of bolts or enlargement of holes will be allowed to correct misalignment.

C. Supply components required for anchorage of fabrications.

D. Where shop welding is used, grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints tight and flush. Round exposed edges to small, uniform radius. Use filler alloy rods that will not discolor when anodized, such as ER 5154, ER 5254, ER 5183, ER 5356 or ER 5556 filler alloy rods.

2.06 ISOLATION COATING

A. Isolation coating shall be applied to all aluminum surfaces in contact with concrete, masonry, or dissimilar metals. Use a heavy coat of bituminous paint.

2.07 FINISHES

A. Anodized in accordance with the Aluminum Association AA-M12-C22-A41. Anodize exposed prefabricated components, except stainless steel fasteners, after fabrication.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field verify measurements for railings before fabrication.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

C. Accurately place metal to be embedded in concrete and hold in correct position while the concrete is placed. Where recesses or blockouts are formed in the concrete, grout metalwork in place after concrete has attained its design strength in accordance with Section 03 30 00.

D. Unless otherwise indicated, field welding of railing is not permitted.

3.03 TOLERANCES

A. Maximum variance from plumb: 1/4 inch.

B. Maximum offset from true alignment: 1/4 inch.

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SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Framing with dimension lumber.
   2. Framing with engineered wood products.
   3. Shear wall panels.
   4. Wood blocking, and nailers.
   5. Related Requirements:
   6. Section 06 16 00 – Sheathing, for sheathing, on gable end walls and roofs.

1.02 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

C. OSB: Will not be allowed.

D. Timber: Lumber of 5 inches nominal size or greater in least dimension.

E. Lumber grading agencies, and abbreviations used to reference them, include the following:
   1. NLGA: National Lumber Grades Authority.
   2. WCLIB: West Coast Lumber Inspection Bureau.
   3. WWPA: Western Wood Products Association.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.04 INFORMATIONAL SUBMITTALS

A. Material Certificates:
   1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Qualification Statements: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
   3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber:
   1. Boards: 15%.
   2. Dimension Lumber: All dimensional lumber shall be certified by the supplier in writing to be kiln dried. The structure shall not be enclosed until lumber moisture content has been verified to be at or below 15%.
   3. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
   4. Allowable design stresses, as published by manufacturer, are to meet or exceed those indicated. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.02 PRESERVATIVE TREATMENT

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
   2. After treatment, redry boards and dimension lumber to specified maximum moisture content.

B. Kiln-dry lumber after treatment to a maximum moisture content of 15%. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   1. Application: Treat items indicated on Drawings, and the following:
   2. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   3. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.

2.03 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions by Grade: No. 2 grade.
   1. Application: Interior partitions not indicated as load bearing.
   2. Species:
      a. Hem-fir (north); NLGA.
      b. Hem-fir; WCLIB, or WWPA.
      c. Douglas fir-larch; WCLIB or WWPA.

B. Load-Bearing Partitions by Grade: No. 2 grade unless noted otherwise in structural drawings.
   1. Application: Exterior walls and interior load-bearing partitions.
   2. Species:
      a. Douglas fir-larch (north); NLGA.

2.04 ENGINEERED WOOD PRODUCTS

A. Source Limitations: Obtain each type of engineered wood product from single source from a single manufacturer.

B. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559.
   1. Extreme Fiber Stress in Bending, Edgewise: 2900 psi
   2. Modulus of Elasticity, Edgewise: 2,000,000 psi
   3. Horizontal Shear: 285 psi

4. Tension Parallel to Grain: 1660 psi

C. Moisture Protection:
   1. For western species (Douglas fir/hemlock), factory end and edge seal laminated veneer lumber with opaque moisture barrier.
   2. For southern and eastern species (southern yellow pine, yellow poplar), factory seal laminated veneer lumber on face, edge, and ends.

D. Rim Boards: Product designed to be used as a load-bearing member and to brace wood I-joists at bearing ends, complying with research or evaluation report for I-joists.
   1. Manufacturer: Provide products by same manufacturer as I-joists.
   2. Material: All-veneer product
   3. Thickness: 1-1/4 inches.
   4. At minimum, comply with APA PRR-401, rim board and rim board plus grades. Factory mark rim boards with APA-EWS trademark indicating thickness, grade, and compliance with APA-EWS standard.

2.05 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Grounds.
   4. Dimension Lumber Items: Construction or No. 2 grade lumber of the following species:
   5. Hem-fir; WCLIB or WWPA.
   6. Douglas Fir Larch; WCLIB or WWPA.

B. Concealed Boards: 15% maximum moisture content and any of the following species and grades:
   1. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
   2. Douglas Fir Larch; Construction or No. 2 grade; WCLIB or WWPA.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.06 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated if noted in drawings, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.07 FASTENERS

A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
   1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an ICC-ES evaluation report acceptable to authorities having jurisdiction, as appropriate for the substrate.

2.08 METAL FRAMING ANCHORS

A. Allowable design loads, as published by manufacturer, are to meet or exceed those of products of manufacturers listed. Manufacturer's published values are to be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors are to be punched for fasteners adequate to withstand same loads as framing anchors.

B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, G60 coating designation.
   1. Use for interior locations unless otherwise indicated.

C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
   1. Use for wood-preservative-treated lumber and where indicated.

D. Joist Hangers: As indicated in structural drawings.

E. Bridging: Rigid, V-section, nailless type, 0.050 inch thick, length to suit joist size and spacing.

F. Rafter Tie-Downs (Hurricane or Seismic Ties): As indicated in structural drawings. At minimum, bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches wide by 0.062 inch thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.

G. Hold-Downs: As indicated in structural drawings.

2.09 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets:
   1. Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
   2. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
   3. Self-adhering sheet consisting of 64mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side ; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

C. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

D. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

G. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

H. Do not splice structural members between supports unless otherwise indicated.

I. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

J. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
   1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
   2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
   3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
   4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.

K. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

L. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

M. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

N. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
   2. ICC-ES evaluation report for fastener.

O. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

P. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
   1. Comply with indicated fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
   2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
   3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.02 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 INSTALLATION OF WALL AND PARTITION FRAMING

A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions. Fasten plates to supporting construction unless otherwise indicated.
   1. For exterior walls, provide size and spacing of studs as indicated in structural drawings unless noted otherwise.
   2. For interior non-bearing partitions and walls, provide 2-by-4-inch nominal- size wood studs spaced 24 inches o.c. unless otherwise indicated.
   3. Provide continuous horizontal blocking at midheight of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.

B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.

C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
   1. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal depth for openings 48 inches and less in width, 6-inch nominal depth for openings 48 to 72 inches in width, 8-inch nominal depth for openings 72 to 120 inches in width, and not less than 10-inch nominal depth for openings 10 to 12 feet in width.
   2. For load-bearing walls, provide double-jamb studs for openings 60 inches and less in width, and triple-jamb studs for wider openings unless noted otherwise. Provide headers of depth indicated in structural drawings.

3.04 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet enough that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

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SECTION 06 16 00

SHEATHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Wall sheathing.
   2. Roof sheathing.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.04 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated plywood.

B. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.
   1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:
   1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.02 WALL SHEATHING

A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, sheathing.
   1. Span Rating: Not less than 24/0.
   2. Nominal Thickness: Not less than 1/2 inch.

B. Oriented-Strand-Board Sheathing: Not allowed.

2.03 ROOF SHEATHING

A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2, sheathing.
   1. Span Rating: Not less than 24/0
   2. Nominal Thickness: Not less than 5/8 inch.

B. Oriented-Strand-Board Sheathing: Not allowed

2.04 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

2.05 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
   3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

END OF SECTION

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SECTION 06 17 53

FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.01 DESCRIPTION

A. Manufacture, supply and erect wood trusses as shown on the drawings and as specified. Work to include anchorage, blocking, curbing, miscellaneous framing and bracing.

1.02 QUALITY ASSURANCE

A. REFERENCES:

1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWPA M6	Brands Used on Forest Products
AWPB LP-22	Standard for Softwood Lumber, Timber, and Plywood Pressure Treated with Waterborne Preservatives for Ground Contact Use
NFPA-NDS	National Design Specification for Wood Construction and Supplement, Revised 1991 Edition, Design Values for Wood Construction
PS 20	U.S. Department of Commerce, Product Standard, American Softwood Lumber Standards
ANSI/TPI 1-95	National Design Standard for Metal Plate Connected Wood Truss construction - 1995
TPI BWT	Bracing Wood Trusses—Commentary and Recommendations
TPI HET	Handling and Erecting Wood Trusses—Commentary and Recommendations
HIB-91	Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses
TPI QST	Quality Standard for Metal Plate Connected Wood Trusses
WCLIB 16	West Coast Lumber Standard Grading Rules
WWPA GRWL	Western Woods Use Book, Chapter III—WWPA Grading Rules for Western Lumber
WTCA	Wood Truss Council of America
IBC	International Building Code with local amendments

1.03 DESIGN

A. Trusses shall be designed in accordance with these specifications. Where any applicable design feature is not specifically covered herein, design shall be in accordance with applicable provisions of NFPA-NDS, ANSI/TPI 95 and IBC.

B. Trusses shall be analyzed and designed for the dead and live loads indicated on the drawings. Truss loads indicated on the drawings are for the completed structure, designer shall take into account construction and erection loads. The effects of snow drifting shall be included in conformance with IBC Chapter 16 in all cases.

C. Truss geometry shall result in an erected building configuration as indicated on the drawings. Camber trusses for dead load deflection in excess of the greater of 3/8 inch or span length divided by 480 (L/480). Limit live load deflection to span length divided by 360 (L/360) and total load deflection to span length divided by 240 (L/240) unless noted otherwise on the drawings.

D. Design shall be conducted under the responsible charge of a Registered Engineer in the State of Washington and calculations/drawings sealed.

E. Design shall indicate required bracing for completed structure. Construction bracing shall be provided by the Contractor in conformance with truss designer's recommendations.

1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Truss design drawings and calculations sealed as indicated in section 1.03
   2. Truss design drawings and calculations shall include as minimum information:
      a. Plan view layout and profile of each type truss.
      b. Required bearing widths.
      c. Design loads including top chord live load, including snow loads, top chord dead load, bottom chord live load, bottom chord dead load, concentrated loads and their points of application and controlling wind and earthquake loads.
      d. Adjustments to lumber and metal connector plate design values for condition of use.
      e. Reaction forces, their points of occurrence and direction.
      f. Metal connector plate type, gauge, size and location of plate at each joint, except where symmetrically located relative to the joint interface.
      g. Lumber size, species and grade for each member.
      h. Location of any required permanent truss member bracing.
      i. Calculated deflection ratio and/or maximum deflection for live and total load.
      j. Controlling compression and tension bar forces in truss members. Forces may be shown on the truss design drawing or on supplemental documents.
      k. Connection requirements for truss-to-truss girder, truss ply-to-ply, field splices, and hold-down at bearing points or otherwise.

l. A copy of this specification section with addenda updates, and all referenced sections with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.

1.05 STORAGE

A. Trusses shall be stored in an area protected from weather, elevated a minimum of 6 inches above the ground on framework and covered with waterproof covering. Trusses shall not be stored in wet or damp areas.

PART 2 PRODUCTS

2.01 LUMBER:

A. Lumber used for truss members shall be in accordance with published values of lumber rules writing agencies approved by board of review of American Lumber Standards Committee. Lumber shall be identified by grade mark of a lumber inspection bureau or agency approved by that board, and shall be as shown on the truss design drawings.

B. Dressed sizes and surfacing of truss members shall conform to manufacturer's standard practices. Narrowest truss member shall be 1 ½ inch in width.

C. Moisture content of lumber shall be no less than 7 percent nor greater than 19 percent at time of manufacture.

D. Adjustment of values for duration of load or conditions of use shall be in accordance with NFPA-NDS

E. Fire retardant treated lumber, if applicable, shall meet specifications of truss design and ANSI/TPI 1-95, paragraph 9.1.5, and shall be redried after treatment in accordance with AWPA Standard C20. Allowable values must be adjusted in accordance with NDS paragraph 2.3.6. Lumber treater shall supply certificate of compliance.

2.02 METAL CONNECTOR PLATES:

A. Metal connector plates shall be manufactured by a WTCA member plate manufacturer and shall be not less than .036 inches in thickness (20 gauge) and shall meet or exceed ASTM A653/A653M Grade 33, and galvanized coating shall meet or exceed ASTM A924/A924M, coating designation G60. Working stresses in steel are to be applied to effectiveness ratios for plates as determined by test in accordance with Section 7 of ANSI/TPI 1-1995.

PART 3 EXECUTION

3.01 MANUFACTURING

A. Trusses shall be manufactured in accordance with truss design drawings which have been reviewed by the Construction Manager, in a properly equipped manufacturing facility of a permanent nature. Trusses shall be manufactured by experienced workers, using precision cutting, jigging and pressing equipment meeting requirements of ANSI/TPI 1-1995, Section 4. Truss members shall be accurately cut to length, angle and true-to-line to assure proper fitting joints within tolerances set forth in ANSI/TPI 1-95, Section 4.

3.02 HANDLING, INSTALLING AND BRACING

A. Trusses shall be handled during manufacturing, delivery and at job site so as not to be subjected to excessive bending.

B. Trusses shall be unloaded on smooth ground to avoid lateral strain. Trusses shall be protected from damage that might result from on-site activities and environmental conditions. Toppling shall be prevented when banding is removed.

C. Trusses shall be handled in the field in accordance HIB-91, TPI HET, and ANSI/TPI 1-95. Field erection shall be in accordance with HIB-91, and shall be consistent with good workmanship and good building practices. Field erection and safety is the responsibility of the Contractor.

D. Trusses shall be set and secured level and plumb, and in correct location. Plumb of each truss shall be held in correct alignment until permanent, is installed. Construction bracing shall be provided by the Contractor in conformance with truss designer's recommendations.

E. Cutting and altering of trusses is not permitted.

F. Concentrated loads shall not be placed atop trusses until all specified bracing has been installed and decking is permanently nailed in place. Stacking full bundles of plywood or other materials atop unsheathed trusses shall be avoided specifically.

PART 4 COMPLETION

4.01 ADJUSTING DEFECTIVE WORK

A. Contractor shall remove damaged or defective trusses, and report to the Construction Manager. New, undamaged trusses shall be provided to replace damaged and defective trusses, unless Construction Manager specifically approves a repair procedure which has been designed and sealed by the truss system Engineer of Record. Damaged or defective truss replacement is not a source of claims for schedule delay by the Contractor.

4.02 REMOVAL OF CONSTRUCTION BRACING

A. Upon completion of the entire structural system of which trusses are a part, Contractor shall remove and dispose of temporary bracing. Contractor is responsible for determining when such bracing is removed and shall not create an unsafe or unserviceable condition.

4.03 CLEANING UP

A. Contractor shall remove excess fasteners, unused blocking, framing, trusses and defective material from jobsite weekly or as required to maintain safe access to the work area by all trades.

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SECTION 07 05 43

CLADDING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Composite framing support (CFS) system with in-fill insulation attached to the interior face of the concrete block wall.

B. Related Requirements:
   1. Section 04 20 00 "Unit Masonry" for concrete masonry unit (CMU) wall substrates.
   2. Section 07 21 00 "Thermal Insulation" for insulation behind interior finishes.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site .

1.03 ACTION SUBMITTALS

A. Product Data: Submit for each type of product indicated; include construction details, material descriptions, dimensions of individual components and profiles, and accessories as necessary for complete fully functioning and assembled system.
   1. Continuous insulation support system attachment methods and required fasteners
   2. Wall-mounted items including doors, windows, louvers, and lighting fixtures
   3. Wall penetrations including pipes, electrical fixtures, and any other utilities

B. Shop Drawings: Show details of relationship of materials with adjacent construction, including fastening and anchorage connection details.
   1. Include layout, spacings, sizes, and thicknesses of cladding support systems; fabrication; and fastening and anchorage details, including mechanical fasteners.
   2. Indicate accessories, connection details, and attachment to adjoining Work.

C. Delegated Design Submittal: For cladding support systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer, and testing agency , and delegated design engineer.

B. Test and Inspection Reports: Submit test and inspection reports on each type of wall cladding/veneer system based on evaluation of comprehensive tests performed by nationally recognized testing agency.

C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with at least ten years of documented experience.
   1. Engineering Review: Manufacturer to provide Technical Engineering Report (TER) based on CFS and cladding system design.
   2. Code Conformance: CFS system to have been evaluated by IAPMO Uniform Evaluation Service and found satisfactory for compliance with 2018 International Building Code.

B. Installer: Company specializing in performing work of this section and the following:
   1. Install system in strict compliance with manufacturer's installation instructions.
   2. Have not less than three years of documented experience.
   3. Factory trained and approved by CFS system manufacturer.

C. Design Engineer's Qualifications: Design structural supports and anchorages under direct supervision of a licensed Structural Engineer experienced in design for this type of Work and licensed in State that Project is located. Engineering information provided shall be signed and verified by licensed Structural Engineer.

D. Environmental: CFS system to follow the below guidelines:
   1. The components shall be certified to be halogen/bromine free.
   2. CFS composite member shall utilize a minimum of 25% post-consumer recycled material content.
   3. Environmental Product Declaration: CFS Manufacturer shall provide a product specific EPD Type III report in accordance with EN 15804 and ISO 14025.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original unopened containers and packaging with labels clearly identifying product name and manufacturer.

B. Deliver components and other manufactured items or accessories without damage or deformation.

C. Storage: Store materials in clean, dry, and level interior areas or outdoor areas for limited duration in accordance with manufacturer's written instructions.

D. Protect components and auxiliary accessories during transportation, handling, and installation from moisture, excessive temperatures and other construction operations in accordance with manufacturer's written instructions.

E. Handle components in strict compliance with manufacturer's written instructions and recommendations, and in a manner to prevent bending, warping, twisting, and surface, edge or corner damage.

1.07 COORDINATION

A. Coordinate construction of cladding support systems over substrate indicated for proper drainage, flashing, trim, back-up support, soffits, and other related Work.

1.08 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of this Work in accordance with manufacturer's written installation instructions and warranty requirements.

1.09 WARRANTY

A. CFS System Warranty: Provide written warranty by manufacturer agreeing to correct defects in manufacturing within a 15 years from date of Substantial Completion.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including rupturing, cracking, or puncturing.
      b. Deterioration of materials beyond normal weathering.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Provide components and materials specified in this Section from single manufacturer for a complete and compatible assembly.

B. Basis of Design Product is Greengirt Smartci cladding support system. Provide it or comparable system by:
   1. Strongwell, Strongirt
   2. Cascade Windows and Doors, Cascade Clip
   3. As approved

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cladding support systems.

B. Structural: Provide system tested in accordance with ASTM E330/E330M and certified to be without permanent deformation or failure of structural members in accordance with design wind velocities for project geographic location and probability of occurrence based on data from wind velocity maps provided in ASCE 7 and as approved by authorities having jurisdiction (AHJ).
   1. Design Loads: As indicated on Drawings .
   2. Provide finite element analysis (FEA) to model and evaluate areas of the longest composite girt cantilever span possible between intermediate framing members/attachment.
      a. FEA shall include max dead load and wind load conditions
      b. FEA shall include point loads representative of fastener locations

c. Maximum directional stresses in model shall have a safety factor of 4 or greater.
d. Stresses shall be indicated and analyzed in 3 directions.
e. FEA shall accurately replicate the wall system and physical loading dynamics.
f. Report shall be furnished with the submittal.
g. FEA shall be approved by a licensed PE.

3. Butt joints (non-interlocking joints) of adjacent girts shall be installed on a minimum surface width of 3" or double stud condition to accommodate proper fastener margins to composite.

C. System Thermal Design: Ensure installed insulation and CFS system, rough opening trim, sub-framing, clips and cladding attachment does not have thermal bridging of fasteners or framing that creates a continuous metal path from exterior surface of insulation to interior face of insulation.

1. System thermal design shall meet or exceed thermal design requirements in compliance with ASHRAE 90.1 energy code.

D. Temperature Range: Comply with structural loading requirements within temperature range of minus 55 deg F to 180 deg F.

E. Fire-Test-Response Characteristics: Provide composite framing support system with fire-test results indicated as determined by test standard indicated and applied by UL or other testing and inspection agency acceptable to authorities having jurisdiction.

1. Surface Burning Characteristics: In compliance with ASTM E84, for foam insulation, composite metal hybrid and interior surfaces as follows:

a. Flame Spread Index (FSI): 25 or less.
b. Smoke Developed Index (SDI): 450 or less.

F. Intermediate Scale Multistory Fire Test: Comply with NFPA 285 or IBC acceptance criteria for wall height above grade and fire separation distances, when wall type and other noted conditions require such testing or compliance.

2.03 COMPONENTS

A. CFS System: Provide CMH system consisting of polyester resin matrix with recycled materials, fire retardant additives and reinforced with integral continuous metal inserts the length of profile at all fastening locations. Reinforce CFS systems with glass strand rovings used internally for longitudinal (lengthwise) strength and continuous strand glass mats or stitched reinforcements used internally for transverse (crosswise) strength.

1. Depth of Girt:
   a. 2 inch deep over sheathing/framed construction
2. On Center Spacing: 24 inch or aligned with framing, see manufacturer instruction
3. Orientation: As indicated on drawings to match gypsum panel orientation
4. Provide continuous non-corrosive steel insert for engagement of fasteners, at least 16 gauge thick with G90 galvanized coating designation in compliance with ASTM A653/A653M.
   a. Fully engage and secure steel insert with adjacent CMH at ends, allowing for thermal expansion.

b. Anchor sub-girts and other wall cladding support accessories to steel insert set into and part of CFS.
c. Provide screw pullout testing that meets or exceeds 50 lbs.

5. Provide integral compression seal in CFS sections to ensure insulation panel will not dislodge.
6. Provide integral anti-siphon grooves on exterior and interior flanges of CFS.
7. Provide force distribution zones integrally designed into profile of CFS.
8. Thermal Transmission: CFS system design should limit rate of heat flow crosswise through the profile section to less than 1.785 watts per 8' length in profile and temperature delta of 100 degrees Fahrenheit. Rate of heat flow to be determined in accordance with ASTM C1045-01, validated by a third party.
9. Surface Burning Characteristics:
   a. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84.
   b. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
10. Self-Extinguishing: Comply with ASTM D635.
11. Barcol Hardness: 45, in accordance with ASTM D2583.
12. Water Absorption: Less than 0.46 percent by weight, within 24 hours, tested in accordance with ASTM D570.
13. Density: Within range of 0.062 to 0.070 lbs/cubic inch, in accordance with ASTM D792.
14. Lengthwise Coefficient of Thermal Expansion: 7.0 x 10^{-6} inch/inch/degrees F, in accordance with ASTM D696.

B. Continuous Insulation (CI): Board Insulation - As specified in Section 07 21 00 "Thermal Insulation."
   1. Assemble CFS system using manufacturer's standard procedures and processes identical to tested units and as necessary to comply with performance requirements indicated.
   2. Comply with CFS system and dimensional and structural requirements as indicated on drawings.
   3. Erect CFS system in established sequence in accordance with manufacturer's standard installation procedures.
   4. Provide uninterrupted, monolithic drainage plane as required per project details.

2.04 ACCESSORIES

A. Provide accessories necessary for complete CFS system including metal closure, trim transition, angle strapping, tie-in brackets, or similar items.

B. Fasteners: Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by CFS system manufacturer for CMH material and project application.
   1. Cladding to CMH: Use standard self-tapping metal screws
   2. CMH to Metal Stud Wall Framing: Use standard self-tapping metal screws.
   3. CMH to Concrete/CMU: Use standard masonry or concrete screw anchors in predrilled hole.

4. CMH to Wood Framing: Use standard wood screw anchors.
5. DO NOT USE powder, air, or gas actuated fasteners or actuated fastener tools. DO NOT USE impact wrenches when fastening to or from the CMH.
6. CMH attachments to follow guidelines of ASCE Structural Plastics Design Manual:

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas of this work, and project conditions with installer present for compliance with requirements for installation tolerances, substrates, CFS system conditions, and other conditions affecting performance of this Work.

B. Examine structural wall framing to ensure that angles, channels, studs, and other structural support members have been installed within alignment tolerances required by CFS system manufacturer.

C. Examine rough-in for components and systems penetrating CFS system to coordinate actual locations of penetrations relative to CFS systems joint locations prior to installation.

D. Verify that mechanical and electrical services for exterior walls have been installed and tested and, if appropriate, verify that adjacent materials and finishes are dry and ready to receive insulation.

E. Proceed with installation only after wall substrate surfaces have been properly prepared and unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrate surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by CFS manufacturer for achieving best result for substrate under project conditions Prepare substrate surfaces using methods recommended in writing by cladding support system manufacturer.

3.03 INSTALLATION

A. Install cladding support system components in accordance with manufacturer's written instructions, approved submittals, and the following:
   1. Install in proper relationship with adjacent materials.
   2. Install cladding support system assembly level, plumb, and square within 1/8 inch in 20 ft. noncumulative allowable tolerance.

B. Install CFS system to meet requirements of ASCE Structural Plastics Design Manual.

C. Install system to fill-in exterior spaces without gaps or voids, and do not compress insulation panels.

D. Trim insulation neatly to fit spaces, and insulate miscellaneous gaps and voids.

E. Fit insulation tight in spaces and tight to exterior side of Mechanical/Electrical services within plane of insulation.

F. Exposed insulation must be protected from open flame.

G. Exterior wall insulation is not intended to be left exposed for extended periods of time without adequate protection.

H. Install CFS system in compliance with system orientation, sizes, and locations as indicated on drawings.

3.04 TOLERANCES

A. Shim and align CFS system within installed tolerances of 1/4 inch in 20 feet, non-cumulative, level, plumb, and on location lines as indicated.

3.05 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

B. Ensure that insulation panels are not exposed to moisture.
   1. Remove wet insulation panels or allow them to completely dry prior to installation of CFS system.

C. Replace damaged insulation prior to Date of Substantial Completion

END OF SECTION

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SECTION 07 10 00

DAMPPROOFING AND WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Dampproofing and waterproofing coatings and membranes for concrete surfaces.
   1. Plastic Lining is not covered by this specification.
   2. Refer to Section 09 90 00 for protective concrete coatings.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete.
   2. Section 09 90 00 Painting and Coating.

1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM C109	Compressive Strength of Hydraulic Cement Mortars (Using 2-in. orCube Specimens)
ASTM C321	Bond Strength of Chemical-Resistant Mortars
ASTM C348	Flexural Strength of Hydraulic-Cement Mortar
COE CRD-C48	Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete

1.04 DEFINITIONS

A. SM – Coating or Membrane - System Manufacturer

B. TR – Coating or Membrane System Manufacturer's - Technical Representative

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. System Manufacturer's (SM) current printed recommendations and product data sheets for proposed systems including:
    a. Volatile organic compound (VOC) data.
    b. Surface preparation recommendations.
    c. Allowable substrate moisture content.
    d. Primer type, coverage rate, and drying time; where required.
    e. Maximum dry and wet-mil thickness per coat.
    f. Product(s) shelf life.
    g. Minimum and maximum curing time between coats.
    h. Atmospheric condition requirements during application and curing.
    i. Curing time before submergence in liquid.
    j. Thinner to be used.
    k. Ventilation requirements.
    l. Allowable application methods.
    m. Corner, joint, and wall penetration details.
    n. Backfill procedure recommendations including termination bar if required.
5. Affidavits signed and sealed by an officer of the SM's corporation, attesting to compliance of each system component with federal, state, and local air pollution control regulations and requirements.
6. SM's detailed, written instructions for system installation including graphic details for terminations, pipe penetrations, metal embedments, gate frames, concrete joints, and other terminations as coordinated by Contractor.
7. Schedule of all surfaces where dampproofing, waterproofing coating, and sheet membrane waterproofing will be applied.

B. Informational Submittals:
1. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
2. List of cleaning and thinner solutions allowed by the SMs.
3. Storage and handling requirements including temperature, humidity, and ventilation for system materials as recommended by the SMs.
4. The Contractor and SM shall each provide five project references with contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

1.06 QUALITY ASSURANCE

A. General:
   1. Materials in each system shall be the products of a single SM.
   2. Installation of each system shall be by a single installation Contractor, approved by the SM.

B. Quality Control:
   1. The Contractor is responsible for the workmanship and quality of the system installation. Inspections by the Owner's Representative or the System Manufacturer's Technical Representative (TR) will not relieve or limit the Contractor's responsibilities.
   2. Installation methods shall conform to requirements of this specification. Changes in the system installation requirements will be allowed only with the written acceptance of the Owner's Representative before work commences.
   3. Only personnel who are trained by the TR specifically for the system or who are approved by the SM specifically for the system are allowed to perform the system installation specified in this Section.
   4. For repairs, provide the same products, or products recommended by the SM, as used for the original installation.
   5. Identify the points of access for inspection by the Owner's Representative. Provide ventilation, ingress and egress, and other means necessary for the Owner's Representatives to safely access the work areas.
   6. Conduct and inspect the work so that the system is installed as specified. Work that does not conform to the specifications shall be corrected.

1.07 SPECIAL WARRANTY

A. Waterproofing coating and sheet membrane waterproofing SM and the installation Contractor agree to repair or replace components of the waterproofing system that fail in materials or workmanship within 5 years from the date of completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

A. Dampproofing Coating:
   1. W.R. Meadows, Sealtight Sealmastic Emulsion.
   2. ChemMasters, MasterGard 400.
   3. Euclid Chemical Company, Dehydratine 75.

B. Epoxy Waterproofing Coating:
   1. Tnemec Series 69.
   2. Ameron Amercoat 385.
   3. International Protective Coatings Intergard 670 HS.

2.02 MATERIALS

A. Dampproofing Coating:
   1. Cold applied, asphalt emulsion.

B. Epoxy Waterproofing Coating:
   1. Polyamidoamine epoxy resin.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

3.02 DAMPPROOFING COATING

A. Location:
   1. Apply to the earth side of concrete walls which are below grade at the following locations or as indicated on the Drawings:
      a. Walls at unoccupied crawl spaces.
      b. Wall areas above the water table and the waterproofing membrane or coating at walls common with rooms, tunnels or galleries to be occupied by equipment, piping or personnel.
      c. Walls of concrete channels, basins and tank walls (above and below ground water table).
   2. Do not apply to walls that are to be provided with waterproofing sheet membrane with protection board or to walls that are placed directly against an excavated surface.
   3. Dampproofing is not a substitute for waterproofing.

B. Surface Preparation:
   1. New concrete shall have cured at least 28 days. Remove loose concrete and laitance from new concrete surfaces by abrasive blasting. Repair voids and cracks as specified in Section 03 30 00. Pre-dampen the surface as recommended by the product manufacturer.
   2. Do not proceed with dampproofing Work until all projections through the concrete surface are installed.

C. Application:
   1. Apply one or more coats at the manufacturer's recommended dry film thickness for optimum performance. Surfaces to be coated must be kept damp during the application procedure. Drying time between coats: as recommended by the manufacturer.

3.03 EPOXY WATERPROOFING COATING

A. Location:
   1. Except where sheet membrane waterproofing is indicated at the earth side of walls and slabs on the Drawings, apply epoxy waterproofing coating to the process liquid and earth side of walls and elevated slabs which are common with rooms, tunnels or galleries to be occupied by equipment, piping, conduit, or personnel, or as indicated on the Drawings.

B. Surface Preparation:
   1. New concrete shall have cured at least 28 days and allowed to dry to a moisture content recommended by the coating manufacturer. Remove loose concrete and laitance by abrasive blasting. Repair voids and cracks as specified in Section 03 30 00.

C. Application:
   1. Total dry film thickness: minimum 16 mils.
   2. Apply two or more coats at the manufacturer's recommended dry film thickness.
   3. Drying time between coats: as recommended by the manufacturer.

END OF SECTION

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SECTION 07 21 00

THERMAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Polyisocyanurate foam-plastic board insulation.
   2. Glass-fiber blanket insulation.
   3. Extruded-polystyrene foam-plastic board insulation at slab.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Research Reports: For foam-plastic insulation, from ICC-ES.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:
   1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
   3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes less than 25 and 450 when tested in accordance with ASTM E84.

B. Fire-Resistance Ratings: Comply with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Indicate design designations from UL's "Fire Resistance Directory" or from listings of another qualified testing agency.

C. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

D. Identification mark in "Labeling" Paragraph below is required by the International Energy Conservation Code unless insulation Installer is providing certification specified in "Informational Submittals" Article.

E. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

F. Coordinate R-value in "Thermal-Resistance Value (R-Value)" Paragraph below with insulation types selected; copy subparagraph as needed for different R-values at multiple locations.

G. Thermal-Resistance Value (R-Value): R-value as indicated on Drawings in accordance with ASTM C518.

2.02 POLYISOCYANURATE BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2, 25-psi minimum compressive strength.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. DuPont de Nemours, Inc.
      b. Firestone Building Products.
      c. Johns Manville; a Berkshire Hathaway company.
      d. The Dow Chemical Company.

2.03 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I;with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Certainteed; SAINT-GOBAIN.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Owens Corning.

2.04 EXTRUDED-POLYSTYRENE BOARD INSULATION:

A. ASTM D 1621, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Chemical Company.
      b. Owens Corning.
      c. Atlas EPS.

2. R-value: R-10 for 24” at slab perimeter.

2.05 ACCESSORIES

A. Insulation for Miscellaneous Voids:
   1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.02 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.03 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
   1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
   2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.

3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.04 INSTALLATION OF CAVITY-WALL INSULATION

A. Polyisocyanurate Board Insulation: Install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face and as recommended by manufacturer.
1. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.

3.05 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by stapling flanges of insulation to flanges of wood studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.06 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07 41 13.16

STANDING-SEAM METAL ROOF PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Standing-seam metal roof panels.
   2. Cover Board.
   3. Underlayment.

B. Related Requirements:
   1. Section 07 21 00 " Thermal Insulation" for insulation used in horizontal Standing-seam metal roof applications.
   2. Section 07 62 00 " Sheet Metal Flashing and Trim" for roof-drainage sheet metal fabrications and roof sheet metal fabrications.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

C. Samples: For each type of metal panel indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Warranties: Sample of special warranties.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
   1. Wind Loads: As indicated on Drawings.
   2. Other Design Loads: As indicated on Drawings.
   3. Deflection Limits: For wind loads, no greater than of the span.

B. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
   1. Uplift Rating: As indicated on Drawings.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range):120 deg F, ambient; 180 deg F, material surfaces.

2.02 STANDING-SEAM METAL ROOF PANELS

A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AEP Span a brand of ASC Profiles LLC, a part of BlueScope. - SpanSeam (Basis of design).
      b. CENTRIA, a Nucor Brand.
      c. Garland Company, Inc. (The).
      d. Taylor Metal Products.
   2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
      a. Nominal Thickness: 24 gauge.
      b. Exterior Finish: Three-coat fluoropolymer.
      c. Color: To match Taylor Metal Products “Cool” Kynar 500 Musket, Hylar 5000, or closely matching as determined by the owner at time of construction.
   3. Seam Type: 180-degree seams.
   4. Panel Profile: Flat pan.
   5. Clips: Two piece, floating, designed to accommodate thermal movement.
      a. Material: 0.028-inch- nominal thickness, aluminum-zinc alloy-coated steel sheet.
      b. Clip Spacing: As indicated on approved Shop Drawings.
   6. Panel Coverage: 16 inches.
   7. Panel Height: 2 inches.

2.03 COVER BOARD

A. Provide ½” glass mat roof boards under metal deck, either adhered to insulation board or mechanically fastened. Manufacturer: Georgia Pacific DensDeck or approved equal.

2.04 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
   1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
   2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.
   3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carlisle WIP Products; a brand of Carlisle Construction Materials.
      b. Henry Company.
      c. Protecto Wrap Company.

2.05 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
   1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
   2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels

E. Panel Fasteners: Self-tapping screws designed to withstand design loads.

F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
   1. Joint Sealant: ASTM C920 as recommended in writing by metal panel manufacturer.

2.06 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.07 FINISHES

A. Panels and Accessories:
   1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat.
   2. Concealed Finish: White or light-colored acrylic or polyester backer finish.

PART 3 EXECUTION

3.01 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.02 INSTALLATION OF COVER BOARD

A. Install cover board over insulation in accordance with manufacturer's written installation instructions. Install with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

3.03 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
   1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3.04 INSTALLATION OF STANDING-SEAM METAL ROOF PANELS

A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
   1. Install clips to supports with self-tapping fasteners.

2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

C. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.05 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

SECTION 07 46 46

FIBER-CEMENT SIDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes fiber-cement siding and soffit.

B. Related Requirements:
   1. Section 06 10 00 "Rough Carpentry" for wood furring, nailers, and blocking the soffit framing.
   2. Section 06 16 00 "Sheathing" for backing at the siding.

1.03 COORDINATION

A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: For fiber-cement siding and soffit including related accessories.

C. Samples for Verification: For each type, color, texture, and pattern required.
   1. 12-inch- long-by-actual-width Sample of siding.
   2. 12-inch- long-by-actual-width Sample of soffit.

1.06 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of fiber-cement siding and soffit.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.

C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.

D. Sample Warranty: For special warranty.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish full lengths of fiber-cement siding and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

1.09 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Build mockups for fiber-cement siding and soffit including accessories.
      a. Size: 48 inches long by 48 high.
      b. Include outside corner on one end of mockup.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with labels intact until time of use.

B. Store materials on elevated platforms, under cover, and in a dry location.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including cracking and deforming.
      b. Deterioration of materials beyond normal weathering.
   2. Warranty Period: 25 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.02 FIBER-CEMENT SIDING

A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.

B. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie “Hardi-Panel Siding”, Sierra 8 texture. Provide products by one of the following:
   1. CertainTeed Corporation.
   2. GAF.
   3. James Hardie Building Products, Inc.
   4. Nichiha Architectural Panels.

C. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.

D. Nominal Thickness: Not less than 5/16 inch.

E. Factory Priming: Manufacturer's standard acrylic primer.

2.03 FIBER-CEMENT SOFFIT

A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
   1. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie “HardieSoffit”. Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation.
      b. James Hardie Building Products, Inc.
      c. Nichiha Architectural Panels.

B. Nominal Thickness: Not less than 1/4 inch.

C. Pattern: 24-inch wide sheets with smooth texture.

D. Ventilation: Provide perforated soffit.

E. Factory Priming: Manufacturer's standard acrylic primer.

2.04 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
   1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.

B. Flashing: Provide aluminum flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
   1. Finish for Aluminum Flashing: Factory-prime coating.

C. Fasteners:
   1. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch (6 mm), or three screw-threads, into substrate.
   2. For fastening fiber cement, use hot-dip galvanized fasteners.

D. Underlayment:
   1. Provide a drainable weather resistant barrier over the plywood sheathing as recommended by siding manufacturer.
      a. DuPont – Tyvek “DrainWrap”.
      b. Fortifiber Building Systems Group – Two-Ply “Hydrotex” Drainable WRB.
      c. Benjamin Obdyke – “Hydrogap” Drainable Housewrap.
      d. As approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement siding and soffit and related accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.03 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
   1. Do not install damaged components.
   2. Install fasteners no more than 16 inches (600 mm) o.c.

B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.

3.04 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Formed roof-drainage sheet metal fabrications.
   2. Formed wall sheet metal fabrications.
   3. Formed Soffit edge enclosures.
   4. Formed fascia board enclosures.
   5. Miscellaneous drip edge flashing.

B. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

C. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leak-proof, secure, and noncorrosive installation.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.06 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change: 120 deg F , ambient; 180 deg F , material surfaces.

2.02 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: prepainted by coil-coating process to comply with ASTM A 755/A 755M.
   1. Exposed Coil-Coated Finish:
      a. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   2. Color: As selected by Architect from manufacturer's full range.
   3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.03 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.04 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
   1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
   2. Obtain field measurements for accurate fit before shop fabrication.
   3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
   4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

I. Do not use graphite pencils to mark metal surfaces.

2.05 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers and gutter accessories from same metal as gutter.
   1. Gutter Profile: "Fascia" Style F according to cited sheet metal standard.
   2. Expansion Joints: Built in.
   3. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
   4. Gutters with Girth up to 15 Inches : Fabricate from the following materials:
      a. Aluminum-Zinc Alloy-Coated Steel: 0.0276 inch thick.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.
   1. Fabricated Hanger Style: Fig 1-35A according to SMACNA's "Architectural Sheet Metal Manual."
   2. Fabricate from the following materials:
      a. Aluminum-Zinc Alloy-Coated Steel: 0.0276 inch thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

B. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
   1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
   2. Use lapped expansion joints only where indicated on Drawings.

C. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws .

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Seal joints as required for watertight construction.
   1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F , set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F .
   2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.03 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
   1. Fasten gutter spacers to front and back of gutter.
   2. Anchor and loosely lock back edge of gutter to continuous eave or apron flashing.
   3. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
   4. Anchor gutter with gutter brackets spaced not more than 24 inches apart to roof deck, unless otherwise indicated, and loosely lock to front gutter bead.
   5. Install continuous gutter screens on gutters with noncorrosive fasteners, removable for cleaning gutters.

C. Downspouts: Join sections with 1-1/2-inch telescoping joints.
   1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
   2. Provide elbows at base of downspout to direct water away from building.
   3. Connect downspouts to underground drainage system.

3.04 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.05 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
B. Clean off excess sealants.
C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07 72 53

SNOW GUARDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Rail-type, seam-mounted snow guards.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
   1. Include details of rail-type snow guards.

C. Samples:
   1. Rail-Type Snow Guards: Bracket, 12-inch- long rail, and installation hardware.

D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include calculation of number and location of snow guards.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the state in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.05 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in the Contract Documents, to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:
   1. Roof snow load.
   2. Snow drifting
   3. Roof slope.
   4. Roof type.
   5. Roof dimensions.
   6. Roofing substrate type and thickness.
   7. Snow guard type.
   8. Snow guard fastening method and strength.
   9. Snow guard spacing.
   10. Coefficient of Friction Between Snow and Roof Surface: 0.
   11. Factor of Safety: 2

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
   1. Snow Loads: As indicated on Drawings.

2.02 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
      b. S-5! Metal Roof Innovations, Ltd.
      c. TRA Snow and Sun, Inc.
   2. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with two rails with integral track to accept color-matching inserts of material and finish used for metal roof.
   3. Brackets and Baseplate: ASTM B209 aluminum; mill finished.
   4. Bars: ASTM B221 aluminum; mill finish.
      a. Profile: Round with integral track to accept color-matching inserts of material and finish used for metal roof.

5. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.
   1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.03 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.
   1. Space rows as indicated on Drawings.
   2. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:
   1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
   2. Rail-Type, Seam-Mounted Snow Guards:
      a. Install brackets to vertical ribs in straight rows.
      b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
      c. Torque set screw according to manufacturer's instructions.
      d. Install cross members to brackets.

END OF SECTION

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SECTION 07 91 26

JOINT FILLERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies preformed joint fillers for isolating concrete elements.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D994	Preformed Expansion Joint Filler for Concrete (Bituminous Type)
ASTM D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

PART 2 PRODUCTS

2.01 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint filler shall be in accordance with ASTM D994 and shall be 1/2 inch thick unless otherwise specified.

2.02 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be in accordance with ASTM D1752, Type II. Cork joint filler thickness shall match the specified joint width.

2.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Provide manufacturer’s data for the material.
   2. Manufacturer's recommendations for handling and installation of the material.

PART 3 EXECUTION

3.01 GENERAL

A. Preformed joint fillers shall be placed into position before the concrete is poured. Where it is necessary for the filler to be fixed to existing concrete or other building materials, a suitable adhesive recommended by the filler manufacturer shall be used. Filler surfaces shall be clean and dry prior to the placement of the concrete.

3.02 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint fillers shall be used for expansion joints in concrete sidewalks, curbs, and roadways.

3.03 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be used for expansion joints in concrete structures. The expansion joint shall be sealed with backer rod and sealant as specified in Section 07 92 00.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.

1.02 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-sealant schedule.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.04 CLOSEOUT SUBMITTALS

A. Warranty Documentation:
   1. Manufacturers' special warranties.
   2. Installer's special warranties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

1.06 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
   1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
   2. Disintegration of joint substrates from causes exceeding design specifications.
   3. Mechanical damage caused by individuals, tools, or other outside agents.
   4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.01 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.02 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Sika Corporation - Building Components.

2.03 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. Sika Corporation - Building Components.
      c. Tremco Incorporated.

2.04 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. Sika Corporation - Building Components.
      c. Tremco Incorporated.

2.05 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adfast.
      b. Construction Foam Products; a division of Nomaco, Inc.
      c. Master Builders Solutions.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) , and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

2.06 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    a. Masonry.
    b. Exterior insulation and finish systems.
3. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    a. Metal.
    b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.02 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
    1. Do not leave gaps between ends of sealant backings.
    2. Do not stretch, twist, puncture, or tear sealant backings.
    3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
    1. Place sealants so they directly contact and fully wet joint substrates.
    2. Completely fill recesses in each joint configuration.
    3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
    1. Remove excess sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.03 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.04 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints at:	
Concrete Walls (except water-holding and below grade portions of structures)	1, 3, 4, 5, 6
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 3, 4, 5, 6
Ceramic Tile Floors	1, 2, 5
Ceramic Tile Walls	1, 3, 5
Material Joints at:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6
Wall Penetrations (Exterior)	1, 5, 6
Wall Penetrations (Interior)	1, 5, 6
Floor Penetrations	5, 6
Ceiling Penetrations	1, 3, 4, 5, 6
Roof Penetrations	5

Joint Locations	Sealant Type(s)
Sheet Metal Flashings	5
Sheet Metal Roofing and Siding	5, 13
Other Joints:	
Threshold Sealant Bed	5
Around Plumbing Fixtures	10

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Standard and custom hollow metal doors and frames.

B. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
   1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
   2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
   3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
   4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
   5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
   6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   9. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
   10. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
   11. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, and finishes.

B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

C. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of anchorages, joints, field splices, and connections.
   6. Details of accessories.

D. Samples for Verification:
   1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.
   1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:
      a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.37, R-Value 2.7, including insulated door, thermal-break frame and threshold.
   2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:
      a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
   1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.07 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
   1. CECO Door Products (C).
   2. Curries Company (CU).
   3. Pioneer Industries (PI).
   4. Steelcraft (L).

2.02 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.03 HOLLOW METAL DOORS

A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
   1. Design: Flush panel.
   2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 “Laminated Core”.
      a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
      b. Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, thermal-break frame and threshold.
      c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, kerf type frame, and threshold.
   3. Level/Model: Level 4 and Physical Performance Level A (Maximum-Duty), Minimum 14 gauge thick steel, Model 2.
   4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
   5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
   6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
   7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Manufacturers Basis of Design:
   1. Curries Company (CU) - Steel-Stiffened - 747 Series.

2.04 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.
   1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
   2. Frames: Minimum 14 gauge thick steel sheet.
   3. Size: 5 ¾- inches (146 mm) wide by 2-inches (51 mm) deep, unless otherwise indicated.

4. Manufacturers Basis of Design:
    a. Curries Company (CU) – M Series (equal rabbet).

C. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.05 FRAME ANCHORS

A. Jamb Anchors:
    1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
    2. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.06 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.07 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:
    1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.

D. Hollow Metal Frames:
    1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
    a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
3. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
4. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
5. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
6. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
7. Jamb Anchors: Provide number and spacing of anchors as follows:
    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.
        3) Four anchors per jamb from 90 to 120 inches high.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
8. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 71 00 Section "Door Hardware."
    1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
    2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
    3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
    4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.08 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
   1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Standard Steel Doors:
      a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
      d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

3.04 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

3.05 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 77 00 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
   1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION

SECTION 08 14 00

FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

A. This section includes the following:
   1. Solid-core doors wood-veneer faced pocket door.
   2. Factory finishing flush wood doors.

B. Related Sections:
   1. Section 081113, Hollow Metal Doors and Frames for hollow metal frames to receive wood doors.
   2. Section 087100, Door Hardware for wood door preparation for door hardware.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standards Institute (ANSI): A208.1, Particleboard.
   2. Architectural Woodwork Institute (AWI), Architectural Woodwork Manufacturers Association of Canada (AWMAC), and the Woodwork Institute (WI): AWI/AWMAC/WI Architectural Woodwork Standards (AWS).
   3. Door and Hardware Institute (DHI):
      a. DHI-WDHS-3, Recommended Hardware Locations For Wood Flush Doors.
      b. DHI A115 Series, Hardware Preparation.
   4. International Code Council (ICC): A117.1, Accessible and Usable Buildings and Facilities.
   5. National Fire Protection Association (NFPA):
      a. 80: Standard for Fire Doors and Other Opening Protectives.
      b. 105: Standard for Smoke Door Assemblies and Other Opening Protectives.
   6. U.S. Department of Justice (US DoJ): U.S. Architectural and Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1.03 SUBMITTALS, GENERAL

A. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.

B. If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner's Representative shall be the final authority for determining acceptability of requested deviations.

C. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of door.
   1. Include details of core and edge construction and trim for openings.
   2. Include factory-finishing specifications.
   3. Manufacturer's installation instructions.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
   1. Indicate dimensions and locations of mortises and holes for hardware.
   2. Indicate requirements for veneer matching.
   3. Indicate location and extent of hardware blocking.
   4. Indicate construction details not covered in Product Data.
   5. Indicate doors to be factory finished and finish requirements.

C. Samples for Initial Selection: For factory-finished doors.

D. Samples for Verification:
   1. Factory finishes applied to actual door face materials, approximately 8 inches by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
   2. Corner sections of doors, 8 inches by 10 inches, with door faces and edges representing actual materials to be used.
      a. Provide samples for each species of veneer and core material.
      b. Finish veneer faced door samples with same materials proposed for factory finished doors.
   3. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.05 INFORMATIONAL SUBMITTALS

A. Quality Standard Compliance Certificates: WI Certified Compliance Program certificates.

B. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

B. As-Built Drawings: A copy of as-built shop drawings and system specifications shall also be included in the systems manual.

C. Warranties: At project closeout, provide to Owner an executed copy of the manufacturer's standard warranty outlining the warranty terms, conditions, and exclusions from coverage.

1.07 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Owner's Representative, except with Owner's Representative's approval. If revisions are proposed, submit comprehensive explanatory data to Owner's Representative for review.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Supplier shall provide Contractor with detailed recommendations and instructions for product storage.

1. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Ordering: Conform to manufacturer's ordering instructions and lead time requirements to avoid construction delays.

C. Inspect products and materials upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Owner's Representative. Otherwise, remove and replace damaged items as directed.

D. Deliver products materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

1. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.

E. Store products in manufacturer's unopened packaging until ready for installation.

F. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.09 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 degrees F and 90 degrees F and relative humidity between 43 percent and 70 percent during the remainder of the construction period.
   1. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy standards. If necessary, provide artificial heating, cooling and ventilation to maintain required environmental conditions.

1.10 WARRANTY

A. General: Warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
   1. Failures include, but are not limited to, the following:
      a. Warping (bow, cup, or twist) more than 1/4 inch in a 42 inch by 84 inch section.
      b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. The products and materials described in this section shall meet the following minimum design operating requirements.

B. General Performance: Flush wood doors shall be furnished and applied without failure due to defective manufacture, fabrication, installation, or other defects in construction.

C. VOC Content: Products shall comply with VOC content limits in accordance with BAAQMD requirements and standards.

D. Performance Grade:
   1. Extra Heavy Duty; Aesthetic Grade: Premium.

E. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WI “Architectural Woodwork Standards.”
   1. Provide WI Certified Compliance Labels indicating that doors comply with requirements of grades specified.

2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
3. Composite Wood Products: Hardwood plywood, particleboard, and medium density fiberboard composite wood products used on the interior or exterior of the building shall meet the requirements for formaldehyde as specified in ARB's Air Toxics Control Measure (ATCM) for Composite Wood (17 CCR 93120 et seq.).

2.02 MANUFACTURERS

A. Manufacturers:
   1. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ASSA ABLOY Wood Doors (GR); GPD Series.
      b. Eggers Industries (EG); Premium Series.
      c. Marshfield-Algoma (MF); Signature Series.
      d. VT Industries (VT); Artistry Series.

2.03 SOLID-CORE DOORS

A. Particleboard Core: Bonded particleboard core complying with ANSI A208.1, Grade LD-2, with binder containing no urea-formaldehyde resin.

B. Blocking:
   1. Provide wood blocking in particleboard-core doors as follows:
      a. 6-inch top-rail blocking.
      b. 6-inch bottom-rail blocking.
      c. 6-inch midrail blocking, in doors indicated to have exit devices.
      d. 2-1/2-inch stile blocking.

C. Construction: Five plies with stiles and rails bonded to core, then entire unit abrasive planed before veneering.

2.04 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Premium.
   2. Faces: Grade AA Faces.
   3. Species and Cut: White oak, rift cut.
   4. Exposed Vertical Edges: Matching same species as faces. Wood or composite material, one piece, laminated, or veneered. Minimum requirements per WDMA Section P-1, Performance Standards for Architectural Wood Flush Doors.
   5. Horizontal Edges: Solid wood or structural composite material meeting the minimum requirements per WDMA Section P-1, Performance Standards for Architectural Wood Flush Doors.
   6. Orientation: Run grain vertical.

7. Assembly of Veneer Leaves on Door Faces: Running match.
8. At doors over 40 percent of the face cut-out for lights and or louvers, furnish engineered composite lumber core.

2.05 FABRICATION

A. Factory-fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
   1. Comply with clearance requirements of referenced quality standard for fitting.

B. Factory-machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

C. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 80 00, Glazing.

2.06 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.

B. Transparent Finish:
   1. Grade: Premium.
   2. Finish: WI System 9 UV-curable coating or WI System 4 Conversion Varnish.
   3. Staining: None required.
   4. Effect: Semi-filled finish, produced by applying an additional finish coat to partially fill the wood pores.
   5. Sheen: Satin.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine doors and installed door frames before hanging doors. Verify conditions ready to receive Work of this section before beginning.
   1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and ate installed with level heads and plumb jambs.
   2. Reject doors with defects.

B. If substrate preparation is the responsibility of another installer, notify Owner's Representative of unsatisfactory preparation before proceeding. Do not begin installation until substrates have been properly prepared.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Beginning of the Work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.02 PREPARATION

A. Review areas of potential interference and conflicts, and coordinate layout and support provisions for interfacing work.

B. Do not begin installation until substrates have been properly prepared. If substrate preparation is the responsibility of another installer, notify Owner's Representative of unsatisfactory preparation before proceeding.

C. Clean, prepare, and treat substrates according to manufacturer's written instructions. Clean substrates of projections and substances detrimental to application.

3.03 INSTALLATION

A. Hardware: For installation, see Section 087100, Door Hardware.

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

D. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
   1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
      a. Comply with NFPA 80 for fire-rated doors.
      b. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
      c. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project Site.

F. Field modifications to doors shall not be permitted, except those specifically allowed by manufacturer or fire rating requirements.

3.04 ADJUSTING

A. Operation: Re-hang or replace doors that do not swing or operate freely.

B. Replacement: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes access doors and frames for walls and ceilings.

B. Related Requirements:
   1. Section 09 29 00 – Gypsum Board for substrate at gypsum board-clad wall and ceiling assemblies.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.

B. Product Schedule: For access doors and frames.

PART 1 - GENERAL

1.03 PRODUCTS

A. Flush access doors and frames with exposed flanges.

1.04 ACCESS DOORS AND FRAMES

A. Flush Access Doors with Exposed Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide basis of design product or comparable approved product.
      a. Basis of Design: Acudor Products, Inc. Model UF 5000
      b. Karp Associattes, Inc
      c. Milcor Inc.
   2. Description: Face of door flush with frame, with standard width exposed flange proportional to door size and concealed hinge.
   3. Locations: Ceilings.
   4. Door Size: As indicated on Drawings, or as required for access.
   5. Door Material: Metallic-coated steel sheet, 16 gauge.
      a. Finish: Factory primed, paint to match surrounding finish.
   6. Frame Material: Same material, thickness, and finish as door.
   7. Hinges: Manufacturer's standard concealed hinge
   8. Latch and Lock: Stainless steel cam latch, screwdriver operated.

1.05 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.

D. Latch and Lock Hardware:
   1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

1.06 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: Same material as door face.

E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

1.07 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 2 EXECUTION

2.01 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.02 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

2.03 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION

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SECTION 08 31 20

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Factory-fabricated single leaf aluminum floor access doors and frames with water drainage. Include telescoping ladder safety post.

1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM B221	Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B632	Aluminum-Alloy Rolled Tread Plate
ASTM A240	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Stainless Steel Nuts
AASHTO	American Association of State Highway and Transportation Officials
OSHA	U.S. Dept. of Labor, Occupational Safety and Health Administration

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Statement of experience for both manufacturer and installer.
   5. Fabrication drawings showing layouts, connections to structure, and anchoring details.
   6. Erection and installation drawings showing construction details, reinforcement, anchorage, and installation with relation to the building construction.
   7. Drain pipe layout from the drain coupling to the discharge point.

B. Informational Submittals:
   1. Manufacturer's product data showing conformance to the specification.
   2. Structural calculations for the floor access door design provided by the manufacturer and sealed by a registered professional engineer registered in the State of Washington.
   3. Instructions for the storage, handling, installation, and operation.
   4. Manufacturer's warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer: Minimum of 5 years' experience manufacturing similar products.

B. Installer: Minimum of 2 years' experience installing similar products.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packaging, stored in a dry, protected, well-vented area. Inspect product upon receipt and report damage to carrier and manufacturer.

1.06 SPECIAL WARRANTY

A. Materials shall be free of defects in material and workmanship for a period of 5 years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following manufacturers are acceptable. The manufacturer's standard product may require modification to conform to specified requirements.
   1. The Bilco Company.
   2. Babcock Davis.
   3. Halliday Products.
   4. East Jordan Iron Works (EJ).
   5. Approved Equal.

2.02 PERFORMANCE/DESIGN CRITERIA

A. Door leafs shall be reinforced to support a minimum live load of 300 psf or AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span. See Floor Access Door Schedule at the end of this section, which indicates loading criteria required at each location.

B. Nominal opening sizes and hinge opening side shall be as noted on the Drawings and in the Floor Access Door Schedule.

2.03 MATERIALS

A. Access doors, single leaf or double leaf: 1/4 inch minimum aluminum with diamond tread pattern; ASTM B632, 6061-T6.

B. Channel frame shall be 1/4 inch minimum extruded aluminum with bent down anchor tabs around the perimeter: ASTM B221, 6061-T6.

C. Hardware: ASTM A240 Type 316 stainless steel throughout.

D. Fasteners:
   1. Bolts: ASTM F593
   2. Nuts: ASTM F594

2.04 COMPONENTS/ FEATURES

A. Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled door leaf operation throughout the entire arc of opening; and to act as a check in retarding downward motion of the cover when closing.

B. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material. The upper tube shall prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4 inch gusset support plate.

C. Door leafs shall be equipped with a hold-open arm which automatically locks the door in the open position. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the door and the latch release shall be protected by a flush, gasketed, removable screw plug. A stainless steel snap lock with fixed handle shall be mounted on the underside of the door.

D. Provide heavy forged aluminum hinges with 1/4 inch minimum diameter stainless steel pins.
   1. Hinges must operate in such a manner to prevent the door leafs from protruding into the channel frame.
   2. Design hinges specifically for horizontal installation.
   3. Hinges shall be through-bolted to the cover with tamperproof stainless steel lock bolts and through-bolted to the frame with stainless steel bolts and locknuts.

E. A continuous ethylene propylene diene monomer (EPDM) gasket shall be mechanically attached to the aluminum frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.

F. A 1.5 inch drain coupling shall be provided.

G. Provide a fall protection grating system at all access doors. Manufacturer shall install the grating system when the door is fabricated.
   1. Design Criteria: Meet OSHA 29 CFR 1910.23 requirements for fall protection.

2. Grating panel material: Aluminum with powder coat paint finish.
3. Grating panel color: High visibility OSHA safety yellow or orange.
4. Grating panel shall lock automatically in the full open position.
5. Grating panel shall lift open in the opposite direction as the door(s).
6. Hold open feature: Stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.
7. Lift mechanism and hardware: Stainless steel lifting mechanisms as specified above or all fall protection panels that weigh over 50 pounds.
8. Grating openings: Reinforced with easy-open aluminum covers for removal of instrumentation below access doors.

H. Provide safety chain made of non-corrosive material that will span across the corners of double leaf access doors when open.

I. Provide telescoping ladder safety posts for easy, safe ladder access through the access door openings.
1. Material: Stainless steel.
2. Telescoping post to be permanently mounted to the top two rungs of fixed ladders.
3. Post must automatically lock in the fully raised position to provide the user with a firm and steady hand-hold.
4. Post to have release lever that allows the post to be easily lowered to its retracted position.

2.05 FINISHES

A. Door and frame: Mill finish aluminum with heavy bituminous coating where in contact with concrete.

B. Telescopic safety post: aluminum or stainless steel.

C. Springs: Electro-coated acrylic finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall conform to the manufacturer’s recommendations.

B. Frame shall be accurately cast in place and securely anchored to concrete. Installation of access doors after concrete is placed is not allowed.

C. Set frame level, plumb and in proper alignment with adjacent work.

D. Contractor shall field route a 1.5 inch Schedule 80 PVC drain pipe from the 1.5 inch drain coupling on all access doors to the water or floor level below. Place drain pipe clear of the access area below the door and as approved by the Owner's Representative.

3.03 REPAIR/RESTORATION

A. Repair finishes damaged during installation.

B. Remove and replace doors that are warped, bowed, or otherwise damaged.

3.04 ADJUSTING

A. Adjust doors and hardware after installation for proper operation.

3.05 CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer that will not damage finish.

3.06 FLOOR ACCESS DOOR SCHEDULE

Floor Access Doors						
Mark	Location/Room Number	Clear Opening Size [1]	Leafs	Loading	Fall Protection Grating	Comments
H-01	Valve Vault U03	4'-0" x 6'-0"	Double	300 psf	Yes	Three access hatches
H-02	Rinse Water Tank Roof Access Hatch	2'-6" x 4'-0"	Double	300 psf	Yes	Access to roof

Note:

1. *Clear opening is defined as the dimensions such that objects can pass through the floor access door. Lifting and other hardware shall be outside of the opening dimensions.*

END OF SECTION

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SECTION 08 62 23

TUBULAR DAYLIGHTING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tubular daylighting devices and accessories.

1.02 RELATED SECTIONS

A. Section 06100 [06 10 00] - Wood Framing; Site built wood curbs and nailers.

B. Section 074113.16 - Standing Seam Metal Roof Panels: Flashing of skylight base.

C. Section 07600 [07 60 00] – Flashing and Sheet Metal: Metal curb flashings.

D. REFERENCES

E. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

G. ASTM A 463/A 463M - Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process.

H. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process.

I. ASTM A 792/A 792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

J. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.

K. ASTM E 283 - Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

L. ASTM E 308 - Standard Practice for Computing the Colors of Objects by Using the CIE System.

M. ASTM E 330 - Structural Performance of Exterior Windows, Curtain Walls and Doors.

N. ASTM E 547 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference.

O. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

P. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane.

Q. ASTM D 635 - Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position.

R. ASTM D 1929 - Test Method for Ignition Properties of Plastics.

S. ASTM D 2843 – Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.

T. ASTM F 1642 – Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading.

U. ASTM F 2912 – Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading.

V. AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights; 2011.

W. FM Standard 4431 - The Approval Standard for Skylights.

X. GSA-TS01-2003: Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings.

Y. ICC-ES AC-16 - Acceptance Criteria for Plastic Skylights; 2008.

Z. IBC Section 1710 - Load Test Procedure for Wind Load Testing on Rooftop Daylight Collecting System - Structural Performance Testing - Devised by ATI PE); 2012.

AA. IBC Section 2606.7.2 – Installation – Diffuser Fall Out Test (Devised by PE); 2012.

1.03 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 greater than 99.5% percent for the Visible Light spectrum (400 nm to 700 nm) providing maximized visible light transmission and less than 25% 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 to ASTM E 308.

B. BRIGHTEN UP 160 DS

1. AAMA/WDMA/CSA 101/IS2/A440, Class CW-PG70 size tested 14 inch (356 mm), Type TDDCC.
    a. Air Infiltration Test: Air infiltration will not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
    b. Water Resistance Test:
        1) Passes water resistance; no uncontrolled water leakage with a pressure differential of 10.7 psf (512 Pa) or 15 percent of the design load (whichever is greater) and a water spray rate of 5 gallons/hour/sf for 24 minutes when tested in accordance with ICC-ES AC-16, ASTM E 547 and ASTM E 331.
    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 E 330.
        1) No breakage, permanent damage to fasteners, hardware parts, or damage to make system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 60 psf (2.87 kPa) in accordance with ICC AC-16 Section A, or Negative Load of 70 psf (3.35 kPA) if tested per ICC AC-16 Section B.
    d. Hurricane Resistance:
        1) Meets Florida Building Code TAS, 201, TAS, 202 and TAS 203 for Impact and non-impact components.
        2) Meets ASTM E 1886 and ASTM E1996 for missile and cyclic pressure differential testing.
    e. Fire Testing:
        1) When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code.
        2) Self-Ignition Temperature - Greater than 650 degrees F per ASTM D-1929.
        3) Smoke Density: Rating no greater than 450 per ASTM E 84 in way intended for use. Classification C.
        4) Rate of Burn and/or Extent: Maximum Burning Rate: 2.5 inches/min (62 mm/min) Classification CC-2 per ASTM D 635.
        5) Rate of Burn and/or Extent: Maximum Burn Extent: 1 inch (25 mm) Classification CC-1 per ASTM D 635.

1.04 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. QUALITY ASSURANCE

H. Manufacturer Qualifications: Engaged in manufacture of tubular daylighting devices for minimum 20 years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry, undamaged, seals and labels intact.

B. Store products in manufacturer's unopened packaging until ready for installation.

1.06 PROJECT CONDITIONS

A. 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.

1.07 WARRANTY

A. Daylighting Device: Manufacturer's standard warranty for 10 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Solatube International, Inc.; 2210 Oak Ridge Way, Vista, CA 92081. Tel. Toll Free: 888-765-2882. Tel: (760) 477-1120. Fax: (760) 597-4488. Email: commsales@solatube.com. Web: www.solatube.com.

B. Substitutions: As approved.

2.02 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. Brighten Up Series: Solatube Model 160 DS, 10 Inch Daylighting System.
    1. Model:
        a. Solatube Model 160 DS used for daylighting systems with suspended or hard ceilings. AAMA Type TDDCC.
    2. Capture Zone:
        a. Domes:
            1) Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.
                a) Outer Dome Glazing: Type DA, 0.125 inch (3 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.
                    (1) Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.
            2) Dome Seal: Polyethylene foam seal, black, 0.13 inch thick by 10.73 diameter, 2 PCF polyethylene foam.
            3) LightTracker Reflector, made of aluminum sheet, thickness 0.015 inch (0.4 mm) with Spectralight Infinity. Positioned in the dome to capture low angle sunlight.
        b. Dome Options:
            1) Dome Edge Protection Band: Type PB, for fire rated Class A, B or C roof applications. Aluminized steel nominal thickness of 0.028 inches (0.7 mm).
        c. Flashings:
            1) Roof Flashing Base:
                a) One Piece: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube. Sheet steel, corrosion resistant conforming to ASTM A 653/A 653M or ASTM A 463/A 463M or ASTM A792/A 792M, 0.028 inch plus or minus .006 inchthick.
                    (1) Base Flat: Flat Type F4, no pitch 4 inches (102 mm) high.
                    (2) Base Flat: Flat Type F6, no pitch 6 inches (152 mm) high.
                    (3) Base Pitched: Pitched Type FP, to match roof slope, 4 inches (102 mm) high.
                    (4) Flashing Options:
                b) Metal Roof Flashing Kit: Type MR, includes Butyl tape, flashing screws, speed nuts, corner washers and polyurethane sealant.
    3. Transfer Zone:
        a. Extension Tubes: Aluminum sheet, thickness 0.015 inch .
            1) Reflective Tubes:
                a) Reflective angle adapter tube (standard Top and Bottom Tubes), providing up to a 30-degree angle adjustment.
                b) Reflective extension tube, Type EXX and Type EL with total length of run per verified field conditions.
                c) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

2) Extension Tube Options
    a) Wire Suspension Kit: Type E, Use the wire suspension kit when additional bracing to the structure is required.
4. Thermal Insulation Panel: Type TIP, high-performance dual-glazed, tube insulation system.
5. Delivery Zone:
    a. Ceiling Ring: Injection molded impact resistant acrylic. Nominal thickness is 0.110 inches (2.8 mm).
    b. Ceiling Ring Seal: Polyethylene foam seal, white, 0.25 inch (6.4 mm) wide by 0.19 inch (4.8 mm) high, 2 PCF polyethylene foam with low-tack pressure sensitive adhesive.
    c. Upper glazing: PET GAG plastic with EPDM low density sponge seal to minimize condensation and bug, dirt, and air infiltration per ASTM E283. The nominal thickness is 0.039 inches (0.99 mm).
        1) Natural Effect Lens: Type LN.
        2) Square Diffuser Assemblies for Tubes Penetrating Ceilings: Ceiling mounted box transitioning from round tube to square ceiling assembly, supporting light transmitting surface at bottom termination of tube 10 inches by 10 inches square diffuser opening.
        3) Square OptiView Decorative Fixture: Type L11, molded polycarbonate plastic Fresnel Lens classified as CC1 material (nominal thickness is 0.022 inches (0.61 mm)) with white metal bezel (nominal thickness is 0.16 inches (4 mm)), and decorative metal fasteners.

2.03 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

3.01 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.

3.02 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.

3.03 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. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of Owner, Architect, or Contractor, or their designated representative. Correct if needed before proceeding with installation of subsequent units.

F. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

3.04 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.

3.05 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

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SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes commercial door hardware for the following:
   1. Swinging doors.
   2. Sliding doors.
   3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:
   1. Mechanical door hardware.
   2. Cylinders specified for doors in other sections.

C. Related Sections:
   1. Division 08 Section “Hollow Metal Doors and Frames”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
   1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   2. ICC/IBC - International Building Code.
   3. NFPA 70 - National Electrical Code.
   4. NFPA 80 - Fire Doors and Windows.
   5. NFPA 101 - Life Safety Code.
   6. NFPA 105 - Installation of Smoke Door Assemblies.
   7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
   1. ANSI/BHMA Certified Product Standards - A156 Series.
   2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
   3. ANSI/UL 294 - Access Control System Units.
   4. UL 305 - Panic Hardware.
   5. ANSI/UL 437- Key Locks.

1.03 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
   2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
   3. Content: Include the following information:
      a. Type, style, function, size, label, hand, and finish of each door hardware item.
      b. Manufacturer of each item.
      c. Fastenings and other pertinent information.
      d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
      e. Explanation of abbreviations, symbols, and codes contained in schedule.
      f. Mounting locations for door hardware.
      g. Door and frame sizes and materials.
      h. Warranty information for each product.
   4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Informational Submittals:
   1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.04 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.05 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
   1. Function of building, purpose of each area and degree of security required.
   2. Plans for existing and future key system expansion.
   3. Requirements for key control storage and software.
   4. Installation of permanent keys, cylinder cores and software.
   5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.06 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.07 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.08 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
   1. Structural failures including excessive deflection, cracking, or breakage.
   2. Faulty operation of the hardware.
   3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
   1. Quantity: Provide the following hinge quantity:
      a. Two Hinges: For doors with heights up to 60 inches.
      b. Three Hinges: For doors with heights 61 to 90 inches.
      c. Four Hinges: For doors with heights 91 to 120 inches.
      d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
   2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
      a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
      b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.
   3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
      a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
      b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
   4. Hinge Options: Comply with the following:
      a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:
    a. McKinney (MK) - TA/T4A Series, 5-knuckle.
    b. Approved equal.

2.02 SLIDING AND FOLDING HARDWARE

A. Sliding and Folding Door Hardware: Hardware is to be of type and design as specified and should conform with ANSI/BHMA A156.14.
    1. Sliding Bi-Passing Pocket Door Hardware: Provide complete sets consisting of track, hangers, stops, bumpers, floor channel, guides, and accessories indicated.
    2. Cascading: Provide a bi-parting or single direction telescoping system as required with a minimum 200 lb. per door capacity.
    3. Bi-folding Door Hardware: Rated for door panels weighing up to 125 lb.
    4. Pocket Sliding Door Hardware: Rated for doors weighing up to 200 lb.
    5. Manufacturers:
        a. Pemko (PE).
        b. Approved equal.

2.03 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.
    1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
    2. Furnish dust proof strikes for bottom bolts.
    3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
    4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
    5. Manufacturers:
        a. Rockwood (RO).
        b. Approved equal.

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
    1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
    2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
    3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
    4. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.

5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
6. Manufacturers:
    a. Rockwood (RO).
    b. Approved equal.

2.04 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.
1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):
1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.05 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
   1. Manufacturers:
      a. Lund Equipment (LU).
      b. MMF Industries (MM).
      c. Telkee (TK).

2.06 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.
   1. Manufacturers:
      a. Corbin Russwin Hardware (RU) - ML2000 Series.
      b. Approved equal.

2.07 DEADLOCKS AND LATCHES

A. Narrow Case Deadlocks and Deadlatches: ANSI/BHMA 156.13 Series 1000 Grade 1 narrow case deadlocks and deadlatches for swinging or sliding door applications. All functions shall be manufactured in a single sized case formed from 12 gauge minimum, corrosion resistant steel (option for fully stainless steel case and components). Provide minimum 2 7/8" throw laminated stainless steel bolt. Bottom rail deadlocks to have 3/8” diameter bolts.
   1. Manufacturers:
      a. Adams Rite Manufacturing (AD) - MS1850S / MS1950 Series.
      b. Approved equal.

2.08 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
   1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
   4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:
   1. Strikes for Mortise Locks and Latches: BHMA A156.13.
   2. Strikes for Bored Locks and Latches: BHMA A156.2.

3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.09 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
   1. Exit devices shall have a five-year warranty.
   2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
   3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
   4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
   5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
   6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
      a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
      b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
   7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
   8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
   9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
   10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
   11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.
   1. Provide exit devices with functions and features as follows.
      a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
      b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.

c. No catch points: addition of applied deflectors or other added components are not allowed.
d. No visible plastic.
e. Heavy duty end caps with flush and overlapping options made of stainless steel, brass, or bronze with architectural finishes.
f. Constructed of all stainless steel.
g. Stainless steel pullman type latch with deadlock feature.
h. Narrow or wide style exterior trim as specified in the hardware sets.
i. Center case adjustability on concealed vertical rod exit devices; single operation with hex key individually adjusts top or bottom latches. No retainer screws or clips required to maintain adjustment.
j. Ten-year limited warranty for mechanical features.

2. Manufacturers:
a. Corbin Russwin Hardware (RU) - PED4000 / PED5000 Series.
b. Approved equal.

2.10 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Heavy duty surface mounted door closers shall have a 30-year warranty.
2. Manufacturers:
a. Norton Rixson (NO) - 7500 Series.

b. Approved equal.

2.11 ARCHITECTURAL TRIM

A. Door Protective Trim
   1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
   2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
   3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
   4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
      a. Stainless Steel: 300 grade, 050-inch thick.
   5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
   6. Manufacturers:
      a. Rockwood (RO).
      b. Approved equal.

2.12 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
   1. Manufacturers:
      a. Rockwood (RO).
      b. Approved equal.

2.13 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
   1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
   1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:
   1. Pemko (PE).
   2. Approved equal

2.14 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

1.1 FINISHES

B. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

D. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
   1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
   1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
   3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
   4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.05 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.06 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.07 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.08 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

Hardware Sets

Set: 1.0

Doors: 102A

Description: EXT PAIR - FUTURE CHEM STORAGE

6	Hinge (heavy weight)	T4A3386 (NRP)	US32D	MK
1	Self Latching Flush Bolt	2845/2945 as Req'd	US32D	RO
1	Dust Proof Strike	570	US26D	RO
1	Concealed Vert Rod Exit	PED5859 N9CV59PT	630	RU
1	Concealed Vert Rod Exit, Exit Only	PED5801 EO	630	RU
1	Rim Cylinder	SFIC x Temp core as req'd - Coordinate with Owner for final keying instructions		
1	Permanent Core	SFIC type - Keyed to City Standards		
2	Surface Closer - Parallel Rigid Arm	PR7500	689	NO
2	Kick Plate	K1050 10" High CSK BEV	US32D	RO
2	Door Stop	466-RKW	Black	RO
1	Astragal	305CN		PE
1	Gasketing (Head)	2891AS		PE
2	Gasketing (Jambs)	290AS		PE
2	Door Bottom	210APK		PE
1	Threshold	2727A or Per Sill Detail		PE
1	Position Switch	DPS		SU

Notes: Wiring to door position switch by Security Contractor.

- Door position switch monitors open/closed status.

Set: 2.0

Doors: 101A

Description: EXT SGL - MAINTENANCE

3	Hinge, Full Mortise	TA2314 (NRP)	US32D	MK
1	Storeroom Lock	ML2057 NSA LC	630	RU
1	Mortise Cylinder	SFIC x Temp core as req'd - Coordinate with Owner for final keying instructions		
1	Permanent Core	SFIC type - Keyed to City Standards		
1	Surface Closer - Tri-pack	7500 Mounting as Req'd	689	NO
1	Kick Plate	K1050 10" High CSK BEV	US32D	RO
1	Door Stop	441H	US26D	RO
1	Gasketing	303AS		PE
1	Door Bottom	210AV		PE
1	Threshold	2727A or Per Sill Detail		PE
1	Position Switch	DPS		SU

Notes: Wiring to door position switch by Security Contractor.

- Door position switch monitors open/closed status.

Set: 3.0

Doors: 102C

Description: INT SGL - CLOSET (POCKET DOOR)

1	Pocket Door Track Kit	PF28200A		PE
1	Pocket Door Kit (req'd for 1-3/4" Door)	PF134KIT		PE
1	Mortise Deadlock	MS1850SN450 450	628	AD
1	Mortise Cylinder	SFIC x Temp core as req'd - Coordinate with Owner for final keying instructions		
1	Permanent Core	SFIC type - Keyed to City Standards		
2	Flush Pulls	BF97L x BF97 BTB Mtg.	US32D	RO

1	Position Switch	DPS		SU

Notes: Wiring to door position switch by Security Contractor.

- Door position switch monitors open/closed status.

Set: 4.0

Doors: 100A

Description: EXT SGL - RR

3	Hinge, Full Mortise	TA2314 (NRP)	US32D	MK
1	Security Entrance Lock w/Occupancy Indicator	ML2075 NSA M34 V21 LC	630	RU
1	Mortise Cylinder	SFIC x Temp core as req'd - Coordinate with Owner for final keying instructions		
1	Permanent Core	SFIC type - Keyed to City Standards		
1	Surface Closer - Tri-pack	7500 Mounting as Req'd	689	NO
1	Mop Plate	K1050 6" High CSK BEV	US32D	RO
1	Wall Stop	403	US26D	RO
1	Gasketing	303AS		PE
1	Sweep	315CN		PE
1	Threshold	2727A or Per Sill Detail		PE
1	Position Switch	DPS		SU

Notes: Wiring to door position switch by Security Contractor.

- Door position switch monitors open/closed status.

END OF SECTION

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SECTION 08 91 19

FIXED LOUVERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies intake and exhaust air louvers and accessories.

B. Performance and Design Requirements:
   1. General: Louver shall be suitable for air supply or discharge service and shall be sized as shown on the drawings.

1.02 QUALITY ASSURANCE

A. Reference:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AA 45	Designation System for Aluminum Finishes
AMCA Standard 500	Test Methods for Louvers, Dampers, and Shutters
ASTM B221	Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
ASTM C1071	Standard Specification for Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material)

B. Certification:
   1. Louvers shall bear the AMCA certified ratings seal for both air performance and water penetration.

1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Design-Builder, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Design-Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Design-Builder with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' certificates of compliance with specified industry standards.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Louvers shall be Airolite, Construction Specialties, Ruskin, or equal, modified to provide the specified features.

2.02 MATERIALS

Component	Material
Blades	ASTM B221, 6063-T52 extruded aluminum alloy
Frame	ASTM B221, 6063-T52 extruded aluminum alloy
Fasteners	Stainless steel or aluminum
Bird screen	Aluminum

2.03 EQUIPMENT FEATURES

A. Blades:
   1. Blades shall be of the fixed, drainable type with interlocking blade braces to provide an uninterrupted horizontal line. Blades for all louvers shall be minimum 0.081 inch (12 gage) thick. Slideable interlocked mullions shall have provisions for expansion and contraction.

B. Frame:
   1. The frame shall be minimum 0.081 inch (12 gage) thick for all louvers. The louver frame shall be assembled by welding. The head, sill, and jamb shall be one-piece structural members and shall have an integral calking slot and retaining bead.

C. Screen:
   1. The louver shall be furnished with a removable bird screen constructed of 1/2-inch mesh, 16-gage (0.063 inch) wire and secured within a 10-gage extruded aluminum frame. The screen shall be mounted on the interior louver face but independent of the louver.

D. Finishes:
   1. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide a four-coat system.
   2. Color: Full selection of manufacturer's standard, custom and premium colors for final selection by Owner.
   3. Product and Manufacturer:
      a. Duranar Metallic XL Specialty Color 4-Coat System by PPG Industries Coatings and Resin Division, Incorporated.
      b. or approved equal.

2.04 COMBINATION LOUVERS

A. Combination louver shall be a stationary blade type louver and adjustable blade damper mounted together in a common frame. The stationary louver and frame shall be as specified in paragraphs 2.02 and 2.03. The adjustable blades shall be extruded 6063T5 aluminum, 0.125 inch (8 gage) thick. The adjustable blade linkage shall be concealed in the louver frame and located out of the air stream. Vinyl edge seals shall be provided on the damper blades. The adjustable blades shall pivot on 1/2-inch diameter aluminum or steel pins located at the blade ends and attached to the operator linkage. The pivot pins shall be mounted on self-lubricating nylon or oil impregnated bronze bearings. Jamb seals shall be provided to prevent air leakage around closed damper blades.

2.05 OPERATORS

A. Electric Actuators:
   1. Operators for combination louvers, where specified, shall be 120-volt motor actuators provided complete with all necessary linkage to position the damper throughout its full operating range. The actuator shall be mounted on the outside of the louver frame and shall have sufficient torque to position the size of damper served at the specified conditions. The damper area served by each operator shall not exceed the maximum area recommended by the actuator manufacturer. Time required for the operator's full stroke shall not exceed 1 minute.

B. Pneumatic Actuators:

1. Operators for combination louvers, where specified, shall be piston, rolling diaphragm type pneumatic actuators provided complete with all necessary linkage to position the damper throughout its full operating range. The actuator shall be mounted outside of the louver frame and shall have sufficient torque and length of travel to accurately position the size of damper served at the specified conditions. The damper area served by each actuator shall not exceed the maximum area recommended by the actuator manufacturer. Time required for the operator's full stroke shall be 1 minute.

2.06 PRODUCT DATA

A. Certified results of pressure drop test data and water penetration data for all louvers shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. The louver shall be aligned, connected, and installed as specified and in accordance with the manufacturer's recommendations. A bituminous coat shall be applied to all aluminum surfaces in contact with concrete or masonry.

3.02 TESTING

A. After completion of installation, all louvers with operating dampers, both manually and automatically operated, shall be completely field tested to ensure compliance with these specifications.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interior gypsum board.
   2. Tile backing panels.

B. Related Requirements:
   1. Section 09 30 13 – Ceramic Tiling for cementitious backer units installed as substrates for ceramic tile.
   2.

1.02 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Gypsum wallboard.
   2. Gypsum board, Type X.
   3. Gypsum ceiling board.
   4. Cementitious backer units.
   5. Water-resistant gypsum backing board.
   6. Interior trim.
   7. Joint treatment materials.

B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.

C. Samples: For the following products:
   1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

D. Samples for Verification: For the following products:
   1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.03 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.04 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 PRODUCTS

2.01 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.02 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

2.03 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Manufacturers: Subject to compliance with requirements, provide all products by one of the following:
   1. Certainteed; SAINT-GOBAIN.
   2. James Hardie Building Products, Inc.
   3. National Gypsum Company.
   4. USG Corporation.

2.04 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

B. Gypsum Board, Type X: ASTM C1396/C1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C1396/C1396M.
   1. Thickness: 5/8” inch.
   2. Long Edges: Tapered.

D. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Core: 5/8 inch , Type X.
   2. Long Edges: Tapered.
   3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.05 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
   1. Thickness: 5/8 inch
   2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.06 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. L-Bead: L-shaped; exposed long flange receives joint compound.
      d. Expansion (control) joint.

2.07 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
      a. Use setting-type compound for installing paper-faced metal trim accessories.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound

D. Joint Compound for Tile Backing Panels:
   1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.08 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
   1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. EXECUTION

2.09 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.10 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

2.11 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Wallboard Type: As indicated on Drawings and Vertical surfaces unless otherwise indicated.
   2. Type X: As indicated on Drawings and Where required for fire-resistance-rated assembly
   3. Ceiling Type: As indicated on Drawings and Ceiling surfaces unless otherwise indicated
   4. Mold and Moisture-Resistant Type: Provide in moisture sensitive areas and on walls that have plumbing fixtures. Side walls within twenty-four inches of plumbing fixtures will also receive mold and moisture resistant gypsum board.

B. Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
   3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

2.12 INSTALLATION OF TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated on Drawings.

B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

2.13 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on shop drawings and according to ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.

2. LC-Bead: Use at exposed panel edges
3. L-Bead: Use where indicated on Drawings

2.14 FINISHING OF GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in Section 09 91 24 – Interior Painting.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

2.15 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Glazed wall tile.
   2. Waterproof membranes.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:
   1. Product Data: For adhesives, indicating VOC content.
   2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
   3. Laboratory Test Reports: For sealers, indicating compliance with requirements for low-emitting materials.

C. Samples:
   4. Each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide samples of each color blend.
   5. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required.
   6. Stone thresholds.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from the same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.05 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain tile of each type from one source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:
   1. Joint sealants.
   2. Metal edge strips.

D. PRODUCTS

1.06 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

1.07 TILE PRODUCTS

A. Ceramic Wall Tile Type TW-1
   1. Manufacturers: Subject to compliance with requirements, provide basis of design product or comparable product by one of the following
      a. Basis of Design: Color Wheel Linear by Daltile; a brand of Dal-Tile Corporation.
      b. American Olean; a brand of Dal-Tile Corporation.
      c. Seneca Tiles, Inc.
   2. Certification: Tile certified by the Porcelain Tile Certification Agency.
   3. Face Size (TW-1): 4 inches by 12 inches
   4. Face Size Variation: Non-Rectified.
   5. Thickness: 5/16 inch
   6. Face: As indicated.
   7. Dynamic Coefficient of Friction: N/A.
   8. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
   9. Grout Color: As selected by Architect from manufacturer's full range.
   10. WATERPROOF MEMBRANES

B. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

C. Waterproof Membrane, Polyethylene Sheet: Polyethylene faced on both sides with fleece webbing; 0.008-inch nominal thickness.

D. Verify adhesives have a VOC content of 65 g/L or less.

1.08 SETTING MATERIALS

A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
   1. For wall applications, provide nonsagging mortar.

PART 2 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.
   a. Dry, redispersible form, prepackaged with other dry ingredients.
   b. Liquid-latex form for addition to prepackaged dry-grout mix.

C. Water Cleanable epoxy grout: ANSI A118.3 with a VOC content of 65 g/L or less.

D. MISCELLANEOUS MATERIALS

E. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

F. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless steel, ASTM A276/A276M or ASTM A666, 300 Series exposed-edge material.

G. EXECUTION

2.02 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
   2. Verify that concrete substrates for tile floors installed with adhesives bonded mortar bed or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.03 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

2.04 INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
   1. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

B. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

C. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

D. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.

E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
   1. Porcelain Tile: 1/8 inch unless recommended otherwise by manufacturer.

G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

I. Metal Edge Strips: Install at exposed edge of tile flooring meets other flooring that finishes flush with top of tile.

J. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

K. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

L. INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

M. Interior Floor Installations, Concrete Subfloor:
   1. Interior Wall Installations, Metal Studs or Furring:
   2. Ceramic Tile Installation TCNA W244F: Thinset mortar on fiber-cement backer board over bonded waterproof membrane.
      a. Tile Type: Ceramic
      b. Thin-Set Mortar: Modified dry-set mortar.
      c. Grout: High performance unsanded cement grout.

END OF SECTION

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SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Thermoset-rubber base (TS).
   2. Resilient molding accessories.

B. Related Requirements:
   1. Section 09 65 19 “Resilient Tile Flooring” for floor coverings associated with resilient base and accessory installation.
   2. “Finish Schedule and Legend” for designations associated with resilient base and accessory installation as shown on the drawings

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

1.03 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.05 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 PRODUCTS

2.01 THERMOSET-RUBBER BASE (RB-1)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flexco
   2. Johnsonite; a Tarkett Company.
   3. Roppe Corporation, USA.
   4. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
   5. Style and Location:
      a. Cove Style: All Locations.

B. Thickness: 0.125 inch.

C. Height: 6 inches.

D. Lengths: Coils in manufacturer's standard length.

E. Outside Corners: Job formed.

F. Inside Corners: Job formed.

G. Colors: As indicated in the drawing set, “Finish Schedule and Legends”.

2.02 RESILIENT MOLDING ACCESSORY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flexco.
   2. Johnsonite; a Tarkett Company.
   3. Roppe Corporation, USA.
   4. Description: Rubber reducer strip and transition strip for resilient floor covering.

B. Profile and Dimensions: As indicated.

C. Locations: Provide rubber molding accessories in areas indicated in drawings.

D. Colors and Patterns: As selected by Architect from full range of industry colors.

2.03 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

C. Metal Edge Strips: Extruded aluminum with mill finish of wide shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.03 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhered resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 8 inches in length.
      a. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 8 inches in length.
      a. Miter or cope corners to minimize open joints.

3.04 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum horizontal surfaces thoroughly.
   3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 09 67 23

RESINOUS FLOORING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. High-performance resinous flooring systems.
   2. Integral cove base

B. Related Sections:
   1. Concrete – Section 03 30 00

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Data must state that moisture testing is not required

B. Installer Certificates for Qualification: Signed by manufacturer certifying that installers comply with specified requirements.

C. Material Certificates: For each resinous flooring component, from manufacturer.

D. Material Test Reports: For each resinous flooring system.

E. Maintenance Data: For maintenance manuals.

F. Samples: Submit one sample of coating, indicating coating applied on horizontal surfaces. Sample shall illustrate transition from Resinous Flooring system. Provide sample which is a true representation of proposed field applied finish-created by the contractor; not laboratory applied finish. Provide minimum 12 feet by 4 feet field sample color and four (4) texture options for owner approval as a mockup at location designated by General Contractor for review and written approval prior to installation of any other areas.

G. Product Schedule: For resinous flooring.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
   1. Engage an installer who is approved in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
   2. Installer Letter of Certification: Installer to provide letter stating that they have been in business for at least 10 years and listing 5 projects in the last 2 years of similar scope. For each project provide: project name, location, date of installation, contact information, size of project, and manufacturer of materials with system information.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Pre-installation Conference: Conduct conference at Project site before work and mockups begin.

D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full-thickness mockups on 48-inch square floor area selected by Architect.
   2. Simulate finished lighting conditions for Architect's review of mockups.
   3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
   4. Mockup shall demonstrate desired slip resistance for review and approval by General Contractor prior to installing project areas.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by:
   1. The Sherwin Williams Company, Cleveland, OH.
   2. Approved equal.

B. Bases of Design, CONC-1 and CONC-1B: Polycrete MD with Resuflor 3741 finish.
   1. Slurry: Dur-A-Flex, Polycrete MD at 3/16”
   2. Broadcast: 5310 Dry Silica (20-40 mesh) into wet slurry.

3. Topcoat: Resuflor 3741 @ 15 mil, 100 sf/gal.
4. Total System Thickness 1/4” nominal.

C. Wall finish, EP-1: Resuprime 3579 with Resuflor 3741 finish
1. Epoxy Primer: Resuprime 3579
2. Topcoat: Resuflor 3741

2.02 MATERIALS

A. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24)].
1. Resinous Flooring: 100 g/L.

2.03 HIGH - PERFORMANCE RESINOUS FLOORING

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance, resin-based, monolithic floor surfacing designed to produce a seamless floor.

B. System Characteristics:
1. Color and Pattern: As indicated from manufacturers listed above.
2. Slip Resistance: Provide slip resistant finish.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspection: Prior to commencing Work, thoroughly examine all underlying and adjoining work, surfaces and conditions upon which Work is in any way dependent for perfect results. Report all conditions which affect Work. No "waiver of responsibility" for incomplete, inadequate or defective underlaying and adjoining work, surfaces and conditions will be considered, unless notice of such unsatisfactory conditions has been filed and agreed to in writing before Work begins. Commencement of Work constitutes acceptance of surfaces.

B. USE ONLY MOISTURE INSENSITVE SYSTEMS, that require no moisture testing and warrantied by manufacturer. No systems allowed that require moisture testing.

C. Only installers approved by the manufacturer in writing shall perform installation of the material.

D. Surface Preparation: Remove all surface contamination, loose or weakly adherent particles, laitance, grease, oil, curing compounds, paint, dust and debris by blast track method or approved mechanical means (acid etch not allowed). If surface is questionable, try a test patch. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 03732 to achieve CSP 4.

3.02 ENVIRONMENTAL CONDITIONS

A. All applicators and all other personnel in the area of the RF installation shall take all required and necessary safety precautions. All manufacturers' installation instructions shall be implicitly instructions shall be implicitly followed.

B. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

C. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

E. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.03 APPLICATIONS

A. Install resinous floor over properly prepared concrete surface in strict accordance with the manufacturer's directions.
   1. Install the primer and/or base coats over thoroughly cleaned and prepared concrete.
   2. Install topcoat over flooring after excess aggregate has been removed.
   3. Maintain a slab temperature of 60°F to 80°F for 24 hours minimum before applying floor topping.

B. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

C. Sealant: Saw cut resinous floor topping at expansion joints in concrete slab. Fill sawcuts with sealant prior to final seal coat application. Follow manufacturer's written recommendations.

D. Apply primer over prepared substrate at manufacturer's recommended spreading rate.

E. Slip Resistant Finish: Provide grit for slip resistance.

F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

G. Cove Base: Apply cove base mix to wall surfaces at locations shown to form cove base height shown in drawing. Follow manufacturer's printed instructions and details including taping, mixing, priming, troweling, sanding, and top coating of cove base

H. Wall finish: Apply primer and 2 coats of finish coating, height shown in drawing. Follow manufacturer's printed instructions

3.04 COMPLETED WORK

A. Cleaning: Upon completion of the Work, clean up and remove from the premises surplus materials, tools, appliances, empty cans, cartons and rubbish resulting from the Work. Clean off all spattering and drippings, and all resulting stains.

B. Protection: Protect Work in accordance with manufacturer's directions from damage and wear during the remainder of the construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

C. Contractor shall insure that coating is protected from any traffic until it is fully cured to the satisfaction of the coating manufacturer.

END OF SECTION

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SECTION 09 90 00

GENERAL COATING SPECIFICATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section specifies coating system materials, surface preparations, application, and minimum quality control (QC) requirements.
      a. For architectural painting and coating systems refer to Sections 09 91 14 and 09 91 23 and finish schedule provided on the Drawings.
   2. This Section includes:
      a. All substrates exposed to non-corrosive or moderately corrosive environment.
      b. Atmospheric, weathering exposure, non-corrosive building exposure conditions and piping, equipment, and structures not exposed to immersion services or corrosive headspace (gaseous) exposures, and
      c. Immersed ferrous substrates.
   3. The Contractor is solely responsible for all aspects of QC inspections for the work covered by this Section. The QC inspection personnel and coating manufacturer technical representative (CTR) are provided by the General Contractor at no additional cost to the Owner. Inspections, testing, or other forms of quality checks may be provided by the Construction Manager for quality assurance (QA) checks but in no way relieve the Contractor of sole responsibility for quality and performance of the installed coating system.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 80 Environmental Conditions
   2. Section 01 33 00 Submittal Procedures
   3. Section 01 45 00 Contractor Quality Control
   4. Section 01 45 23 Testing and Inspection Services
   5. Section 01 61 45 Area Exposure Designations
   6. Section 01 66 00 Product Storage and Handling
   7. Section 01 99 00 Reference Forms
   8. Section 07 10 00 Damproofing and Waterproofing
   9. Section 09 91 14 Exterior Painting
   10. Section 09 91 23 Interior Painting

1.03 DEFINITIONS

A. Specific coating terminology used in this Section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions.
   1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.

2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed by compressed air.
3. AMPP: Association for Materials Protection and Performance (Merger of National Association of Corrosion Engineers and Society for Protective Coatings).
4. Anchor Pattern: Profile or texture of prepared surface(s).
5. ANSI: American National Standards Institute.
6. Bug Holes: Cavities or air voids resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.
7. Coating Thickness: The total dry film thickness of primer, intermediate, and/or finish coats.
8. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section.
9. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.
10. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the independent technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR. This refers to a CSM technical representative and not a sales or marketing representative. The cost of this independent technical representative is the responsibility of the General Contractor.
11. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.
12. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). DFT is the thickness of a coating as measured above the substrate.
13. Dry Spray: Dry, flat, probably textured coating surface when spray gun held too far from substrate.
14. Drying Time or curing time: Time interval between application and curing of material before exposure to service conditions.
15. Dry to Recoat: Time interval between application of material and ability to receive next coat.
16. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.
17. Feather Edging: Reducing the thickness of the edge of paint.
18. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.
19. Field Coat: The application or the completion of application of the coating system after installation of the surface receiving coating at the site of the work.
20. Fish Eyes: Separation or pulling apart of wet film of coating to expose underlying film or substrate.
21. Flash Report: A report by email or text to the Construction Manager and Engineer identifying issues requiring immediate attention and approval.
22. Hold Point: A defined point, specified in this Section, at which work shall be halted for a quality inspection.
23. Holiday: A discontinuity, skip, or void in coating or coating system film that exposes the substrate.
24. Honeycomb: Segregated condition of hardened concrete due to non-consolidation.

25. ICRI: International Concrete Repair Institute.
26. Incompatibility: Inability of a coating to perform well over another coating because of lack of cure of prior coating, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.
27. Laitance: A layer of weak, non-durable concrete containing cement fines that are brought to the surface through bleed water because of concrete finishing and/or over-finishing.
28. LEED: Leadership in Energy and Environmental Design certification program by the US Green Building Council.
29. Mil: 0.001 inch, one thousandth of an inch.
30. Mudcracking: Deep irregular cracks in coating that resemble dried mud caused by non-flexible coatings applied too thickly or built-up in corners.
31. NACE: National Association of Corrosion Engineers to be renamed Association of Materials Performance and Protection or AMPP.
32. NAPF: National Association of Pipe Fabricators.
33. Certified Coatings Inspector: Must be AMPP Certified to Level 3 and have at least 10 years' experience in wastewater coatings inspection.
34. Overspray: Coating spray, particularly such coating that failed to strike the intended surface and ended up on surfaces not to be coated.
35. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.
36. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.
37. QA: Quality Assurance
38. QC: Quality Control
39. QCP: Quality Control Person representing the Contractor and responsible for QC Testing, Inspection and associated documentation.
40. Quality Control Testing and Inspection Plan (QCTIP).
41. Repair Mortars: Cementitious, polymer modified cementitious, or polymer-based mortars used to restore concrete or masonry substrates to overall continuous, coatable surfaces by filling voids and excess substrate profile that cannot be hidden by the DFT of the coating system.
42. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces at typically shallow depths up to 1/4 inch thick.
43. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.
44. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.
45. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
46. SSPC: The Society for Protective Coatings soon to become part of AMPP.
47. Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall be applied prior to full coat application.

48. Saturated Surface Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
49. Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.
50. Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
51. TPC: Technical Practice Committee.
52. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).
53. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in a liquid such as water or wastewater at least intermittently if not constantly.
54. Weld Spatter: Beads of metal scattered near seam during welding.
55. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

1.04 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, use the last version of the document before it was discontinued.

Reference	Title
ANSI/ASC 29.4 Exhaust Systems	Abrasive Blasting Operations – Ventilation and Safe Practice
ANSI/NSF 61/600	Drinking Water System Components Health Effect
ANSI B74.18	Grading of Certain Abrasive Grain on Coated Abrasive Material
ASTM C1583	Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method)
ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
ASTM D2200 (SSPC-VIS1)	Pictorial Surface Preparation Standards for Painting Steel Surfaces
ASTM D3359	Standard Test Methods for Rating Adhesion by Tape Test
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces

Reference	Title
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness by Notch Gages
ASTM D4541	Standard Test Methods for Pull-Off Strength of Coatings on Metal Substrates Using Portable Adhesion Testers
ASTM 5402	Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
ASTM D6677	Standard Test Method for Evaluating Adhesion By Knife
ASTM D7234	Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
ASTM E337	Standard Test Method for Measuring Humidity With a Psychrometer
ASTM F22	Water Break Test
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	Standard Test Method for Measuring Relative Humidity in Concrete Floor Slabs Using Insitu Probes.
FS 595b	Federal Standard Colors
ICRI 310.2	Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
ISO 8502-3 (Part 3)	Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
NACE Publication 6D-163	A Manual for Painter Safety
NACE Publication 6G-164 A	Surface Preparation Abrasives for Industrial Maintenance Painting
NACE Standards	National Association of Corrosion Engineers, TPC.
NACE Standard RP0188	Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NAPF 500-03	Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings
NAPF 500-03-04	Abrasive Blast Cleaning for Ductile Iron Pipe
NAPF 500-03-05	Abrasive Blast Cleaning for Cast Ductile Iron Fittings
OSHA 1910.144	Safety Color Code for Marking Physical Hazards
OSHA 1915.35	Standards – 29CFR – Painting
SSPC-AB 1	Mineral and Slag Abrasives
SSPC-PA 1	Shop, Field, and Maintenance Painting of Steel
SSPC-PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC-PA 9	Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages
SSPC-PA Guide 1	Guide for Illumination of Industrial Painting Project
SSPC-PA Guide 3	A Guide to Safety in Paint Application
SSPC-PA Guide 6	Guide for Containing Debris Generated During Paint Removal Operations
SSPC-PA Guide 11	Guide for Protecting Corners, Edges, Crevices and Irregular Steel Geometries by Stripe Coating
SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning
SSPC-SP 5/NACE #1	White Metal Blast Cleaning

Reference	Title
SSPC-SP 6/NACE #3	Commercial Blast Cleaning
SSPC-SP 7/NACE #4	Brush-Off Blast Cleaning
SSPC-SP 10/NACE#2	Near-White Blast Cleaning
SSPC-SP 11	Power Tool Cleaning to Bare Metal
SSPC SP WJ-1/NACE WJ-1	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating-Clean to Bare Substrate
SSPC SP WJ-2/NACE WJ-2	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating-Very Thorough Cleaning
SSPC SP WJ-3/NACE WJ-3	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating-Thorough Cleaning
SSPC SP WJ-4/NACE WJ-4	Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating-Light Cleaning
SSPC-SP 13/NACE #6	Surface Preparation of Concrete
SSPC-SP 16	Brush-off Blast Cleaning Non-Ferrous Metals
SSPC SP-CAB 1	Abrasive Blast Cleaning of Concrete and Cementitious Materials – Thorough Cleaning
SSPC SP-CAB 2	Abrasive Blast Cleaning of Concrete and Cementitious Materials – Intermediate Cleaning
SSPC SP-CAB 3	Abrasive Blast Cleaning of Concrete and Cementitious Materials – Brush Blast Cleaning
AMPP SP21548	Pressurized Water Cleaning of Concrete and Cementitious Materials- Thorough Cleaning
SSPC-TR2	Wet Abrasive Blast Cleaning
SSPC-TU-3	Overcoating
SSPC-Guide 15	Field Methods for Retrieval and Analysis of Soluble Salts on Substrates.
SSPC V2	Systems and Specifications: Steel Structures Painting Manual, Volume 2
SSPC-VIS 1	Visual Standard for Abrasive Blast Cleaned Steel
SSPC-VIS 3	Visual Standard for Power and Hand – Tool Cleaned Steel
SSPC-VIS 4	Visual Standards (Water-jetting)
SSPC-VIS 5	Visual Standards (Wet Abrasive Blast Cleaning)
WPCF Manual of Practice No. 17	Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications.
LEED	Leadership in Energy and Environmental Design

1.05 QUALITY ASSURANCE

A. Standardization:

1. Provide materials and supplies that are standard products of CSMs. Provide materials in each coating system from a single CSM.
2. The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Engineer that they are equal in generic resin type, composition, durability, range of film thickness, and usefulness, for the purpose intended. Requests for consideration of CSMs other than those specified in this Section will be considered, provided the following minimum conditions are met.
    a. The proposed coating system uses an equal or greater number of separate coats to achieve the required total DFT.
    b. The proposed coating system uses coatings of the same generic type as that specified including curing agent type.

c. Include information listed in paragraph 1.07, demonstrating that the proposed CSM's product is equal to the specified coating system.

d. Provide a list of Contractor and CSM references for the proposed product in similar situations where the coating of the same generic type has been applied. Include the project name, city, state, owner, phone number of owner; coating system reference and number from this Section 09 90 00; type of facility in which it was used, generic coating type, and year coating was applied.

e. Alternate coating systems submitted by the Contractor must be approved by the Engineer. There is no guarantee that alternate systems will be approved, and this is left exclusively up to the discretion of the Engineer. At least 3 competitive products have been provided in this Specification. The Contractor is encouraged to submit one of the specified coating systems.

f. At any time when there is conflict between the CSM's product data and the COAT SPEC requirements regarding surface preparation, material application, or any other coating details, the more stringent requirements will take precedent.

B. Shop and Field Contractors Quality Control Requirements:

1. Prior to any work, hold a pre-construction meeting with the coating subcontractor and coating system manufacturer's technical representatives (CTR) to review the scope of work, the accepted submittals and any comments, and review all surface preparation, application, curing, mixing, storage, and overall QC and testing requirements. Provide a minimum of 48 hours' notice to the Engineer and Owner in case they desire to attend the meeting.
2. The Contractor is solely responsible for the workmanship and quality of the coating system installation by the Contactor's CSA. Inspections by the Construction Manager, the Engineer, the Owner, or the CTR will not relieve or limit the Contractor's responsibilities for the quality of the coating system.
3. Conform to requirements of this specification and the standards referenced in this Section. Changes in the coating system installation requirements will be allowed only with the written acceptance by the Engineer and CSM before work commences.
4. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section. The CTR to verify in writing that the Contractor's personnel installing the coating systems covered by this Section have the appropriate training and/or experience to properly perform the coating systems work.
5. Provide a Quality Control Person (QCP) who is a certified NACE, SSPC, or AAMP Coatings Inspector with at least 5 years of experience inspecting coating work similar to the work covered by this Section. The QCP to perform all QC inspection testing and inspection tasks while fully documenting all efforts required by these specifications and/or additional CSM's requirements.
6. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
7. For repairs, I provide the same products, or products recommended by the CSM, as used for the original coating.
8. Identify the points of access for inspection by the Owner, Engineer and/or Construction Manager. Provide ventilation, ingress and egress, and other means necessary for the Engineer, Owner, or Construction Manager's personnel to safely access the work areas.

9. Contractor's CSA to conduct the work so that the coating system is installed as specified and inspect the work continually to ensure that the coating system is installed as specified. Correct coating system work that does not conform to the specifications or is otherwise not acceptable to the as-specified requirements at no additional cost to the Owner.
10. Provide full time inspection with trained and certified quality control (QC) inspectors performing all QC procedures as the coating work proceeds in accordance with the requirements of this section. Minimum qualifications for QC inspectors on concrete projects is AMPP-CCI Level 1 with a minimum of 3 years' experience in QC processes, providing they are under the direct supervision of a AMPP Certified CCI Level 2 Concrete Coatings Inspector. On non-concrete related project, the minimum QC inspector is AMPP Basic Coating Inspector (NACE/SSPC Level 1) with a minimum of 3 years' experience in QC processes, providing they are under the direct supervision of a AMPP Certified Coatings Inspector (NACE/SSPC Level 2) or AMPP Senior Coatings Inspector (NACE/SSPC Level 3) in good standing, with at least 10 years of similar coatings work experience. An AMPP Basic Coating Inspector (NACE/SSPC Level 1) with a minimum of 3 years' experience in QC processes, providing they are under the direct supervision of a AMPP Certified Coatings Inspector (NACE/SSPC Level 2) or AMPP Senior Coatings Inspector (NACE/SSPC Level 3) in good standing, with at least 10 years of similar coatings work experience may be acceptable providing the AMPP Basic, AMPP Certified and AMPP Senior coating inspectors can each can show verifiable proof of performing inspection successfully on 5 verifiable concrete projects similar in size and scope as the project that is part of this specification.
11. The Contractor's QC personnel to measure DFT of metal surfaces as per SSPC-PA2. Take measurements as often as necessary to ensure the DFT requirements of the specification are met. Measure DFT of metallic surfaces using Type II Magnetic (Ferrous) and Type II Eddy Current Non-Ferrous) Dry Film Thickness gauges. Use only gauges calibrated within 1 year of use. Perform testing of DFT on concrete substrates as per SSPC-PA9 using Ultrasonic DFT gauges or another suitable method (e.g., Calculating material usage vs square feet coverage) to ensure DFT requirements are met.
12. Contractor/CSA to submit for approval a QCTIP for the work covered by this Section (see 00 97 00A Inspection Check List). List all tests and inspection tasks in the QCTIP including referenced and applicable standards to be conducted and the frequency in which these tests or tasks will be performed. This frequency can be addressed for certain tests such as air and substrate temperature or dew point on an hourly per shift basis. Or this frequency can be addressed on a per number of square feet basis for tests and tasks such as wet and DFT tests or adhesion tests. Include in the QCTIP a written record which identified when (time and date) work not conforming to the specification requirements is identified, a written record of the proposed corrective actions for such non-conforming work and a record of when that action was performed (time and date). Describe all corrective action for non-conforming work in detail with referenced digital photographs taken of the re-work for subsequent review by the Owner's representative.

13. Complete the Coating System Quality Control Checklist, Form 09 90 00-A, included in Section 09 90 00 –Part 4 for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Quality Control Checklist. For each portion of the work, install the coating system, document all QC measures performed, and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Quality Control Checklist, sign the checklist indicating that the work has been installed and inspected as specified and attach a final copy of all individual QC checks or test results as applicable and required.
14. Submit a daily QC inspection report from the QCP that describes and documents all QC tests and inspection tasks performed including frequency of performance and test results (including test data) and referenced standard followed for each shift the CSA works. Submit these reports on the morning of the following day the work was performed to the Construction Manager. Include with the daily QC report a written account of all non-conforming work, subsequent corrective measures and annotated digital photographs. Submit a standard inspection form to be used for these reports for review by the Engineer. CSA's QC Inspector to use approved inspection report forms to record all QC inspection and testing throughout the performance of the coating work.

C. Quality Control Hold Points:
   1. The Contractor's QCP to conduct QC inspections of the coating work as it proceeds to meet all specified quality requirements. In addition, conduct inspection at Hold Points during the coating system installation and record the results on Form 09 90 00-A. Coordinate Hold Points with the CTR, Engineer and Construction Manager so they Construction Manager or Engineer may observe the Quality Control inspections on a scheduled basis. Provide the Construction Manager or Engineer a minimum of 1 days' notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:
      a. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, measure and record ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. Confirm the weather and/or environmental conditions within the structure comply with the requirements specified by the CSM.
      b. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, perform cleaning to remove all oil, grease, dirt, soluble salts, and all other foreign contaminants from the surface.
      c. Monitoring of Surface Preparation. Spot check degree of cleanliness, surface profile, and surface pH testing, as required. Confirm compressed air used for surface preparation or blow down cleaning is free from oil and moisture.
      d. Post Surface Preparation. Upon completion of the surface preparation, measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09 90 00 and in the CSM's written instructions.
   2. After surface preparation and prior to the application of primer and coatings the surfaces the CSA must ensure that any remaining dust meets the acceptable level of the specification requirements.
      a. Monitoring of Coatings Application. Inspect, measure, and record the WFT and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

b. Post Application Inspection. Identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems as may be observed.

c. Post Cure Evaluation. Measure and inspect the overall DFT. Conduct a DFT survey, and perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09 90 00 and/or in the CSM's written instructions.

d. Follow-up to Corrective Actions and Final Inspection. Measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. Include final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

D. Responsibilities of the CTR:

1. General:

a. Provide the services of the CTR to be on site to routinely verify in writing that the application personnel have successfully performed representative portions of the surface preparation, filler/surface application, coating system application, and QC Inspection in accordance with this Section 09 90 00. Include testing or witnessing the contractors testing for the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and DFT of the coating systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. These inspections are not expected to be full-time, but rather to assure that inspections by the CTR are performed on representative portions of all major steps of the coating work to ensure the CSM approves those representative portions of the work to be in compliance with the CSM's recommendations and instructions. This inspection is in addition to the inspection performed by the Contractor in accordance with paragraph 1.05C of this section. The CTR shall provide a reasonable level of oversight of the contractor's QC processes to be representative of key steps in the work, at their discretion, to provide a final sign-off certification that the CSM's products have been properly installed.

2. Coating System Inspection:

a. The CTR shall verify representative steps of the coating work are performed properly per the manufacturer's instructions; the CTR shall coordinate and confirm the planned inspections by the Contractor's QCP are being performed per the QCTIP to assure quality of the work meets the requirements of both these specifications and any additional manufacturer's requirements; and the CTR shall verify or witness the contractors QC processes of the following QC steps at their discretion:

1) Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.

2) Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.

3) Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, and other terminations at different substrates).

4) Inspect application of the filler/surface materials for concrete and masonry substrates.
5) Inspect application of the primers and finish coats including WFT and DFT of the coatings.
6) Inspect coating systems for cure.
7) Review adhesion testing of the cured coating systems for conformance to specified criteria.
8) Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
9) Conduct a final review of completed coating system installation for conformance to the specifications.
10) CTR to prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's recommendations.

3. Final Report:
   a. Upon completion of coating work for the project, the CTR shall prepare a letter summarizing the inspection findings and shall attach the site visit reports required in 1.05 D.2. a.10. Include a statement that the completed work was performed in accordance with the requirements of this Section 09 90 00 and the CSM's recommendations based on the inspections performed by the CTR.

1.06 DELIVERY AND STORAGE

A. General:
1. Procedures: In accordance with Section 01 66 00.
2. Deliver materials to the job site in their original, unopened containers. Properly label each container P. Handle and store materials to prevent damage to or loss of label, meeting the project requirements or the CSM's if more stringent.
3. Include the following information on material container labels.:
   a. Name or title of product
   b. CSM's batch number
   c. CSM's name
   d. Generic type of material
   e. Application and mixing instructions
   f. Hazardous material identification label
   g. Shelf-life expiration date
4. Store materials in enclosed structures protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Store flammable materials in accordance with state and local requirements.
5. Clearly mark containers indicating personnel safety hazards associated with the use of or exposure to the materials.
6. Provide Safety Data Sheets (SDS) for each material to the Construction Manager.
7. Store and dispose of hazardous waste including waste solvents and coatings, according to federal, state and local requirements.

1.07 SUBMITTALS:

A. Action Submittals:

1. Provide in accordance with Section 01 33 00:

a. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (☑) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph, and provide a detailed explanation of the reasons for requesting the deviation. Engineer is the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined signifies compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections along with justification(s) for requested deviations to the specification requirements is cause for rejection of the entire submittal and no further submittal material will be reviewed.

b. CSM's current printed recommendations and product data sheets for coating systems including:

1) VOC data
2) Surface preparation recommendations
3) Primer type, where required
4) Maximum dry and wet film mil thickness per coat
5) Minimum and maximum curing time between coats, including atmospheric conditions limitations for each (temperature, dewpoint difference from temperature, etc.)
6) Curing time before exposure to elements
7) Thinner to be used with each coating
8) Ventilation requirements
9) Minimum atmospheric conditions during which the paint shall be applied
10) Allowable application methods
11) Maximum allowable moisture content
12) Maximum shelf life

c. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.

d. Safety Data Sheets (SDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.

e. List of cleaning and thinner solutions allowed by the CSMs.

f. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

g. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including, but not limited to, pipe penetrations, metal embedments, and other terminations to be determined from the contract drawings. Include detailed treatment for coating system at joints/terminations in concrete and concrete masonry unit assemblies.

h. CSM's detailed maximum chloride level tolerance for all coatings to be applied on metallic surfaces.

i. Provide a minimum of 5 project references each for the Contractor and CSA including contact name, address, and telephone number where similar coating work has been performed by their companies in the past 5 years.

j. The QCITP as specified in Article 1.05 D 2 and including all pertinent QC requirements covered in the Quality Control Table 09 90 00 – 1 found under Part 4 of this Section. Include:

   1) the QC Inspection Forms

   2) A list of who is responsible for performing and documenting all QC tests and inspection tasks.

k. Shop primer product data sheet and letter stating that shop primer is compatible with the field applied topcoats for all equipment on other items.

l. A daily QC inspection report from the QCP that documents all QC tests and inspections performed and their results for each day of the work. Document all non-compliant work for coating repair. Coordinate the report with the QCTIP provided per 1.05 C.1. Deliver daily QC report electronically to the Construction Manager and Engineer the morning of the following day.

m. Submit a Flash Report (see definitions section for Flash Report definition) from the QCP immediately identifying any items or issues that require immediate attention to the project Engineer

n. Letter from CTR confirming that Contractor's personnel to perform coating work have been trained or have appropriate experience to perform the work covered by this Section.

o. Resume of the Contractor's QCP responsible for performing the QC Testing and Inspection tasks delineated in the Contractor's Inspection and Testing Plan.

B. Informational Submittals:

1. Procedures: Section 01 33 00.
2. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in Article 1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.
3. Submit reports specified in Article 1.05 while the work is underway.

C. Closeout Submittals:

1. Procedures: Section 01 33 00
2. Submit the Coating System Quality Control Checklists using Form 09 90 00-A, for the coating work.

D. Product substitution requests:
   1. Refer to the General Conditions and/or General Requirements for substitution requests procedures for materials or requests to substitute other specification requirements, which are handled differently than the normal project submittal procedures.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Notwithstanding the listing of product names in this Section 09 90 00, provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. See Section 1.05 for detailed QC requirements required by the contractor. Do not apply coatings to a surface until the specified affidavits have been submitted, reviewed and accepted. Failure to comply with this requirement is cause for rejection and removal of such materials from the site.
   2. The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system.
      a. As indicated on the Drawings, for architectural coating and painting system finish schedules, refer to Section 09 91 14 and 09 91 23.

Material Requirements for Coating Systems: All of the United States including California Except SCAQMD

Coating System	CSM	First Coat(s)	Finish Coat(s)
Epoxy Coatings			
E-1	AkzoNobel	Interseal 670HS	Interseal 670HS
	Carboline	Carboguard 890	Carboguard 890
	PPG	Amerlock 2/400 Series	Amerlock 2/400 Series
	Sherwin Williams	Macropoxy 646 FC	Macropoxy 646 FC
	Tnemec	Series V69	Series V69
E-1-G	AkzoNobel	Intergard 251HS	Interseal 670HS
	Carboline	Carboguard 890	Carboguard 890
	PPG	Amerlock 2/400 Series	Amerlock 2/400 Series
	Sherwin Williams	Macropoxy 646 FC	Macropoxy 646 FC
	Tnemec	Series V69	Series V69
E-2	AkzoNobel	Interseal 670HS	Interseal 670HS
	Carboline	Carboguard 890 series	Carboguard 890 series
	PPG	Amerlock 2/400 Series	Amerlock 2/400 Series
	Sherwin Williams	Dura-Plate 235	Dura-Plate 235
	Tnemec	Series V69	Series V69

Material Requirements for Coating Systems: All of the United States including California Except SCAQMD				
Epoxy Polyurethane				
EU-1	AkzoNobel	Interzinc 52 Series	Intergard 251HS	Interthane 990 Series
	PPG	Amercoat 68 HS	Amerlock 2/400 Series	Pithane Ultra
	Carboline	Carbozinc 859 series	Carboguard 890	Carbothane 134 series
	Sherwin Williams	Galvapac 1K Zinc	Macropoxy 646FC	Hi Solids Polyurethane 250
	Tnemec	Tneme-Zinc 90G-1K97	Series V69	Series 1094
Grease				
G	Texaco	N/A		Rust Inhibitive Grease
	Chevron	N/A		E.P. Roller Grease
Latex Acrylic				
L-2	Benjamin Moore	Series 110 Stix Primer		Corotech V331 DTM Acrylic
	Carboline	Sanitile 120		Carbocrylic 3359 MC
	PPG	Pitt-Tech Plus 4020 PF		Pitt-Tech Plus 4216
	Sherwin Williams	Pro-Cryl Primer		Sher-Cryl HPA
	Tnemec	Series 1028 or 1029		Series 1028 or 1029
Miscellaneous				
M-1	Carboline	Carbowrap Tape series Paste		Carbowrap series Petrolatum Tape
	Denso	Denso Paste		Densyl Tape
	Trenton	Waxtape Primer		#1 Wax Tape
M-2	AkzoNobel	Interseal 670HS		Interseal 670HS
	Carboline	Carbomastic 615		Carbomastic 615
	PPG	Amerlock 2/400 Series		Amerlock 2/400 Series
	Sherwin Williams	Tank Clad HS		Tank Clad HS
	Tnemec	Series 135		Series 135

**See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.*

PART 3 EXECUTION

3.01 COATINGS

A. General:

1. Do not use coating products until the Engineer, Construction Manager, Owner, or Owner's Representative has accepted the affidavits specified in paragraphs 1.07 and 2.01 and the CTR has trained the Contractor and CSA in the surface preparation, mixing, and application of each coating system.
2. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.
3. Only use primers accepted as part of the coating submittal for the specific project components, including for shop applied primers.

B. Shop and Field Coats:

1. Shop Applied Prime Coat: Except as otherwise specified, prime coats may be shop-applied or field-applied. Use only shop-applied primers which have been identified and accepted as part of the coating submittal. It must be compatible with the specified coating system and applied at the minimum DFT recommended by the CSM. Provide data sheets identifying the shop primer as a Submitted for Approval as required in Article 1.07. All requirements for surface preparation, inspections and testing, and documentation apply to shop applied primers. Perform adhesion tests on the shop primer as specified in paragraph 3.01 B.3. Adhesion Confirmation. Remove damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09 90 00 and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09 90 00, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
2. Field Coats: Apply field coats consisting of one or more prime coats and one or more finish coats to build up the coating to the specified coating system DFT. Unless otherwise specified, do not apply finish coats until other work in the area is complete and previous coats have been inspected.
3. Adhesion Confirmation: Perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate and (2) the specified field coatings adhere to the shop applied coat. Test results showing an adhesion rating of 4A or better on surfaces are required for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 4B or better on other surfaces are acceptable for coating thicknesses less than 5 mils.
4. Test compatibility of coatings applied over existing coatings of different generic chemistry for compatibility through test patches applied and provided time for cure. After suitable cure time as per the CSM, perform adhesion testing as per 3.01.B.3 prior to proceeding.

C. Application Location Requirements:

1. Equipment, non-immersed, non-corrosive atmosphere: For items of equipment, or parts of equipment that are not immersed in service, shop prime and then finish coat in the field after installation with the specified or acceptable color. If the shop primer requires top coating within a specified period, finish coat the equipment in the shop and then touch-up paint after installation in the field. If equipment removal and reinstallation is required for the project, touch-up coating the field following reinstallation.
2. For OEM equipment that is partially or totally immersed, provide manufacturer's standard NSF/ANSI/CAN 61/600 approved coatings.

3.02 PREPARATION

A. General:

1. Prepare each type of surface in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the more stringent requirements shall take precedence.

2. Clean and dry surfaces to be coated. Before applying coating or surface treatments, remove oil, grease, dirt, rust, mill scale, old, weathered coatings, and other foreign substances. Remove oil and grease before mechanical cleaning. Where testing reveals chloride contamination, remove chlorides prior to blast cleaning or other mechanical surface preparation methods. Where mechanical cleaning is accomplished by blast cleaning, wash, grade, and free the abrasive from contaminants that might interfere with the adhesion of the coatings. Use air for blast cleaning that is free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.
3. Protect all surfaces and equipment not to be coated from dust and overspray. Schedule cleaning and coating so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Remove or mask hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces prior to surface preparation and coating operations. Reinstall removed items following completion of coating. Disconnect and move equipment adjacent to walls to permit cleaning and coating of equipment and walls. Replace and reconnect items following coating.

B. Blast Cleaning:
   1. Meet the following requirements for abrasive blast cleaning:
      a. Do not reuse blast abrasive. Do not use silica sand for the blast abrasive. Use blast abrasive media which provides the most efficient cutting action to achieve the profile and degree of cleanliness specified.
      b. Filter compressed air used for blast cleaning and ensure it contains no condensed water or oil. Clean moisture traps at least once every 4 hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.
      c. Install oil separators just downstream of compressor discharge valves and at the discharge of the blast pot discharges. Check and clean oil separators on the same frequency as the moisture traps as defined above.
      d. Regulators, gauges, filters, and separators must be in use on compressor air lines to blasting nozzles at all times during this work.
      e. Install an air dryer or desiccant filter drying unit which dries the compressed air prior to blast pot connections. Use and maintain the dryer for the duration of surface preparation work.
      f. Use abrasive blast nozzles of the venturi or other high velocity type supplied with a minimum of 100 pounds per square in gauge (psig) air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness specified.
      g. Provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.
      h. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, reclean the surface by water jetting and/or abrasive blast cleaning until the specified degree of cleanliness is reclaimed.
      i. Protect mechanical, electrical, and other equipment adjacent to and surrounding the work area from dusts, overspray and general damage.

C. Solvent Cleaning:

1. Use emulsifying type solvent wash, solvent wipe, or cleaners , including but not limited to those used for surface preparation in accordance with SSPC-SP 1 Solvent Cleaning, which emit no more than [340 g/l VOCs for AIM regions], [250 g/l for CARB regions], [100 g/l for SCAQMD regions], contains no phosphates, is biodegradable and is compatible with the specified primer.
2. Use clean white cloths and clean fluids in solvent cleaning.

D. Metallic Surfaces:

1. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) and NACE International (NACE) specified for each coating system. See Coat Spec for each coating system in this Section 09 90 00. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Select blast particle size to produce the specified surface profile. Use solvent in solvent cleaning operations as recommended by the CSM.
2. Take the following steps if soluble chloride contamination is suspected or is possible/plausible. Following initial blast cleaning of steel substrates, test for the presence of soluble chlorides using the retrieval and analysis method designated as Method 4.2.2. Adhesively Bonded Latex Patch or Cell as described in SSPC-TG15. Test accordance with ISO 8502-6/8502-9 at the rate of 4 tests per 1,000 sq. ft. of steel surface area to be coated, but no less than a total of 4 tests per component. The target threshold or tolerance conductivity level for soluble chloride contamination shall be approved in writing by the CSM's CTR for each product that is part of the application.
3. Prepare metallic surfaces based upon comparison with SSPC-VIS1-89 (ASTM D2200) and as described in the COATSPEC for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, on the first day of cleaning operations, provide abrasive blast metal reference panels meeting the standards specified for acceptance by the Construction Manager. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels accepted by the Construction Manager as meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. Provide a reference panel for each type of abrasive blasting to be used as the comparison standard throughout the project.
4. Blast cleaning requirements for steel, ductile iron, and stainless steel substrates are as follows:
    a. Prepare steel piping in accordance with SSPC-SP 6/NACE#3 (Commercial Blast Cleaning) and prime before installation. Prepare ductile iron piping surfaces including fittings in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.
    b. Abrasive blast clean stainless steel surfaces in accordance with SSPC-SP 16 to leave a clean uniform appearance with a minimum uniform surface profile of 1.5 to 2.5 mils, unless required to be greater by the CSM.
    c. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum-cleaning prior to coating application. Blow down cleaning with compressed air is not permitted.

d. Prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.

e. Continuously monitor and maintain ambient environmental conditions in the enclosure to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

5. Abrasive blast clean galvanized steel surfaces per SSPC SP 16 to produce a minimum surface profile of 1.0 to 1.5-mil profile and to remove all corrosion products. Caution–follow CSM's specific recommendations for surface prep, including abrasive blast cleaning.

E. Concrete Surfaces:

1. Inspect concrete surfaces prior to surface preparation and prepare concrete surfaces in accordance with SSPC-SP 13/SP CAB/NACE #6 (also called NACE 6).
2. Prior to surface preparation for degree of cleanliness and profile, prepare substrate cracks and areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges per CSM recommendations.
3. Evaluate the surface profile for prepared concrete surfaces to be coated by comparing the profile of the prepared concrete with the profile of the ICRI 310.2 (molded surface profile replicas). Prepare surface profile in accordance with the COATSPEC requirements and the CSM's recommendations.
4. Inspect prepared concrete substrates for surface cleanliness after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. Reinspect repaired concrete surfaces for cleanliness prior to application of the coating system.
5. Prepare concrete substrates using methods such as dry abrasive blast cleaning, high, or ultra-high-pressure water jetting in accordance with SSPC-SP 13 /SP CAB /NACE #6 to meet the following requirements:
    a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances.
    b. Open up air voids or bugholes to expose their complete perimeter by blast cleaning or other methods. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable.
    c. Concrete substrate must be dry prior to the application of repair mortars, filler/surfaces, or coating system materials.
    d. Produce a concrete surface with a minimum pH of 9.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
    e. Following inspection of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate.
    f. Remove debris produced by blast cleaning from the structures to be coated and dispose of legally off site.

6. Should abrasive blast cleaning or high or ultrahigh pressure water jetting not remove degraded concrete, use chipping or other appropriate tools to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Do not use equipment that will damage the underlying sound concrete such as pneumatic or electric chipping tools which will bruise or cause micro-cracking of the concrete substrate. Concrete substrates must be dry prior to the application of polymer based or mortars or filler/surfacers coating system materials.
7. Test moisture content of concrete to be coated in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test.
8. If moisture is detected, the CSA in cooperation with the CTR shall perform additional moisture testing vis ASTM F1869 or ASTM F2170 to determine the extent of the moisture vapor transmission. The acceptable limit for the application of barrier coatings for ASTM F1869 is < 3lbs/1,000 sq ft/24 hours. The acceptable limit as per ASTM F2170 is an RH value <70 percent.

F. Masonry Surfaces:
1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
2. Confirm masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning or water jetting is used for preparation, allow the masonry to dry. Assess moisture content by the CTR to ensure moisture levels are in tolerance ranges suitable to the coating system being applied prior to coating application work proceeding. Provide Results and CTR to the Engineer or Construction Manager in writing from the CTR before proceeding with application.

G. Fiberglass Reinforced Plastic (FRP) Surfaces:
1. Prepare FRP surfaces by first sanding to establish uniform surface roughness without any gloss remaining while minimizing any excessive removal of resin material. Second, vacuum clean to remove loose FRP dust, dirt, and other materials. Do not use compressed air. Then Solvent clean using clean white rags and allow solvent to evaporate completely before application of coating materials.

3.03 APPLICATION

A. Workmanship:
1. Apply coats to produce an even film of uniform thickness free from runs, drips, sags, ridges, waves, laps, and brush marks and completely coating corners and crevices.

2. Use equipment designed for application of the materials specified. Equip compressors with suitable traps and filters to remove water and oils from the air. Perform a paper blotter test when requested by the Construction Manager or Engineer to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. Limit the amount of oil and moisture in spray air to be less than the limits recommended by the CSM. Equip spray equipment with mechanical agitators, pressure gages, pressure regulators, and spray nozzles of the proper sizes.
3. Apply each coat evenly and sharply cut to line. Avoid over-spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, equipment, and all other adjacent areas and installations by taping, drop cloths, or other suitable masking measures.
4. Use coating applications method -- conventional or airless spray, plural component spray, brush or roller, or trowel -- as recommended by CSM.
5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.
6. Lightly sand glossy undercoats to provide a surface suitable for the proper application and adhesion of subsequent coats. Vary color for each successive coats for coating systems wherever possible to provide visual confirmation of coverage.
7. Prior to overall coating system application on complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces as per SSPC PA Guide 11 with the primer coat material using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

B. Coating Properties, Mixing and Thinning:
1. Coatings, when applied, shall provide a satisfactory film and smooth even surface. Thoroughly stir, strain, and keep at a uniform consistency all coating materials during application. Mix coating materials consisting of 2 or more components in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather, and method of application, the coating may be thinned but only as recommended by the CSM. The VOC of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, do not reduce coating materials more than necessary to obtain the proper application characteristics. Use thinner as recommended by the CSM.

C. Atmospheric Conditions:
1. Apply coatings only to surfaces that are dry and only under conditions of evaporation rather than condensation. Do not apply coating systems during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. Maintain these conditions for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain the required atmospheric and surface temperature for proper coating application and cure at no additional cost to the Owner.

D. Concrete Substrate Temperatures and Detail Treatment:
   1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system only occur during the cooler evening hours. Include all cost for working outside of normal hours in the bid.
   2. Repair all bubbles, fish eyes, pinholes, or other discontinuities that form in the applied coating system material as recommended by the CSM. Repair pinholes that develop in the filler/surfacer material or in the first coat of the coating material in accordance with the CSM's recommendations prior to application of the next coat of material. Open up and fill completely all air voids behind or beneath the pinhole with the specified filler/surfacer/coating material. Abrade the coated area around the pinhole repair and recoat that area.
   3. Perform application detail work per CSM's current written recommendations and/or drawings.

E. Protection of Coated Surfaces:
   1. Do not handle, work on, or otherwise disturb items that have been coated until the coating is completely dry and hard. Recoat or retouch shop-coated items after delivery at the site, and upon permanent erection or installation with specified coating when it is necessary to maintain the integrity of the film.

F. Method of Coating Application:
   1. Where 2 or more coats are required, provide sufficient compatible color additive, or contrasting color, in alternate coats to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Do not use color additives containing lead or lead compounds which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
   2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, touch-up prime and coat with 2 coats of the specified coating system to match the color scheduled. Do not apply coatings to a surface until it has been prepared as specified. Apply the primer or first coat by brush to ferrous surfaces that are not blast cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, visually inspect all surfaces, and mark all visible pinholes and/or holidays, repair in accordance with CSM's recommendations, and reinspect visually before applying succeeding coats. Unless otherwise specified, brush, roll, or trowel coats for concrete and masonry.

G. Film Thickness and Continuity:
   1. Confirm WFT following application of each coat.
   2. Do not exceed the surface area covered per gallon of coating for various types of surfaces recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers, or other pretreatment applications. Apply coatings to the thickness specified and in accordance with these specifications.

3. Conduct visual observations of continuity of coating film quality at welds, projections (such as bolts and nuts), and crevices, to verify no holidays exist where the dry-mil thickness has been accepted. This continuity shall be the minimum required for these rough or irregular areas. Recoat pinholes and holidays to the required coverage.
4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified DFT.
5. For concrete substrates, apply a complete skim coat of the specified filler/surfacer material over the entire substrate to produce a relatively flat continuous coatable surface prior to application of the coating system as required in the COATSPEC for the specific coating system. Apply the skim coat to the thickness recommended by the CSM and such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. Special Requirements:
1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. Apply the final coat after erection. Coat structural friction connections and high tensile bolts and nuts after erection. Hand clean or power-tool clean areas damaged during erection and recoat with primer coat prior to the application of subsequent coats. Touch-up surfaces after installation. Confirm surfaces to be coated are clean and dry at the time of application.
2. Except for those to be filled with epoxy grout, coat the underside of equipment bases and supports that have not been galvanized with at least 2 coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

I. Electrical and Instrumentation Equipment and Materials:
1. Electrical and instrumentation equipment and materials shall be shop coated by the equipment manufacturer in compliance with the standard (IEEE, ANSI, NEMA, etc.) referenced in the individual equipment specification. Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM so evidence of prior scratches is not visible in the finish surface

3.04 CLEANUP

A. General:
1. Upon completion of coating, remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

A. General:

1. Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Coat surfaces in accordance with the COATSPEC to the system thickness specified. Use coating systems as specified in paragraph 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule take precedence.
2. Refer to Section 09 91 14 and 09 91 23 and finish schedules on the Drawings for architectural coating and painting requirements.
3. Coating Specification Sheets included in Table A are included this paragraph 3.05.

Table A Coating Specification Sheets

Coating System ID	Coating Material	Surface	Service Condition
E-1	Epoxy	Metal	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
E-1-G	Epoxy	Galvanized Steel	Interior; exterior, covered non-corrosive exposure. Do not use in immersion service.
E-2	Epoxy	Metal	Exposed to high humidity, condensing conditions moderately corrosive vapors.
EU-1	Zinc-epoxy-polyurethane system	Ferrous Metal	Exterior, exposed to direct sunlight, moderately corrosive non-immersed – vapor exposure.
G	Grease	Metal	Ferrous Metal: Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 1 (Solvent Cleaning.)
L-2	100% Acrylic Latex	PVC and CPVC pipe	Exterior, direct sunlight exposure.
M-1	Petrolatum based mastic or wax based wrapping tapes	Metal	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
M-2	Epoxy mastic or equal	Ferrous Metal	Interior moderately, corrosive environment, confined enclosures, where minimal surface preparation is possible. Non-immersed.

Coating System Specification Sheets (COATSPEC)

Coating System Identification: E-1

1. Coating Material:	Epoxy
2. Surface:	Metal
3. Service Condition:	Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure.
4. Surface Preparation:	
a. General:	Shop primed surfaces which are to be incorporated in the work where recoat times have been exceeded shall be prepared in the field by cleaning surfaces by sanding to produce uniform profile of .5 to 1.0 mils and solvent cleaned per SSPC-SP 1. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP6/NACE #3 Commercial Abrasive Blast Cleaning or SSPC-SP 11 to achieve a uniform surface profile of 2.0 to 2.5 mils in the metal substrate and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive sanding and vacuum cleaning prior to receiving finish coats.

Coating System Specification Sheets (COATSPEC)	
b. Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC-SP 6/NACE#3 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2.0 to 2.5 mils.
c. Nonferrous and Galvanized Metal:	Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP 1. Areas of rust penetration shall be spot blasted to SSPC-SP6/NACE#3 Commercial blast (to achieve the 2.0- to 2.5-mil surface profile) and spot primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
5. Application	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM.
c. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC-SP 1 (Solvent Cleaning).
6. System Thickness:	10 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT.
b. Finish:	One or more coats at CSM's recommended DFT per coat to achieve the specified system thickness.
Coating System Identification: E-1-G	
1. Coating Material:	Epoxy
2. Surface:	Galvanized Steel
3. Service Condition:	Interior; exterior, covered, non-corrosive exposure.
4. Surface Preparation:	
a. General:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC-SP 16 to achieve a uniform 1.0- to 1.5-mil profile and spot primed with the primer specified.
b. Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC-SP 16 to impart a 1- to 2-mil profile to the galvanized steel surfaces. Where this cannot be performed due to access limits, prepare by abrading in accordance with SSPC-SP 3, Power Tool Cleaning to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Galvanized Metal:	Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC-SP 1 (Solvent Cleaning).
6. System Thickness:	5 to 8 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT.
b. Finish:	One or more coats at CSM's recommended DFT per coat to the specified system thickness.
Coating System Identification: E-2	
1. Coating Material:	Epoxy
2. Surface:	Metal
3. Service Condition:	Non-immersed, moderately corrosive environment, color required.

Coating System Specification Sheets (COATSPEC)	
4. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils.
	Damaged shop coating shall be cleaned in accordance with SSPC-SP6/NACE #3 Commercial Blast Cleaning or SSPC-SP 11 and vacuum cleaning and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. This cleaning must produce a uniform 1.0- to 1.5-mil profile in the intact shop primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces.
b. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal shall be prepared in accordance with SSPC-SP 16 to achieve a uniform surface profile of 1.0 to 1.5 mils. Galvanized steel with this E-2 coating system shall not be used in routinely wet exposures.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coat shall be an epoxy primer compatible with the specified finish coats.
c. Nonferrous and Galvanized Metal:	Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Nonferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted. If non-ferrous metals are not to be immersed, prepare in accordance with SSPC-SP 16.
6. System Thickness:	16 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT.
b. Finish:	Two or more coats at CSM's recommended DFT per coat to the specified system thickness.
Coating System Identification: EU-1	
1. Coating Material:	Zinc-Epoxy-Polyurethane System
2. Surface:	Ferrous Metal
3. Service Condition:	Exterior, exposed to direct sunlight, moderately corrosive, non-immersed.
4. Surface Preparation:	
a. General:	Undamaged shop primed surfaces which have exceeded recoat times which are to be incorporated in the work shall be prepared in the field by sanding to produce a uniform surface profile followed by Solvent Cleaning per SSPC-SP 1. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified.
b. Ferrous Metal:	Bare ferrous metal surfaces shall be prepared in accordance with SSPC-SP 6 (Commercial Blast Cleaning) 2.0–2.5 mils. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 3.02 Metallic Surfaces.
	Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP 11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC-SP 6/NACE #3 10 (Commercial Near White Blast Cleaning) and spot primed with the specified primer.

Coating System Specification Sheets (COATSPEC)	
c. Galvanized Metal:	Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC-SP 165 (White Metal Brush Off Abrasive Blast Cleaning for Galvanized and Non-Ferrous metal) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP 11 to achieve a uniform 1.0- to 1.5-mil profile. The zinc primer is NOT used on galvanized steel but is spot primed with the primer specified for galvanized metal as recommended by the CSM.
	Nonferrous and galvanized metal shall be prepared in accordance with SSPC-SP 16 (Brush Off Abrasive Blast Cleaning for Galvanized and Non-Ferrous metal) to impart a 1.0- to 2.0-mil profile to the galvanized or non-ferrous steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP 113, Power Tool Cleaning to bare metal to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces.
	For EU-1 over galvanized steel, **DELETE the zinc rich primer**.
5. Application:	Field
a. General:	Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations.
b. Ferrous Metal:	Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a 2-coat system is applied.
6. System Thickness:	3-4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5-6 mils and one finish coat of polyurethane at 2-3 mils DFT.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT
b. Intermediate:	One coat at CSM's recommended DFT
c. Finish:	One coat at CSM's recommended DFT per coat to meet the specified system thickness
Coating System Identification: G	
1. Coating Material:	Grease
2. Surface:	Metal
3. Surface Preparation:	
a. Ferrous Metal:	Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 1 (Solvent Cleaning).
4. Application:	Field
	Coating shall be applied with stiff brush, hand swab, or airless spray gun.
5. System Thickness:	50 square feet per gallon.
6. Coating:	One coat of grease coating.
Coating System Identification: L-2	
1. Coating Material:	100 percent Acrylic Latex.
2. Surface:	PVC and CPVC pipe.
3. Service Condition:	Interior and Exterior non-corrosive to mildly corrosive atmospheres suitable for direct sunlight exposure.
4. Surface Preparation:	Plastic pipe shall be cleaned with solvent compatible with the specified primer and sanded to roughen surfaces to achieve a uniform surface profile of 1.0 to 1.5 mils. Vacuum clean or wipe with a damp rag after sanding to remove all loose dust, plastic particles, and dirt.

Coating System Specification Sheets (COATSPEC)	
5. Application:	Field
6. System Thickness:	3 mils dry film.
7. Coatings:	
a. Primer:	One coat at CSM's recommended DFT.
b. Finish:	One or more coats at CSM's recommended DFT per coat to the specified system thickness.
Coating System Identification: M-1	
1. Coating Material:	Petrolatum based mastic or wax based wrapping tapes.
2. Surfaces:	Metal
3. Service Condition:	Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel.
4. Surface Preparation:	Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC-SP 2 (Hand Tool Cleaning).
5. Application:	All surfaces shall be hand rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout.
	On irregular shaped surfaces, (i.e., nuts, bolts, flanges, valves, etc.) the Contractor shall use either of the following systems recommended by the CSM.
	A. Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The Contractor shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape.
	OR:
	B. An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness.
	Tape shall be spirally wrapped with a 55-percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand during wrapping. On vertical application, contractor shall begin at bottom and proceed upward creating a weatherboard overlap.
6. System Thickness:	Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils.
7. Tape:	Number and types of tape wraps shall be in accordance with the CSM's written instructions.
Coating System Identification: M-2	
1. Coating Material:	Epoxy mastic or equal
2. Surface:	Ferrous Metal
3. Service Condition:	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.
4. Surface Preparation:	
a. Ferrous Metal:	All uncoated ferrous metal surfaces shall be prepared in accordance with SSPC-SP 3 (Power Tool Cleaning), or SSPC-SP 11 (Power to Cleaning to Bare Metal) and SSPC Hand Tool Cleanings prior to assembly. Surface preparation to achieve a uniform surface profile of 2.0 to 2.5 mils. Shop primed ferrous metal surfaces and fabricated assemblies shall be clean and dry prior to the application of field coats. Following assembly, the Contractor shall smooth welds and prominences using power tools prior to the application of the field applied coatings.

Coating System Specification Sheets (COATSPEC)	
5. Application:	Field
a. General:	Prior to the application of field applied coatings, welds, back-to-back angles, sharp or rough edges and weld splatter shall be brushed with the specified prime coat and allowed to cure overnight.
6. System Thickness:	10-15 mils dry film.
7. Coatings:	
a. Prime:	One coat of the CSM's recommended DFT.
b. Finish:	One or more coats of CSM's recommended DFT per coat to the specified system thickness.

3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. General:

1. Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

Coating Systems Schedule (Finish Schedule)		
Location/Surface	**Coating System Identification**	**Standard Color**
General: All Surfaces not Specified by Area or Structure		
1. Galvanized metal	Uncoated unless noted otherwise	
2. Stainless steel	Uncoated unless noted otherwise	
3. Equipment and Metal Appurtenances		
a. Equipment, non-immersed, unless otherwise specified		
1) Interior	E-1	Note 2
2) Exterior	EU-1	Note 2
b. Existing equipment		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		Note 3
a) Interior	E-1	Note 3, Match existing color
b) Exterior	EU-1 without primer	Note 3, Match existing color
c. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; interior and exterior	See paragraph 3.03 Electrical and Instrumentation Equipment and Materials	ANSI 61 Grey (outside) FS 27880 White (inside)
d. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified		
1) Interior	E-1	FS 26306 Grey (outside) FS 27880 White (inside)

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
2) Exterior	EU-1	FS 27722 White (outside) FS 27880 White (inside)
e. Existing electrical and instrumentation panels		
1) Not damaged by work in this contract	Uncoated	--
2) Damaged or exposed to outside surfaces by work in this contract		
a) Interior	E-1	FS 26306 Grey
b) Exterior	EU-1 without primer	FS 26306 Grey (Electrical) FS 27722 White (Instrumentation)
4. Conduit, Piping and Ductwork		
a. Ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified.		
1) Interior – noncorrosive	E-1 or E-1G	Note 2
2) Exterior – noncorrosive	EU-1	Note 2
3) Immersed	E-2	Note 2
4) Buried piping	M-1 or M-2	Not required
b. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified.		
1) Interior	E-1	Match background color
2) Exterior	EU-1	Match background color
c. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports		
1) Not damaged nor modified by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Interior	E-1	Match existing color
b) Exterior	EU-1	Match existing color
d. Racked conduits and cable trays	Uncoated	--
e. Insulated pipe jacketing	Uncoated	--
f. Plastic, fiberglass and flexible conduit and piping		
1) Unless otherwise specified	Uncoated	--
2) PVC and CPVC Piping	L-2	FS 26306 Grey
a) Exposed to direct sunlight	L-2	FS 26306 Grey
b) Not exposed to direct sunlight	L-2	FS 26306 Grey
g. Exposed ductwork, unless otherwise specified	Uncoated	--

Coating Systems Schedule (Finish Schedule)

Location/Surface	Coating System Identification	Standard Color
5. Concrete, Grout, Masonry and Plaster		
a. Immersed tank and channel walls and bottoms.	Uncoated	--
b. Outside concrete walls	Uncoated	--
6. Door and Door Frames	In accordance with 09 91 14 and 09 91 23	
7. Handrails, Gratings, Floor Plates, Manhole Covers, and Hatches		
a. Unless otherwise specified	Uncoated	
b. Existing		
1) Not damaged by work in this contract	Uncoated	--
2) Damaged, exposed, or modified by work in this contract		
a) Interior	E-1	Match existing color
b) Exterior	EU-1 without primer	Match existing color
8. Aluminum Flashing, Light Standards, Supports, and Louvers		
a. Interior and exterior, unless otherwise specified	Uncoated	--
9. Precast Concrete Metalwork		
a. Fasteners, anchors, supports, etc.	EU-1	Match wall
10. Other		
a. Fire hydrants	EU-1	FS 21302 Red
b. Flap gates	EA-1	Beige
c. Aluminum slide gates	Uncoated	--
d. Pipe, ductwork, equipment and appurtenances made from fiberglass, plastic, rubber, including flexible hose, conduit, and plastic coated tubing, in areas not exposed to view (interior) (metal hangers and supports are coated with E-1)	Uncoated	--
e. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations	M-1 or M-2	Manufacturer's color
B. GAC Pressure Vessels and vendor-supplied piping/valves, Exterior	EU-1	Note 1
C. PFAS Treatment System contractor-supplied piping/valves, Exterior	EU-1	Note 1
D. In-Vault piping/valves, immersed	E-2	

Notes:

1. *Owner will select color from coating manufacturer's list of EPA approved colors for potable water.*
2. *Owner to select color from coating manufacturer's full range of standard colors.*
3. *Recoat existing equipment to provide a uniform appearance. Color shall remain the same unless otherwise noted in the Contract Documents.*

3.07 QUALITY ASSURANCE INSPECTION

A. General:
   1. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or sole responsibility for QC as specified by this Section or as required by the CSM's instructions. Inspection by the Owner is optional and is additional to any inspection required to be performed by the Contractor.
   2. The Owner may perform, or contract with an inspection agency to perform, QA inspection and testing of the coating work covered by this Section. These inspections may include the following:
      a. Inspect materials upon receipt to ensure that all are supplied by the same CSM.
      b. Inspect to verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
      c. Inspect and record findings for the degree of cleanliness of substrates.
      d. Inspect and record the pH of concrete and metal substrates.
      e. Inspect and record substrate profile (anchor pattern).
      f. Measure and record ambient air and substrate temperature.
      g. Measure and record relative humidity.
      h. Check for the presence of substrate moisture in the concrete.
      i. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
      j. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
      k. Perform adhesion testing.
      l. Measure and record the thickness of the coating system.
      m. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.
      n. Limited visual observations for defects.

3.08 FINAL INSPECTION

A. General
   1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.
   2. The Construction Manager or Owner's Representative will subsequently conduct a final observation with the Contractor to observe the completed work.
   3. Any obvious defects or non-conforming work shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

PART 4 PROJECT QUALITY CONTROL CHECKLIST

09 90 00-A COATING SYSTEM QUALITY CONTROL CHECKLIST

Project Name

Owner		**Coating System Manufacturer Technical CTR**	
General Contractor (GC)		**Coating System Applicator (CSA)**	
Area or Structure		**Location within Structure**	
Coating System (e.g., E-1)		**Coating Type (e.g., Epoxy, etc.)**	

Coating System Quality Control Checklist

Step	Description	Acceptance Criteria	Parties	Name	Signature	Date
1	Completion of cleaning and substrate decontamination prior to abrasive blast cleaning.	Visual Inspection- Contaminant Free	GC QC			
		ASTM F22 – Concrete-Contaminant Free	CTR QC			
		Blacklight Testing- Contaminant Free	CSA QC			
2	Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated.	As Per SSPC Guide 6	GC QC			
		As per Specification	CTR QC			
			CSA QC			
3	Ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area.	Negative Pressure in Enclosures	GC QC			
		Testing Every 2 hrs Minimum	CTR QC			
		Substrate temp 5°above the dewpoint and stabilized.	CSA QC			
4	Ensuring compressed air for abrasive blasting or coating/lining application is free of oil and moisture	ASTM D4285- Free of all oil & moisture	GC QC			
		1 blotter test per 2 hrs of compressed air usage	CTR QC			
			CSA QC			
5	Completion of Surface Preparation for Substrates to Be Coated. (Steel & Concrete)	Compliance with Sited SSPC/NACE Standards	GC QC			
		Compliance with Specification	CTR QC			
			CSA QC			
	Steel- Dust Level Testing- After surface preparation and prior to application of primers/coatings	ISO 8502-3 (Part 3)	GC QC			
		Dust Rating-1	CTR QC			
		Dust Particle Size - 0	CSA QC			

Step	Description	Acceptance Criteria	Parties	Name	Signature	Date
6	Soluble Chloride Testing (If needed) as per SSPC-Guide 15 (Steel Only)	AS Per CTR allowable limits per product.	GC QC			
			CTR QC			
			CSA QC			
7	Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application.	Compliance with Specification	GC QC			
			CTR QC			
			CSA QC			
8	Completion of Concrete Filler/ Surface Application to Concrete.	Bughole/Void Free	GC QC			
		Flush with Existing Surface	CTR QC			
			CSA QC			
9	Completion of Primer Application.	SSPC-PA 2- Steel	GC QC			
		SSPC-PA 9- Concrete	CTR QC			
		Meets Specified DFT	CSA QC			
10	Completion of intermediate Coat Application and of Detail Treatment at Transitions or Terminations.	SSPC-PA 2- Steel	GC QC			
		SSPC-PA 9- Concrete	CTR QC			
		Meets Specified DFT	CSA QC			
11	Completion of Finish Coat Application and of Detail Treatment at Transitions and Terminations.	SSPC-PA 2- Steel	GC QC			
		SSPC-PA 9- Concrete	CTR QC			
		Meets Specified DFT	CSA QC			
12	Completion of Full and Proper Cure of Coating System.	ASTM D5402- Solvent Based Materials - No material transfer-	GC QC			
		Visual Inspection-Defect Free	CTR QC			
			CSA QC			
13	Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness.	ASTM D5402- Solvent Based Materials - No material transfer-	GC QC			
		Visual Inspection-Defect Free	CTR QC			
		As per Specification	CSA QC			
14	Completion of Localized Repairs to Coating System Following Testing.	Visual Inspection-Defect Free	GC QC			
			CTR QC			
			CSA QC			

Step	Description	Acceptance Criteria	Parties	Name	Signature	Date
15	Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CTR's Quality Requirements.	Visual Inspection-Defect Free	GC QC			
			CTR QC			
			CSA QC			

END OF SECTION

SECTION 09 91 14

EXTERIOR PAINTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Surface preparation and application of paint systems the following exterior substrates at the Restroom and Storage Building:
      a. Fiber Cement Board
      b. Steel and Iron
      c. Galvanized metal
   2. For interior surfaces at the Restroom and Storage Building see Section 09 91 23.
   3. For exterior concrete and concrete masonry units (CMUs) at the Restroom and Storage Building see 09 96 53 Elastomeric Coatings
   4. For all other coatings see Section 09 90 00.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of topcoat product.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. Dulux Canada; a licensed product of PPG Architectural Coatings.
   3. Kelly-Moore Paint Company Inc.
   4. Rodda Paint Co.
   5. Sherwin-Williams Company (The).
   6. Miller Paints.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in the Exterior Painting Schedule for the paint category indicated.

2.02 PAINT PRODUCTS

A. MPI Standards: Provide products complying with MPI standards indicated and listed in its "MPI Approved Products List."

B. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another, and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: Vancouver City Standard, Sherwin Williams, “Buff”, to match existing facilities on site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Fiber-Cement Board: 12 percent.
   2. Gypsum Board: 12 percent.

C. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.03 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions and recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.04 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.05 EXTERIOR PAINTING SCHEDULE

A. Cement Board Substrates:
   1. Latex System MPI EXT 3.3A :
      a. Latex Prime Coat: Exterior, matching topcoat.
      b. Intermediate Coat: Latex, exterior, matching topcoat.
      c. Low-Sheen Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

B. Galvanized-Metal Substrates
   1. Alkyd System MPI EXT 5.3B:
      a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
      b. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
      c. Topcoat: Alkyd, exterior, semi-gloss (MPI Gloss Level 5), MPI #94.

C. Steel and Iron Substrates:
   1. Alkyd System MPI EXT 5.3B:
      a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
      b. Intermediate Coat: Exterior, alkyd enamel, matching topcoat.
      c. Topcoat: Alkyd, exterior, semi-gloss (MPI Gloss Level 5).

END OF SECTION

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SECTION 09 91 23

INTERIOR PAINTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates at the Restroom and Storage Building:
   1. Gypsum board.

B. For Exterior surfaces at the Restroom and Storage Building see Section 09 91 14.

C. For all other surfaces see Section 09 90 00.

D. Related Requirements:
   1. Section 05 50 00 "Metal Fabrications" for shop priming metal fabrications.

1.03 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.
   1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint Products: 1 gal. of each material and color applied.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.07 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Dulux Canada; a licensed product of PPG Architectural Coatings.
   2. Rodda Paint Co.
   3. Sherwin-Williams Company (The).
   4. Miller Paint Co.
   5. Devoe HP Coatings.

B. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in the Interior Painting Schedule for the paint category indicated.

2.02 PAINT PRODUCTS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that the finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.03 INSTALLATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual.".
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
   5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

C. Painting Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed in equipment rooms:
      a. Equipment, including panelboards.
      b. Uninsulated metal piping.
      c. Metal conduit.

3.04 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
   1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
   2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
   3. Allow empty paint cans to dry before disposal.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.05 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:
   1. Latex over Latex Sealer System MPI INT 9.2A:
      a. Prime Coat: Primer sealer, latex, interior, MPI #50.
      b. Intermediate Coat: Latex, interior, matching topcoat.
      c. Topcoat: Latex, interior (MPI Gloss Level 3), MPI #52.

END OF SECTION

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SECTION 09 96 53

ELASTOMERIC COATINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes surface preparation and application of elastomeric coatings to the following exterior substrates:
   1. Exterior Concrete at the Restroom and Storage Building.
   2. Exterior concrete masonry unit walls at the Restroom and Storage Building.
   3. ACTION SUBMITTALS

B. Product Data: For each type of product.
   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

C. Samples for Initial Selection: For each type of elastomeric coating.

D. Samples for Verification: For each type of elastomeric coating indicated. .
   1. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.04 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 90 deg F unless otherwise permitted by manufacturer's written instructions.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before starting or continuing coating operation.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace elastomeric coatings that fail within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Benjamin Moore & Co.; products as designated in the "Elastomeric Coating Schedule" Article in Part 3 or comparable products by one of the following:
   1. Behr Process Corporation.
   2. Benjamin Moore & Co.
   3. PPG Architectural Coatings.
   4. Pratt & Lambert.
   5. Rodda Paint Co.
   6. Sherwin-Williams Company (The).
   7. Products: Subject to compliance with requirements, listed in the Elastomeric Coating Schedule for the paint category indicated.

2.02 MATERIALS

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."

B. Material Compatibility:
   1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, products shall be recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. Colors: Provide Vancouver City Standard, Sherwin Williams, “Buff”, to match existing facilities on site .
   1. Crack Fillers: Elastomeric coating manufacturer's recommended, factory-formulated crack fillers or sealants, including crack filler primers, compatible with substrate and other materials indicated.

D. Primer: Elastomeric coating manufacturer's recommended, factory-formulated, alkali-resistant primer compatible with substrate and other materials indicated.

E. Concrete Unit Masonry Block Filler: Elastomeric coating manufacturer's recommended, factory-formulated, high-performance latex block filler compatible with substrate and other materials indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with manufacturer's requirements for maximum moisture content, alkalinity, and other conditions affecting performance of work.

B. Begin coating only when moisture content of substrate is 12 percent or less when measured with an electronic moisture meter.

C. Verify that substrate is within the range of alkalinity recommended by manufacturer.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

3.02 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

B. Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.
   1. After completing coating operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   1. Remove incompatible primers and reprime substrate with compatible primers as required to produce coating systems indicated.
   2. Perform cleaning and coating application so dust and other contaminants from cleaning process will not fall on wet, newly coated surfaces.

D. Crack Repair: Fill cracks according to manufacturer's written instructions before coating surfaces.

3.03 APPLICATION

A. Apply elastomeric coatings according to manufacturer's written instructions.
   1. Use equipment and techniques best suited for substrate and type of material being applied.
   2. Coat surfaces behind movable items the same as similar exposed surfaces.
   3. Apply each coat separately according to manufacturer's written instructions.

B. Primers: Apply at a rate to ensure complete coverage.

C. Block Fillers: Apply at a rate to ensure complete coverage with pores filled.

D. Elastomeric Finish Coat(s): Manufacturer's recommended number of coats and total dry film thickness for condition of substrate.

E. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats similar to color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

F. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform finish, color, and appearance.

G. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

H. Apply coatings to prepared surfaces as soon as practicable after preparation and before subsequent surface soiling or deterioration.

I. Spray Application: Use spray equipment for application only when permitted by authorities having jurisdiction. Wherever spray application is used, do not double back with spray equipment to build up film thickness of two coats in one pass.

3.04 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following testing procedures:
   1. Owner will engage the services of a qualified testing agency to sample materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
   2. Testing agency will perform tests for compliance of materials with product requirements.
   3. Owner may direct Contractor to stop coating application if test results show materials being used do not comply with requirements. Remove noncomplying materials from Project site, pay for testing, and recoat surfaces that were coated with rejected materials. Remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

B. Field Testing and Inspection: Owner reserves the right to engage the services of a qualified testing agency to verify installed thickness of elastomeric coatings.

C. installed thickness of elastomeric coatings.

3.05 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities, touch up and restore damaged or defaced coated surfaces.

3.06 ELASTOMERIC COATING SCHEDULE

A. Concrete and Concrete Unit Masonry Substrates:
   1. Elastomeric Coating System MPI EXT 4.2D:
      a. Prime Coat: As recommended in writing by topcoat manufacturer.
      b. Block Filler: As recommended in writing by topcoat manufacturer.
      c. Intermediate Coat: As recommended in writing by topcoat manufacturer.
      d. Topcoat: Elastomeric, pigmented, exterior, water-based, flat coating; MPI #113.
         1) Benjamin Moore; Ultra Spec Masonry Elastomeric Waterproof Coating.

END OF SECTION

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SECTION 10 14 23.16

ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
   3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.05 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.02 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
   1. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated over subsurface graphics to acrylic backing sheet to produce composite sheet.
      a. Composite-Sheet Thickness: 0.25 inch.
      b. Subsurface Graphics: Reverse halftone or dot-screen image.
      c. Slide-in changeable insert.
      d. Color(s): As selected by Architect from manufacturer's full range.
   2. Sign-Panel Perimeter: Finish edges smooth.
      a. Edge Condition: Square cut.
      b. Corner Condition in Elevation: Square.
   3. Frame: Horizontal retainers.
      a. Material: Aluminum.
      b. Profile: Square.
      c. Corner Condition in Elevation: Square.
      d. Finish and Color: Clear anodized.
   4. Mounting: Surface mounted to wall with two-face tape.

2.03 SIGN MATERIALS

A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

B. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings.

2.04 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish stainless-steel or hot-dip galvanized devices unless otherwise indicated.
   3. Sign Mounting Fasteners:
      a. Through Fasteners: Exposed metal fasteners with type of head indicated, and installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.05 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
   1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
   2. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
   3. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Install signs so they do not protrude or obstruct according to the accessibility standard.
   3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:
   1. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
   2. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.02 SCHEDULE

A. Room Identification Signs: 4-inches high Braille sign (provide width necessary to accommodate text); adhesive mounting strips. Example of a sign schedule as shown below:

Text	Location
RESTROOM	
MAINTENANCE	
STORAGE	
FIRE RISER ROOM	

B. Accessible Restroom Signs: 8-inches wide by 8-inches high Braille sign; adhesive mounting strips; wording: RESTROOM (with symbol of access and unisex graphic).
   1. Locations:
      a. Building Restrooms

C. Exit Signage: 4-inches wide by 2-inches high Braille sign; adhesive mounting strips; wording: EXIT.
   1. Locations: All exterior doors.

END OF SECTION

SECTION 10 28 00

TOILET, BATH AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Public-use washroom accessories.
   2. Under-lavatory guards.

1.03 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
   1. Identify locations using room designations indicated.
   2. Identify accessories using designations indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.07 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, visible silver spoilage defects.
   2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bobrick Washroom Equipment, Inc.
   2. Bradley Corp
   3. Approved equal.

B. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.

2.02 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
   1. Basis-of-Design Product: Bobrick B-4288.
   2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
   3. Mounting: Surface mounted.
   4. Operation: Non-control delivery with theft-resistant spindle.
   5. Capacity: Designed for 5-inch-diameter tissue rolls.
   6. Material and Finish: Stainless steel, No. 4 finish (satin).

B. Grab Bar:
   1. Basis-of-Design Product: Bobrick B-6806.
   2. Mounting: Flanges with concealed fasteners.
   3. Material: Stainless steel, 0.05 inch thick.
      a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
   4. Outside Diameter: 1-1/2 inches.
   5. Configuration and Length: As indicated on Drawings.

C. Sanitary Disposal Unit:
   1. Basis-of-Design Product: Bobrick B-270.
   2. Mounting: Surface mounted.
   3. Door or Cover: Self-closing, disposal-opening cover.
   4. Receptacle: Removable.
   5. Material: Stainless steel, No. 4 finish (satin).

D. Seat-Cover Dispenser:
   1. Basis-of-Design Product: Bobrick B-4221.
   2. Mounting: Surface mounted.
   3. Minimum Capacity: 250 seat covers.
   4. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
   5. Lockset: Tumbler type.

E. Mirror Unit:
   1. Basis-of-Design Product: Bobrick B-165.
   2. Frame: Stainless-steel channel.
      a. Corners: Manufacturer's standard.
   3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
      a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
      b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
   4. Size: As indicated on Drawings.

F. Soap Dispenser:
   1. Basis-of-Design Product: Bobrick B-2111.
   2. Description: Designed for manual operation and dispensing soap in liquid form.
   3. Material and Finish: Stainless steel, No. 4 finish (satin).

G. Semi-Recessed Paper Towel Dispenser/Waste Receptacle
   1. Basis-of-Design Product: Bobrick B-3942.
   2. Description: Satin finish stainless steel, combination commercial paper towel and disposal receptacle.
   3. Size: 8” deep, 12 gal. capacity, extends 4 1/8” from wall.

2.03 UNDERLAVATORY GUARDS

A. Under-Lavatory Guard:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Plumberex Specialty Products, Inc.
      b. Truebro by IPS Corporation.
   2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
   3. Material and Finish: Antimicrobial, molded plastic, white.

2.04 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.

C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.05 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.02 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION

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SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Babcock-Davis.
      b. Guardian Fire Equipment, Inc.
      c. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
      d. Larsen's Manufacturing Company.
   2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Basis of design: Guardian Fire Equipment, Inc, Model 4010

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

PART 3 EXECUTION

3.01 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
   1. Mounting Height: Top of fire extinguisher to be at 42 inches above finished floor.

END OF SECTION

SECTION 22 00 00

PLUMBING BASIC REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the general requirements for all of the plumbing materials, labor, tools, permits, incidentals, and other services included in Division 22 and wherever specifically mentioned in the Specifications. All equipment and performance in this Section are for a minimum quality of design. The Supplier is responsible for the design and supply of all equipment, their selection and sizing. Not all fixtures and materials are applicable to this project, but when so specified use these specifications.

B. Scope: This Section specifies the general requirements for all of the Plumbing materials, labor, tools, permits, incidentals, and other services included in Division 22 and elsewhere wherever specifically mentioned in the Specifications.
   1. Plumbing fixtures (e.g., sinks; toilets; showers; faucets; floor drains; emergency showers/eyewash stations, etc.)
   2. Water heating units (emergency/eyewash stations, washrooms, and locker rooms)
   3. All associated piping and valves to comply with the plumbing codes.

C. Additional requirements for plumbing systems shall be as shown in the drawings.

D. Enviromental Conditions: See Section: 01 11 80

E. Fasteners: unless indicated otherwise.
   1. Bolts - ASTM A193, grade B8M Class 1 or ASTM A320 B8M Class 1
   2. Nuts – ASTM A194, grade 8M
   3. Washer – 316 SS

F. Governing Standards:
   1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance the more stringent requirements shall govern.
   2. All work shall comply with UL safety requirements.

G. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

H. Coordinate with other trades (e.g., HVAC, Fire Protection, Structural) for routing of equipment and connection points

I. Sanitary sewer drains shall be a minimum of 4 inches.

J. All plumbing designs shall be by an ASPE Certified Plumbing Designer (CPD) in good standing and stamped by a Professional Engineer. The Engineer may be the CPD.

K. Coordinate with site layout for incoming water and outgoing sewer location. Supplier is responsible to route the piping starting approximately 5 feet from the building envelope

1.02 DEFINITIONS

A. Terminology used in this specification conforms to the following definitions:
   1. Authorities Having Jurisdiction: Indicates reviewing authorities, including local building official, local fire marshal, Owner, and other reviewing entity whose approval is required to obtain system acceptance.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and therefore requested by the Manufacturer, underline each deviation and denote by a number in the margin to the right of the identified paragraph. Provide a detailed, written justification for each deviation. The Owner Representatives shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

B. Action Submittal Items for this Section:
   1. A copy specification section, with addendum updates included and each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. In the event that a submittal item is termed differently from the specification revise the text of the submittal item to conform to the phrasing listed in the specifications.
   3. Manufacturer's data including materials of construction, construction details of equipment, wiring diagrams, weight of equipment, mounting, seismic bracing, and support.
   4. Drawings showing general dimensions and confirming the size of equipment, fixtures, motors and drives, and piping connections (Shop Drawings).
   5. Performance curves for pumps developed for the specific application. Performance curves shall show speed, capacity, pressure, and power for specified conditions.
   6. Shop and field painting systems. Include manufacturer's descriptive technical catalog literature and specifications.
   7. Shop Drawings including the physical characteristics of all systems, equipment, and piping layout plans, and control wiring diagrams.
   8. Operation and Maintenance Information: Section 01 33 04.
   9. Samples, where required by the specification section.
   10. Rigid Equipment Mount Installation Checklist (Form 43 05 13-A).
   11. See Division 22 specifications sections for additional requirements.

C. Informational Submittal for this Section:
   1. None.

D. Operations and Maintenance Data and Manuals:
   1. Adequate operation and maintenance information shall be supplied as required in the Submittals section and Equipment Operating and Maintenance
   2. Manual Information section: Operation and maintenance manuals shall be submitted in accordance with the Submittals section and Equipment Operating and Maintenance Manual Information section.
   3. Operation and maintenance manuals are required for electronic trap priming panels, water closets, urinals, faucets and flush valves, emergency fixtures, wash fountains, electric water coolers, food waste disposers, water heaters, circulating pumps, hose reels, expansion tanks, automatic water softener units, water storage tanks, neutralization tanks, oil interceptors, and flammable waste interceptors.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the rules and regulations of Authorities Having Jurisdiction over the work specified herein, including all adopted state and local building codes including plumbing, mechanical, fire, building, and electrical.

B. Welding Qualifications:
   1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS or ASME Standard Qualification Procedures.
   2. All procedure and operator qualifications shall be in written form and subject to Engineer review.
   3. Accurate records of operator and procedure qualifications shall be maintained by Supplier and made available to Engineer upon request.
   4. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Manufacturers Experience: Unless the equipment manufacturer is specifically named in this Section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

D. References Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
ADA	Americans with Disabilities Act
AHRI	Air-Conditioning Heating & Refrigeration Institute
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CSA	CSA International
ETL	Electrical Testing Laboratories
EPA	Environmental Protection Agency
FDA	Food & Drug Administration
FM	Factory Mutual Global
IAPMO	International Association of Plumbing and Mechanical Officials
ICC	International Code Council
HI	Hydraulic Institute Standards
ISO	International Organization for Standardization
MSS	Manufacturers Standardization Society
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
PDI	Plumbing and Drainage Institute
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
UL	Underwriters Laboratories Inc.

E. Unit Responsibility:

1. The Supplier shall furnish and install equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Supplier of his responsibility to the Owner's Representative and Owner for performance of all systems in the contracted scope of supply.

2. The Supplier shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Supplier to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.
3. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Section 01 33 00 - Submittal Procedures. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable.

F. Manufacturer’s Instructions:
1. Follow manufacturer's written instructions.
2. If in conflict with Construction Documents, obtain clarification.
3. Notify the Owner’s Representative in writing before starting work.

G. Drawings:
1. The Drawings shall be taken as diagrammatic. Unless otherwise noted, only the process area drain lines are shown. The sanitary drains and vents shall be designed and laid out by the CPD.
2. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered.

H. Work:
1. All work shall conform to the requirements of ADA, ASME, ASSE, ASTM, NSF, NFPA, and UL safety requirements.

1.05 DELIVERY, STORAGE AND HANDLING

A. Shipping, handling and storage shall be in accordance with the Delivery, Storage, and Handling section.

1.06 COORDINATION

A. Supplier shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

B. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. Each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply.

D. Information on equipment manufacturers' representatives shall be included with the submittals.

E. The equipment as shown on the plans and specified herein, is based on the equipment furnished by one manufacturer. Equipment which is offered as a substitute to the specific requirements of these Specifications and which differs in detail and arrangement from that shown may require changes in design and construction. All costs which result from such changes in design and construction are to be borne entirely and unconditionally by the Contractor and/or the manufacturer; said costs to include but not be limited to structural, piping, mechanical and electrical changes and all engineering costs incurred as a result of the substitution, in the revision of Plans and Specifications, review of design changes by others, preparation of change orders, and any other costs directly resulting from said substitution.

1.07 APPURTENANCES

A. Furnish and install all necessary guides, inserts, anchors and assembly bolts, washers and nuts, hangers, supports, gaskets, couplings, and flanges; and all other appurtenant items shown on the Drawings, specified, or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.

PART 2 PRODUCTS

2.01 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.02 MANUFACTURERS AND FABRICATION

A. Provide like items from one manufacturer, including but not limited to fixtures, pumps, drains, and cleanouts.

B. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

C. Anchor Bolts and Expansion Anchors: Section 05 05 20

1. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt, washer and nut materials shall conform to the requirements above with the provisions of Section 05 05 20 unless otherwise indicated on the Drawings.

2.03 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.04 PERFORMANCE REQUIREMENTS

A. Equipment and products shall meet the minimum performance requirements identified in the Division 22 specification sections.

B. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Electric water coolers shall be UL listed and certified in accordance with AHRI Standard 1010. All materials in contact with water shall comply with the Reduction of Lead in Drinking Water Act. All plumbing fittings and fixtures intended to convey or dispense water for human consumption shall comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for lead-free.

D. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

1. Dimensional Restrictions:
    a. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values.
    b. Supplier shall review the contract Drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineers.

2.05 MATERIALS

A. Base contract upon furnishing materials as specified.

B. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, or CSA approved, or have adequate approval or be acceptable the Authorities Having Jurisdiction.

C. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

D. Gas piping shall be A53 Grade B seamless or A106 Grade B

E. Plumbing fixtures shall be constructed in accordance with the following standards:
   1. Enameled Cast Iron ANSI/ASME A112.19.1M
   2. Vitreous China ANSI/ASME A112.19.2M
   3. Stainless Steel ANSI/ASME A112.19.3M
   4. Faucets ANSI/NSF 61
   5. Emergency/Safety Fixtures ANSI/ISEA Z358.1

F. Electric water coolers shall be UL listed and certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1010. All materials in contact with water shall comply with the Reduction of Lead in Drinking Water Act. All plumbing fittings and fixtures intended to convey or dispense water for human consumption shall comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for lead-free.

2.06 COATINGS

A. Surface Preparation:
   1. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations.
   2. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

B. Except for motors and speed reducers, all fabricated surfaces from ferrous metal shall be coated. Coatings shall electrostatically coat (e-coat) uniformly applied. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness. After e-coat cure, equipment shall receive a spray-applied, polyurethane black topcoat to prevent UV degradation of epoxy e-coat film. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

C. Submit product data on the type coating selected, the coating thickness, the application process used to meet the requirements below and verification of conformance with the salt spray test requirement
   1. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer.

D. Coils/HX exposed to ambient
   1. No material bridging is allowed, including enhanced and micro-channel fin designs
   2. Submit the estimated heat transfer loss of the coil. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation

E-Coating Requirements

Coating Quality	Test Procedure	Coating Performance (Nominal plus)
Dry Film Thickness	ASTM D7091	1 mil
Water Immersion	ASTM D870	1000 hrs
Cross Hatch Adhesion	ASTM B3359	4B-5B Rating

E-Coating Requirements

Coating Quality	Test Procedure	Coating Performance (Nominal plus)
Salt Spray	ASTM B117 ASTM B117-G85	6000 hrs 2000 hrs
Heat Transfer Reduction	AHRI 410	<1%
Humidity	ASTM D1735	1000
Operating pH Range	N/A	3-12
Temperature		-40 F to 300 F
Weathering (topcoat)	ASTM 4587	2200

2.07 COLOR

A. Vitreous china, cast iron, enameled steel, and composite plumbing fixtures shall be white unless otherwise indicated.

B. Equipment shall have the manufacturer's standard color unless otherwise indicated in the schedules or specifications

C. Equipment may use the manufacturer's finish if it meets the criteria above or otherwise indicated in the schedules or individual specifications.

2.08 ELECTRICAL

A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein.

B. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Specifications and Drawings.

2.09 PIPING ACCESSORIES

A. General: Pressure gauge and thermometer ranges shall be approximately 1.5 times the system operating conditions.

B. Waterhammer Arrestors:
   1. Water hammer arrestors shall be installed in water systems upstream of each solenoid valve, quick closing valve, and emergency shower or eyewash.
   2. Water hammer arresters shall be either bellows/diaphragm or piston type. Bellows/diaphragm type arresters shall consist of a stainless-steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be provided on hot- and cold-water supplies and shall be located, with precise location and sizing, in accordance with PDI WH 201.

3. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted. Arresters shall be rated for a maximum working pressure of 350 psig and a temperature range of 33°F to 250°F.
4. Water hammer arresters shall be Smith "Hydrotrol", Josam "75000 Series Absorbotron", Wade "Shokstop", Sioux Chief "Hydra-Rester" or Approved Equal.

C. Drains and Valves:
1. Provide valves where equipment drain connections are furnished and carry the discharge pipe to the nearest floor drain, drain trench, or sump.
2. Where no receptacle for drain exists, install drain piping to 1 inch above the floor. Drain piping and valve materials shall conform to the requirements of the system served.
3. Install escutcheons secured to pipe with set-screw where pipes or tubing pass through exposed walls or ceilings.
4. Vent Flashing at Roof: Section 07 62 00.

D. Trap Primers:
1. Trap primers shall meet ASSE 1018.
2. Electronic Trap Priming Panel:
   a. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol “TPP” and an identifying number.
   b. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations.
   c. Electronic trap priming panels shall consist of a panel, timer, 120 V solenoid, and calibrated manifold system and shall be manufactured by Precision Plumbing Products Inc. “PTS Series”, Zurn, MIFAB, Approved Equal.
   d. Reference the plumbing drawings for the number of priming tubes required per trap priming panel.
   e. See the Division 22 specifications sections for additional requirements.
3. Tailpiece Trap Primers:
   a. Trap primers installed in a flush valve water closet supply or lavatory drain shall consist of a chrome plated brass plumbing fixture tailpiece with a 1/2 inch OD diverter pipe and compression connection for copper tubing.

E. Thermostatic Mixing Valve:
1. Thermostatic mixing valves shall comply with ASSE 1017.
2. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating.
3. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes.
4. The control element shall be of an approved type.
5. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel, or copper.

6. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets.
7. Temperature adjustment range shall be 85°F to 120°F.
8. Accuracy shall be within 3°F of setpoint.
9. Thermostatic mixing valves shall be manufactured by Symmons, Leonard, Powers or Approved Equal.

F. Vacuum Relief Valves:
1. Vacuum relief valves shall have bronze or brass bodies rated for 200 psig and shall be provided with male threaded inlet connections.
2. The valves shall open at 1/2-inch water column vacuum and shall have a venting capacity of at least 15 cubic feet per minute.
3. Vacuum relief valves shall be Watts Regulator "Model LFN36", Cash Acme “VR 801”, Apollo Valves “Model VR” or Approved Equal.

G. Strainers:
1. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated.
2. The blowoff from each strainer shall be equipped with a shutoff valve.
3. Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens.
4. Strainers shall be Watts “Series LF777SI”, Apollo Valves “Model 59-LF”, Wilkins “Model YBXL” or Approved Equal.
5. Strainers located in ductile iron piping systems shall be Y-pattern type with iron body, flanged ends, and monel or stainless steel screens.
6. Strainers shall be Hoffman Specialty “Series 400”, Metraflex “Model TF” or Approved Equal.

H. Hose Faucets:
1. Hose faucets shall be constructed with nickel or chrome plated cast brass body, solid brass stem, threaded bonnet, and “T” style handle.
2. Hose faucets shall be provided with a 3/4-inch male pipe thread inlet and a 3/4-inch male hose thread outlet unless otherwise indicated on the Drawings. Hose faucets shall be Prier Brass “Model C-138NP.75”, Arrowhead Brass Products, Zurn or Approved Equal.
3. Where indicated on the Drawings, hose faucets shall be equipped with hose connection vacuum breakers. Hose connection vacuum breakers shall be provided with 3/4-inch hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc.
4. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements.
5. Hose connection vacuum breakers shall be equipped with manual drain. Hose connection vacuum breakers shall be Febco “Series 731”, Watts Regulator Company “Series 8”, Wilkins “Model BFP 8” oe Approved Equal.

I. Hose Valves:

1. Each angle type hose valve shall consist of an angle valve and hose nipple. Angle valves shall be Class 150 angle type with bronze body, EPDM disc, union bonnet, rising stem, and threaded ends.
2. Angle type hose valves shall be Stockham “B-222T”, Milwaukee, Powell or Approved Equal. Hose nipples shall be one piece, cast brass or bronze, with male NPT and male hose thread ends. A cap and chain shall be provided for hose valves in interior locations. Hose nipples shall be Potter-Roemer, Inc. “2830 Series”, Croker Corp., Elkhart Brass or Approved Equal.
3. Each in-line hose valve shall consist of a straight pattern globe valve. Straight pattern type globe valves shall consist of a brass body with extended valve stem, handwheel, union bonnet, rising stem, and threaded ends.
4. In-line type hose valves shall be Potter-Roemer, Inc. “4120 Series”, Guardian Fire Equipment, Inc. “5320 Series” or Approved Equal.
5. All hose valves shall be 1-1/2-inch size unless otherwise indicated on the Drawings.

J. Wall Hydrants:

1. Wall hydrants shall be freeze proof type with bronze body, polished bronze or chrome plated face, integral vacuum breaker, and removable handle key.
2. Wall hydrants shall be provided with ¾ inch pipe thread inlet and ¾ inch male hose thread outlet. Wall hydrants shall be ASSE 1019-B approved.
3. Wall hydrants shall be Smith “Model 5619”, Zurn “Z1321-C”, Prier “Model C-634” or Approved Equal.

2.10 PLUMBING EQUIPMENT

A. General:

1. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

B. Water Heaters and Accessories:

1. Water heaters shall be furnished and installed where indicated on the Drawings.
2. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated on the Drawings.

2.11 PLUMBING FIXTURES AND ACCESSORIES

A. General:

1. Fixtures shall be water conservation type, in accordance with ASHRAE 189.1 Section 6.3.2.1 (Plumbing fixtures and Fittings).
2. Fixtures for use by the physically handicapped shall be in accordance with ICC A117.1.
3. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces.

4. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.
5. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers.
6. Internal parts of flush valves and flushometer valves, shower mixing valves, shower head face plates, pop-up stoppers of lavatory waste drains, and pop-up stoppers and overflow tees and shoes of bathtub waste drains may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 year.
7. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature.

B. Automatic Controls:
   1. Flushing and faucets systems shall consist of solenoid-activated valves with light beam sensors. Flush valve for water closet shall include an override pushbutton.

C. Access Panels:
   1. Provide flush mounting access panels as required for service of valves, drains, test connections, and other Item requiring maintenance or inspection.
   2. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly.
   3. Ceiling access panels to be minimum 24-inch x 24-inch or required and approved size.
   4. Wall access panels to be minimum 12-inch x 12-inch or required and approved size.
   5. See Division 08 for additional requirements.

D. Water Closets:
   1. General:
      a. Water closets shall be ASME A112.19.2 vitreous china, with an elongated bowl and siphon jet flushing action. The type and water use of water closets shall be as indicated on the Drawings.
      b. All water closets top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve and provided with anchor bolt caps. Water flushing volume of the water closet and flush valve combination shall not exceed 1..6 gallons per flush and shall be provided with anchor bolt caps.
      c. Flush valve type water closets shall be provided with top spud connections for flushometer valves. Flush tank type water closets shall be provided with factory installed tank liners. Field installed liner kits will not be acceptable.
      d. Water closets shall be manufactured by American Standard, Kohler, Eljer or Approved Equal.

2. Seats:
    a. Water closet seats shall be white, solid plastic, contoured, elongated open front type without cover, with concealed check and stainless steel hinges.
    b. The seats shall be manufactured by American Standard, Kohler, Eljer, Church or Approved Equal.
3. Flush Valves:
    a. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel.
    b. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve shall not interfere with the hand rail in ADA stalls. Flush valves for top spud type water closets shall be exposed type, with a chrome plated brass body, an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 1 inch NPT water supply connection.
    c. Flush valves shall be Sloan "Royal 111", Delaney, Zurn or Approved Equal.
4. Supply Set:
    a. A supply set consisting of a 1/2 inch NPT brass angle loose key stop valve, a copper supply tube, and an escutcheon plate shall be furnished for each tank type water closet.
    b. All supply components shall be polished chrome.
5. Chair Carriers:
    a. Wall-mounted water closets shall be provided with adjustable chair carriers. The carriers shall be suitable for the chase depth and piping arrangement and shall consist of a heavy-duty cast iron body, complete with a drainage fitting, pylon feet, a drainage nipple, fitting and fixture gaskets, a positioning frame or template, and mounting hardware.
    b. Chair carriers shall be manufactured by Smith, Josam, Wade or Approved Equal.

E. Lavatories:
1. General:
    a. Lavatory types, dimensions, and water use shall be as indicated on the Drawings.
    b. Lavatories shall be of ASME A112.19.2 vitreous china provided with two integral molded lugs on the back-underside of the fixture, drilled for bolting to the wall in a manner similar to the hanger plate, constructed with overflow drains and soap depressions.
    c. Minimum dimensions of 19 inches wide by 17 inches front to rear, with supply openings for use with top mounted centerset faucets.
    d. Furnish template and mounting kit by lavatory manufacturer. Provide aerator with faucet. Water flow rate shall not exceed 0.5 when measured at a flowing water pressure of 60 psi.
    e. Mount counter with the top surface 34 inches above floor and with 29 inches minimum clearance from bottom of the counter face to floor.
    f. Countertop lavatories shall be self-rimming, and shall be provided with suitable adhesive and/or fastening clamps.
    g. Wall-mounted lavatories shall be drilled for a concealed arm carrier. Faucet drillings shall be 4 inches on center unless otherwise indicated.

h. Lavatories shall be manufactured by American Standard, Kohler, Eljer or Approved Equal.

2. Faucets and Trim:
   a. Lavatory faucets shall be 4 inches on center, of polished chrome, with a vandal-resistant single-lever handle and all-brass or copper waterways. Each faucet shall be provided with a flow restrictor, a cast brass grid strainer or pop-up drain as indicated on the Drawings, and a 1 1/4-inch cast brass tailpiece.
   b. Flow restrictors shall limit water flow as required in section 2.10.F.d or by the applicable codes and standards. Supply sets consisting of 1/2 inch NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be furnished for each lavatory faucet.
   c. All supply components shall be polished chrome. Where indicated to be ADA compliant and exposed to human contact, lavatory supplies shall be insulated.
   d. Lavatory faucets and supply sets shall be manufactured by American Standard, Kohler, Eljer or Approved Equal.
3. Traps:
   a. Lavatory traps shall be at least 1 1/4 inches in diameter, cast brass with polished chrome finish, with an escutcheon flange and a cleanout plug.
   b. Where indicated to be ADA compliant and if exposed to human contact, lavatory traps shall be offset, insulated type.
   c. When insulation is needed, lavatory supplies and traps may be pre-insulated or furnished with an insulation kit for field installation. Insulating material shall be flame retardant closed cell vinyl.
   d. The supply insulating kit shall be snap form type or shall be provided with ties. The trap insulation material shall not require the use of ties or mechanical fasteners to be held in place. Pre-insulated traps and supply insulation kits shall be McGuire Products "ProWrap" or Approved Equal.
   e. Trap and supply insulation kits shall be as manufactured by IPS Corporation-Truebro, Plumberex, Buckaroos, Inc or Approved Equal.
4. Supports:
   a. Wall-hung lavatories shall be provided with a complete ASME A112.6.1M concealed chair carriers with vertical steel pipe fixture support system, including support legs, bearing plates, concealed arms, and anchor bolts. The support legs shall be mounted within the partition wall. For lavatories mounted on masonry walls, support legs may be omitted.
   b. Lavatory supports shall be manufactured by Smith, Josam, Wade or Approved Equal.

2.12 DRAINAGE AND VENT PIPING ACCESSORIES

A. Cleanouts:
   1. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes, and shall be of the required type. Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor.

2. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building.
3. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs, and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall.
4. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron Floor cleanouts shall consist of a two-piece body, a threaded plug, an adjustable head, and a cover.
5. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.
6. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T pattern, 90-degree drainage fitting.
7. Cast iron cleanouts shall be manufactured by Smith, Josam, Wade or Approved Equal. Polypropylene cleanouts shall be manufactured by Orion, Enfield, Zurn or Approved Equal. PVC cleanouts shall be manufactured by Sioux Chief, Plastic Oddities, Zurn or Approved Equal.

B. Floor Drains:
1. Floor drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar.
2. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection.
3. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint.

4. Floor drains shall conform to ASME A112.6.3. Provide drain with trap primer connection, trap primer, and connection piping when indicated on the Drawings. Primer shall meet ASSE 1018. Floor drains shall be of the types specified herein and indicated on the Drawings.
5. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.
6. Cast iron floor drains shall be manufactured by Smith, Josam, Wade or Approved Equal. Polypropylene floor drains shall be manufactured by Orion, Enfield, Zurn or Approved Equal. PVC floor drains shall be manufactured by Sioux Chief, Plastic Oddities, Zurn or Approved Equal.

C. Vent Flashing:
1. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Equipment Mounting:
1. Procedures: Section 43 05 13
   a. Install equipment for the Equipment Mounting Systems specified in Division 22 and in accordance with the Equipment Mounting Schedule specified in Section 43 05 13.
2. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts, and water heaters) so that they may be serviced, reset, replaced, or recalibrated. Do not install equipment in obvious passageways, doorways, scuttles, or crawlspaces which would impede or block intended usage.
3. Install equipment and fixtures in accordance with manufacturer's installation instructions
   a. Maintain manufacturer's recommended clearances.
   b. Install plumb, level, and firmly anchored to vibration isolators per 22 00 00 – 1.03 D.
   c. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly.
   d. When requirements of installation instructions conflict with Construction Documents, request clarification from the Engineer prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines
4. Furnish and install all fixtures with traps and vents unless otherwise specified on the Drawings.
5. Furnish and install all supports, bracing and blocking required for the proper installation of the work specified.
6. Furnish and install miscellaneous supports/metal required for installation of equipment, piping, and vents

7. Sinks that are installed in countertops shall be delivered to the countertop manufacturer so that openings can be coordinated. Sink shall then be shipped to the job site for final installation.

B. Piping and Equipment Identification: Sections 22, 40, and 43.

C. Piping and Valves:
   1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors, or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products, and rating for coordinating installation of piping systems.
   2. Include provisions for servicing and removal of equipment without dismantling piping.
   3. Provide unions, couplings, or flanges where equipment is installed in piping. Unions shall be dielectric unions or couplings At points of connection of ferrous to non-ferrous metal piping, unions, couplings, or flanges shall by dielectric type.
   4. Provide a shut-off stop valve in the branch of every water, air, gas, or vacuum pipe service upstream of every fixture or outlet.
   5. Except for condensate drains, provide valves where equipment drain connections are furnished and carry the discharge pipe to the nearest floor drain, drain trench, or sump. Where no receptacle for drain exists, install drain piping to 1-inch above the floor. Drain piping and valve materials shall conform to the requirements of the system served.
   6. Install escutcheons secured to pipe with set-screw where pipes or tubing pass through exposed walls or ceilings.
   7. Plumbing piping shall not be concrete encased unless otherwise specified on the Drawings.

D. See the Division 22 specifications sections for additional requirements.

E. Water hammer arrestors shall be installed in water systems upstream of each solenoid valve, quick closing valve, and emergency shower or eyewash.

F. Water hammer arresters shall be provided on hot- and cold-water supplies and shall be located, with precise location and sizing, in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

G. Trap primers shall meet ASSE 1018. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol “TPP” and an identifying number. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations.

3.02 COATINGS

A. Per this specification

3.03 CLEANING

A. Prestartup Requirements:
   1. Prior to testing, thoroughly clean the inside of each completed piping system of all dirt, loose scale, sand, and other foreign material.
   2. Cleaning shall be by sweeping, flushing with water or blowing with compressed air, as appropriate for the size and type of pipe.
   3. Flushing shall achieve a velocity of at least 3 feet per second.
   4. The contractor shall install temporary strainers, temporarily disconnect equipment, or take other appropriate measures to protect equipment while cleaning piping.

B. Post Startup Requirments:
   1. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.
   2. Disinfect potable water lines per AWWA C-651
   3. A report shall be provided indicating the successful cleaning of the potable water lines, method used to determine the cleanliness, and results of any tests is required.

3.04 STARTUP REQUIREMENTS

A. System equipment shall be subject to preliminary field tests as indicated in Equipment Startup and Checkout section

3.05 FIELD TESTING AND INSPECTIONS

A. Test all plumbing systems and arrange for inspection by the Authorities Having Jurisdiction.

B. General:
   1. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections.
   2. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Owner's Representative.
   3. All tests shall be conducted in a manner acceptable to Owner's Representative and shall be repeated as many times as necessary to secure Owner's Representative acceptance of each system.
   4. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated.
   5. All repairs to piping shall be made with new materials.
   6. Caulking of threaded joints or holes will not be acceptable.

C. Perform leakage tests on all pipe installed in this project or on any alterations or extensions of existing. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Owner. All visible leaks shall be repaired, regardless of the test results.

D. The test pressure, allowable leakage, and test medium shall be as specified for the piping systems. Test pressure shall be measured at the highest point on the line, except that pressure at lowest point shall not exceed pipe manufacturer's rated test pressure, unless specifically noted otherwise.

E. All visible leaks shall be repaired, regardless of the test results.

F. Perform following operations and checks before units are operated for any purpose:
   1. Verify shipping blocking and bracing have been removed.
   2. Verify unit is secure on mountings and supporting devices and connections for piping, electrical, etc. are complete. Verify proper thermal overload protection is installed in motors, starters and disconnects.
   3. Perform specified cleaning and adjusting. Disconnect pump drives from motors, verify proper motor rotation, and verify free rotation and smooth operation of bearings. Reconnect drive systems, align , and install guards.
   4. Lubricate bearings and other moving parts with factory-recommended lubricants.
   5. Disable automatic temperature control operators, where applicable.

G. Start-up equipment, in accordance with manufacturer's start-up instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial check of systems.
   2. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Document tests and include in Operation and Maintenance Manuals.

H. The equipment and controls of this Section shall be completely tested, adjusted, and placed in operating condition.

I. Retest equipment and controls, as necessary, during the progress of the work. No work shall be covered until it is properly tested and made tight.

J. Replace damaged or malfunctioning controls and equipment with new. Refurbished is not acceptable.

K. When about to turn the apparatus over to the Owner, put all parts of the apparatus in perfect working order and thoroughly clean out all parts of the equipment.

L. Clean exterior and interior surfaces of each unit.

3.06 TESTING, TRAINING, AND COMMISSIONING

A. In accordance with Section 01 45 23 – Testing and Inspection Services

B. Upon completion of work and adjustment of equipment and systems testing, demonstrate to the Owner's Representative that equipment furnished and installed or connected under provisions of these Specifications functions in manner required.

END OF SECTION

SECTION 22 10 01

PIPING SYSTEM SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

Process Service Identifier	Process Service	Piping System Schedule	Fluid Category	Pipe Marker Background Color
SD	Sanitary Drain		Wastewater	[Green]
PW	Potable Water		Water	[Dark Blue]
3W	Nonpotable Water		Water	[Purple]

1.02 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Pipe Connections and Joints:
1. BABS – Bell and Ball Spigot
2. BAS – Bell and Spigot
3. BSS – Bolted Split Sleeve Coupling
4. BW – Butt Weld
5. CGRV – Cut (or Cast) Grooved End Coupling
6. CPLG – Coupling
7. CPRSN – Compression
8. FLG – Flanged
9. FLRD – Flared
10. FP – Full Penetration
11. FSW – Fusion Socket Weld
12. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
13. HLF CPLG – Half Coupling
14. LR ELL – Long Radius Elbow
15. PGRV - Proprietary Groove Coupling
16. PO – Push-on

17. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
18. RGRV – Rolled Grooved End Coupling
19. RMJ – Restrained Mechanical Joint
20. SLV – Solvent Weld
21. SLDR – Solder or Brazing
22. SR ELL – Short Radius Elbow
23. SW – Socket Weld
24. THD – Threaded
25. UN – Union

C. Flanges:
   1. FF – Full Face
   2. RF – Raised Face
   3. SO – Slip-On
   4. THD – Threaded
   5. WN – Weld Neck

D. Materials:
   1. DI – Ductile Iron
   2. SS – Stainless Steel
   3. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
   1. FP – Full Penetration
   2. SML – Seamless
   3. WLD – Welded

F. Other:
   1. CFT - Cured Film Thickness
   2. DFT – Dry Film Thickness
   3. Dim – Dimensions
   4. M or E Pipe – Matches or exceeds rating of connecting pipe
   5. Thk – Thickness
   6. Sch – Schedule
   7. Std – Standard
   8. STD – Standard Weight or Standard

1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.9	Building Services Piping
ASME B32	Solder Metal
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME B1.1	Unified Inch Screw Threads
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A126	Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135	Electric-Resistance-Welded Steel Pipe
ASTM A181/181M	Forgings, Carbon Steel, for General Purpose Piping
ASTM A182/182M	Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A320/320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A536	Ductile Iron Castings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals

Reference	Title
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C110	Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
AWWA C153	Ductile-Iron Compact Fittings
AWWA C200	Steel Water Pipe, 6 Inches and Larger
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C301	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
AWWA C600	Installation of Ductile-Iron Water Mains and their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA M11	Steel Pipe - A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-S-8660C	Silicone Compound
MIL-STD-810C	Environmental Test Methods
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
NSF/ANSI 61:	Drinking Water System Components – Health Effects
SSPC	Society for Protective Coatings
IPC	International Plumbing Code

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe size (nominal diameter) and the Process Service Identifier for the contents of the pipeline are specified in pipe line labels on the drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

PART 3 SCHEDULES

3.01 PIPESPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this Section. Piping System Schedules are assigned a Section number in the range from 40 05 02.00 through 40 05 02.99.

END OF SECTION

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SECTION 23 00 00

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) BASIC REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Scope: This Section specifies the general requirements for all of the HVAC materials, labor, tools, permits, incidentals, and other services included in Division 23 and elsewhere wherever specifically mentioned in the Specifications.
   1. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

B. Environmental Conditions: See Section: 01 11 80

C. Fasteners: unless indicated otherwise.
   1. Bolts - ASTM A193, grade B8M Class 1 or ASTM A320 B8M Class 1
   2. Nuts – ASTM A194, grade 8M
   3. Washer – 316 SS

D. Governing Standards:
   1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance the more stringent requirements shall govern.
   2. All work shall comply with UL safety requirements.

E. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

F. Coordinate with other trades (e.g., Plumbing, Fire Protection, Structural) for routing of equipment and connection points

G. Power Supply:
   1. Power supply to equipment with motors shall be as indicated by manufacturer. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

H. Metal Thickness:
   1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.02 DEFINITIONS

A. Terminology used in this specification conforms to the following definitions:
   1. Authorities Having Jurisdiction: Indicates reviewing authorities, including local building official, local fire marshal, Owner, and other reviewing entity whose approval is required to obtain system acceptance.
   2. ACH: Air changes per hour.

3. SCFM: Standard cubic feet per minute.
4. ACFM: Actual cubic feet per minute
5. Ft^2: Square foot.
6. TAB: Testing and Balancing.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and therefore requested by the Manufacturer, underline each deviation and denote by a number in the margin to the right of the identified paragraph. Provide a detailed, written justification for each deviation. The Owner Representatives shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

B. Action Submittal Items for this Section:
   1. A copy specification section, with addendum updates included and each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. If the specification includes the submittal item, revise the text of the submittal item to conform to the phrasing listed in the specifications.
   3. Manufacturer's data including materials of construction, construction details of equipment, wiring diagrams, weight of equipment, mounting, seismic bracing, and support.
   4. Drawings showing general dimensions and confirming the size of equipment, fixtures, motors and drives, and piping connections. (Shop drawings)
   5. Performance curves for pumps and fans developed for the specific application. Performance curves shall show speed, capacity, pressure, and power for specified conditions.
   6. Shop and field painting systems. Include manufacturer's descriptive technical catalog literature and specifications.
   7. Shop Drawings including the physical characteristics of all systems, equipment, and piping layout plans, and control wiring diagrams.
   8. Operation and Maintenance Information: Section 01 78 23.
   9. Samples, where required by the specification section.
   10. Rigid Equipment Mount Installation Checklist (Form 46 05 29-A).
   11. See Division 23 specifications sections for additional requirements.
   12. Certificates of Unit Responsibility.
   13. Sound Power rating for both fan inlet and outlets at rated capacity.
   14. Installation forms in accordance with Section 43 05 13.

15. Testing and Commissioning forms in accordance with Sections 23 05 93 and 23 08 00.

C. Informational Submittal for this Section:
   1. Structural Design and Anchorage: Section 01 73 24.

D. Operations and Maintenance Data and Manuals:
   1. Adequate operation and maintenance information shall be supplied as required in the Submittals section and Equipment Operating and Maintenance
   2. Manual Information section: Operation and maintenance manuals shall be submitted in accordance with the Submittals section and Equipment Operating and Maintenance Manual Information section.

E. Drawings and Data:
   1. The data and specifications for each unit shall include, but shall not be limited to, the following:
      a. Fans:
         1) Name of manufacturer.
         2) Type and model.
         3) Construction materials, thickness, and finishes.
         4) Overall dimensions and required clearances.
         5) Net weight and load distribution.
         6) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in SCFM as the abscissa and brake horsepower, total static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.
         7) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
         8) Where specified, information on equipment manufacturers' representatives.
      b. Equipment (all other types):
         1) Name of manufacturer.
         2) Type and model.
         3) Construction materials, thickness, and finishes.
         4) Manufacturer's performance data.
         5) Overall dimensions and required clearances.
         6) Net weight and load distribution.
         7) Wiring diagrams.
      c. Temperature controls:
         1) Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.

2) Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.
3) Sequence of operation for each system corresponding to the control schematics.
4) Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.
5) Space thermostat schedule indicating the types of covers and means of adjustment for each space.
6) Conduit and wire types.
7) Where specified, information on equipment manufacturers' representatives.

d. Seismic Design Requirements:
1) Confirmation of compliance with the requirements of the Special Provisions section.

e. Operation and Maintenance Data and Manuals:
1) Adequate operation and maintenance information shall be supplied as required in Section 01 78 23 and Section 01 33 00. Operation and maintenance manuals shall be submitted in accordance with Section 01 33 00. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the rules and regulations of Authorities Having Jurisdiction over the work specified herein, including all adopted state and local building codes including plumbing, mechanical, fire, building, and electrical.

B. Welding Qualifications:
1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS or ASME Standard Qualification Procedures.
2. All procedure and operator qualifications shall be in written form and subject to Engineer review.
3. Accurate records of operator and procedure qualifications shall be maintained by Supplier and made available to Engineer upon request.
4. The mechanical system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Manufacturers Experience: Unless the equipment manufacturer is specifically named in this Section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

D. Reference Standards:
   1. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
AABC	Associated Air Balance Council, National Standards for Total System Balance
ADA	Americans with Disabilities Act
AHRI	Air-Conditioning Heating & Refrigeration Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineering
ASTM	ASTM International
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CSA	CSA International
ETL	Electrical Testing Laboratories
EPA	Environmental Protection Agency
FDA	Food & Drug Administration
FM	Factory Mutual Global
IAPMO	International Association of Plumbing and Mechanical Officials
HI	Hydraulic Institute Standards
ISO	International Organization for Standardization
MSS	Manufacturers Standardization Society
NEBB	National Environmental Balancing Bureau, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
UL	Underwriters Laboratories Inc.
IBC	International Building Code
IFC	International Fire Code

Reference	Title
IMC	International Mechanical Code
IPC	International Plumbing Code
UPC	Uniform Plumbing Code
UL 1995	Heating and Cooling Equipment

E. Unit Responsibility:
   1. The Supplier shall furnish and install equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Supplier of his responsibility to the Owner's Representative and Owner for performance of all systems in the contracted scope of supply.
   2. The Supplier shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Supplier to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.
   3. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Section 01 33 00 - Submittal Procedures. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable.

F. Manufacturer's Instructions:
   1. Follow manufacturer's written instructions.
   2. If in conflict with Construction Documents, obtain clarification.

3. Notify the Owner's Representative in writing before starting work.

G. Drawings:
   1. The Drawings shall be taken as diagrammatic, unless otherwise noted.
   2. Size of ductwork and pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered.

1.05 DELIVERY, STORAGE AND HANDLING

A. Shipping, handling and storage shall be in accordance with the Delivery, Storage, and Handling section.

1.06 COORDINATION

A. Supplier shall verify that each component of the HVAC system is compatible with all other parts of the system; that all piping, ductwork, equipment, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

B. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. Each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply.

D. Information on equipment manufacturers' representatives shall be included with the submittals.

E. The equipment as shown on the plans and specified herein, is based on the equipment furnished by one manufacturer. An equipment which is offered as a substitute to the specific requirements of these Specifications and which differs in detail and arrangement from that shown may require changes in design and construction. All costs which result from such changes in design and construction are to be borne entirely and unconditionally by the Contractor and/or the manufacturer; said costs to include but not be limited to structural, piping, mechanical and electrical changes and all engineering costs incurred as a result of the substitution, in the revision of Plans and Specifications, review of design changes by others, preparation of change orders, and any other costs directly resulting from said substitution.

1.07 APPURTENANCES

A. Furnish and install all necessary guides, inserts, anchors and assembly bolts, washers and nuts, hangers, supports, gaskets, couplings, and flanges; and all other appurtenant items shown on the Drawings, specified, or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.

PART 2 PRODUCTS

2.01 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.02 MANUFACTURERS AND FABRICATION

A. Provide like items from one manufacturer, including but not limited to: fans, air handlers, air conditioning units, heat pump units, heaters, vibration isolation devices, etc.

B. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

C. Anchor Bolts and Expansion Anchors: Section 05 05 20.
   1. Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt, washer and nut materials shall conform to the requirements above with the provisions of Section 05 05 20 unless otherwise indicated on the Drawings.

2.03 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.04 PERFORMANCE REQUIREMENTS

A. See Section 43 05 11.

B. All air moving equipment fans shall be sized such that the correct SFCM is the output ACFM at the hottest, most humid condition with enough horsepower for the coldest inlet temperature. All controls shall have a temperature reset based on the outside temperature adjusting for the proper SCFM or ACH.

C. Coordination:
   1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
   2. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Owner’s Representative, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
   3. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

4. The independent TAB agency shall be contracted prior to construction to do “balancability reports”. The TAB agency shall perform periodic site walk throughs to identify items prior to testing. These include but are not limited to finding located or missing dampers and valves, variable air volume (VAV) box sizing, piping issues, duct sealing, and issues with building pressures.
5. Prior to official cleaning, testing, adjusting, and balancing, the mechanical contractor shall pre-test each section prior to any air balance agency testing, inspector witnessing, mechanical engineer witnessing, duct insulation installation, duct shafts are closed up, or any other structural construction that will have an impact is continued. Return air ducts and exhaust may be tested with positive pressure.
6. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.
7. Mechanical contractor is responsible for coordinating with the project air balance agency.
8. For additional TABB coordination requirements consult Division 23 and the following Specifications:
    a. Testing Adjusting and Balancing for HVAC: Specification 23 05 93.
    b. Commissioning of HVAC: Specification 23 08 00.
    c. Sheetmetal Ductwork and Accessories: Section 23 30 00.
    d. Other ductwork as required
9. Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct-mounted equipment, and control components.

D. General Equipment Stipulations:
1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the Special Provisions section, the requirements specified herein shall take precedence.
2. Unless otherwise noted, all equipment handling air shall meet the duct seal and leakage classes per 23 30 00. Manufacturer shall provide test data confirming cabinet construction can meet the requirement

E. Seismic Design Requirements: Seismic design requirements for products specified herein shall be as indicated in the Section 01 73 24.

F. Insulation Requirements: See Section 23 07 00.
1. Equipment and products shall meet the minimum performance requirements identified in the Division 23 Specifications.

G. Design Criteria:
1. Design of HVAC equipment shall be based on the atmospheric conditions at the project site. Temperature, humidity, prevailing wind speed and direction, elevation, corrosive or contaminated environments, and human comfort shall be considered, as applicable.
2. Equipment sizing shall be based on Environmental Conditions: See Section: 01 11 80

H. Dimensional Restrictions:
   1. Layout dimensions will vary between manufacturers. At least 3 feet of clear access space shall be provided on all sides of the unit
   2. Equipment shall be designed to operate at the elevation indicated ENVIROMENTAL CONDITIONS: See Section: 01 11 80. All equipment furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

I. Type, Performance, Characteristics, Arrangement, Accessories: As noted in the Division 23 specification sections.

J. Fans and Shafts:
   1. Statically and dynamically balanced per AMCA 204 fan application category BV-3 (ISO 1940 Grade 6.3) or better and designed for continuous operation at maximum rated fan speed and motor horsepower.
   2. Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.

K. Electric Motor General Requirements:
   1. Designed for continuous operation in 40°C environment.
   2. For temperature rise in accordance with NEMA MG-1 limits for insulation class, service factor, and motor enclosure type.
   3. Type specified, scheduled, or noted for respective units.
   4. The use of ECM motors on HVAC equipment, up to 10 HP is acceptable with engineering concurrence. Coordinate with engineer

L. Provide ductwork and equipment supports, hangers, guides, and anchors as specified herein.

M. When standard hangers, supports, and accessories are not adequate the Contractor shall employ a registered Structural Engineer, registered in the state where the work is to be installed, to prepare design calculations for all such supports, hangers, and accessories for seismic restraint needed for the ductwork and equipment installation. Calculations and shop drawings shall be signed by the above-named engineer and submitted to the Owner’s Representative.

N. Special Features for Hazardous Environments:
   1. Provide for particular units when noted or scheduled on Drawings, spark proof fan wheels and explosion proof motors.

2.05 MATERIALS

A. Base contract upon furnishing materials as specified.

B. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, or CSA approved, or have adequate approval or be acceptable the Authorities Having Jurisdiction.

C. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

D. Gas piping shall be A53 Grade B seamless or A106 Grade B.

2.06 COATINGS

A. Surface Preparation:
   1. All fabricated surfaces from ferrous metal, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations.
   2. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

B. Coatings shall be electrostatically coated (e-coat) and uniformly applied. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness. After e-coat cure, equipment shall receive a spray-applied, polyurethane black topcoat to prevent UV degradation of epoxy e-coat film. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

C. Submit product data on the type coating selected, the coating thickness, the application process used to meet the requirements below and verification of conformance with the salt spray test requirement.
   1. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer.

D. Coils/HX exposed to ambient
   1. No material bridging is allowed, including enhanced and micro-channel fin designs
   2. Submit the estimated heat transfer loss of the coil. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation

E-Coating Requirements

Coating Quality	Test Procedure	Coating Performance (Nominal plus)
Dry Film Thickness	ASTM D7091	1 mil
Water Immersion	ASTM D870	1000 hrs
Cross Hatch Adhesion	ASTM B3359	4B-5B Rating
Salt Spray	ASTM B117 ASTM B117-G85	6000 hrs 2000 hrs
Heat Transfer Reduction (Coils Only)	AHRI 410	<1%
Humidity	ASTM D1735	1000
Operating pH Range	N/A	3-12
Temperature		-40 F to 300 F (Coils Only) See 01 11 80
Weathering (topcoat)	ASTM 4587	2200

2.07 COLOR

A. Equipment shall have the manufacturer's standard color unless otherwise indicated in the schedules or specifications.

B. Equipment may use the manufacturer's finish if it meets the criteria above or otherwise indicated in the schedules or individual specifications.

2.08 ELECTRICAL

A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein.

B. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

C. See section 40 67 00 for controls and control panel requirements.

2.09 ACCESS PANELS/DOORS

A. General: Provide flush mounting access panels as required for service of valves, drains, and test connections and other Item requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24-inch x 24-inch or required and approved size. Wall access panels to be minimum 12-inch x 12-inch or required and approved size. Babcock-Davis Series BN (non-rated), BI series (rated) or equal. All panels/doors shall incorporate doors/access panels with air seals suitable to provide airtight seal shall be provided between door and frame. The door swing shall be such as to open against system pressures.

2.10 AIR FILTRATION

A. General: Air filters in air handlers shall be 2-inch thick, MERV 8, pleated, disposable filters unless noted otherwise in Division 23 sections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Equipment Mounting:
   1. Procedures: Section 43 05 13
      a. Install equipment for the Equipment Mounting Systems specified in Division 23 and in accordance with the Equipment Mounting Schedule specified in Section 43 05 13.
   2. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts, and water heaters) so that they may be serviced, reset, replaced, or recalibrated. Do not install equipment in obvious passageways, doorways, scuttles, or crawlspaces which would impede or block intended usage.
   3. Install equipment and fixtures in accordance with manufacturer's installation instructions
      a. Maintain manufacturer's recommended clearances.

b. Install plumb, level, and firmly anchored to vibration isolators per manufacturer's requirements.
c. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly.
d. When requirements of installation instructions conflict with Construction Documents, request clarification from the Engineer prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines

4. Furnish and install all supports, bracing and blocking required for the proper installation of the work specified.
5. Furnish and install miscellaneous supports/metal required for installation of equipment, ductwork, piping, and vents

B. Piping and Equipment Identification: Divisions 33, 40, and 43.

C. Piping and Valves:
1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors, or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products, and rating for coordinating installation of piping systems.
2. Include provisions for servicing and removal of equipment without dismantling piping.
3. Provide unions, couplings, or flanges where equipment is installed in piping. Unions shall be dielectric unions or couplings at points of connection of ferrous to non-ferrous metal piping, unions, couplings, or flanges shall by dielectric type.
4. Provide a shut-off stop valve in the branch of every water, air, gas, or vacuum pipe service upstream of every fixture or outlet.
5. Except for condensate drains, provide valves where equipment drain connections are furnished and carry the discharge pipe to the nearest floor drain, drain trench, or sump. Where no receptacle for drain exists, install drain piping to 1-inch above the floor. Drain piping and valve materials shall conform to the requirements of the system served.
6. Install escutcheons secured to pipe with set-screw where pipes or tubing pass through exposed walls or ceilings.

D. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify the Owner's Representative of discrepancy.

E. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.

3.02 COATINGS

A. Per this specification and Section 09 90 00.

3.03 CLEANING

A. Prestartup Requirements:
   1. Prior to testing, thoroughly clean the inside of each completed piping system of all dirt, loose scale, sand, and other foreign material.
   2. Cleaning shall be by sweeping, flushing with water or blowing with compressed air, as appropriate for the size and type of pipe.
   3. Flushing shall achieve a velocity of at least 3 feet per second.
   4. The contractor shall install temporary strainers, temporarily disconnect equipment, or take other appropriate measures to protect equipment while cleaning piping.

B. Post Startup Requirements:
   1. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.
   2. Upon completion of the duct system cleaning, the duct system shall be visually inspected for cleanliness to verify no visible contaminants are present to the satisfaction of Owner's Representative.
   3. If the visual inspection is inconclusive, then additional tests in accordance with the National Air Duct Cleaners Association shall be performed. Any ducts that are considered not to be clean by the Owner's Representative shall be re-cleaned and re-tested. Any damaged materials or surfaces shall be repaired or replaced.
   4. A report shall be provided indicating the successful cleaning of the ductwork, method used to determine the cleanliness, and results of any tests is required.

3.04 STARTUP REQUIREMENTS

A. System equipment shall be subject to preliminary field tests as indicated in Equipment Startup and Checkout section

3.05 FIELD TESTING AND INSPECTIONS

A. Test all HVAC systems and arrange for inspection by the Authorities Having Jurisdiction.

B. General:
   1. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections.
   2. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Owner's Representative.
   3. All tests shall be conducted in a manner acceptable to Owner's Representative and shall be repeated as many times as necessary to secure Owner's Representative acceptance of each system.
   4. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated.
   5. All repairs to piping shall be made with new materials.
   6. Caulking of threaded joints or holes will not be acceptable.

C. Perform leakage tests on all pipe installed in this project or on any alterations or extensions of existing. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Owner. All visible leaks shall be repaired, regardless of the test results.

D. The test pressure, allowable leakage, and test medium shall be as specified for the piping systems. Test pressure shall be measured at the highest point on the line, except that pressure at lowest point shall not exceed pipe manufacturer's rated test pressure, unless specifically noted otherwise.

E. All visible leaks shall be repaired, regardless of the test results.

F. Perform following operations and checks before units are operated for any purpose:
   1. Verify shipping blocking and bracing have been removed.
   2. Verify unit is secure on mountings and supporting devices and connections for ductwork, electrical, etc. are complete. Verify proper thermal overload protection is installed in motors, starters and disconnects.
   3. Perform specified cleaning and adjusting. Disconnect fan drives from motors, verify proper motor rotation, and verify fan wheel free rotation and smooth operation of bearings. Reconnect fan drive systems, align belts, and install belt guards.
   4. Lubricate bearings and other moving parts with factory-recommended lubricants.
   5. Verify manual and automatic volume control dampers are positioned properly and that fire and smoke dampers in related ductwork are in full-open position.
   6. Disable automatic temperature control operators, where applicable.

G. Startup equipment, in accordance with manufacturer's startup instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   1. Do not place equipment in sustained operation prior to initial balancing of systems.
   2. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Document tests and include in Operation and Maintenance Manuals.

H. The equipment and controls of this Section shall be completely tested, adjusted, and placed in operating condition.

I. Retest equipment and controls, as necessary, during the progress of the work. No work shall be covered until it is properly tested and made tight.

J. Replace damaged or malfunctioning controls and equipment with new. Refurbished is not acceptable.

K. When about to turn the apparatus over to the Owner, put all parts of the apparatus in perfect working order and thoroughly clean out all parts of the equipment.

L. Clean exterior and interior surfaces of each unit. Vacuum clean fan wheel and surfaces exposed to the air handled by the unit.

M. Check damper operation and linkages. Adjust for proper damper operation.

N. Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
1 inch pleated	1.0 inch water column
2 inch pleated	1.0 inch water column

O. Perform ductwork pressure test prior to air balancing per 23 30 00 Sheet Metal Ductwork and Accessories.

P. All heating, ventilating, and air conditioning systems installed under this Section shall be carefully adjusted by a qualified Air Balancing Contractor to deliver and exhaust air quantities as specified or described herein while maintaining the spaces served at the design temperature and design air pressure differentials. A final balancing report shall be produced and submitted to the Owner showing the airflow SCFMs, fan statics, and motor amperages.

3.06 TESTING, TRAINING, AND COMMISSIONING

A. In accordance with Section 01 45 23 – Equipment and System Performance and Operational Testing

B. Upon completion of work and adjustment of equipment and systems testing, demonstrate to the Owner's Representative that equipment furnished and installed or connected under provisions of these Specifications functions in manner required.

C. Manufacturer's Field Services:
   1. Furnish services of a qualified person at time approved by Owner's Representative, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner's Representative that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work.
   2. Complete instruction and demonstration prior to final job site observations.

D. TABB Procedures and Requirements: See Section 23 05 93.

3.07 ROOF CURBS

A. Roof curbs to be mounted level on roof in accordance to NRCA manuals and details. Secure to structure per engineered/sealed seismic installation details.

B. Seal openings between curb, roof opening, ducts, electrical conduits, piping, and building interior.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. This Section covers the cleaning, testing, adjusting, and balancing of the air and hydronic system(s) associated with the process Hot Water and heating, ventilating, and air conditioning (HVAC) and odor control system(s).

B. Governing Standards:
   1. Except as modified or supplemented herein, all work covered by this Section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between any state law or local ordinance and this Section the latter shall take precedence.
   2. All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air and hydronic systems.

C. Work Included: Provisions for testing, adjusting, and balancing of HVAC systems under actual operating conditions and design flow rates, including:
   1. Taking pre-tests of existing systems as identified on the Drawings.
   2. Balancing airflow and water flow within distribution systems, including sub-mains, branches, and terminals, to specified quantities according to specified tolerances.
   3. Adjusting total HVAC systems to provide specified quantities.
   4. Measuring electrical performance of HVAC equipment.
   5. Setting quantitative performance of HVAC equipment.
   6. Verifying that automatic control devices are functioning properly.
   7. Measuring sound and vibration.
   8. Reporting results of the activities and procedures specified in this Section.

1.02 RELATED SECTIONS

A. As required by Section 23 00 00 and Division 01 - General Requirements.

1.03 SUBMITTALS (IN ADDITION TO 23 00 00)

A. Action Submittal Items for this Section:
   1. Drawings showing general dimensions and confirming the size of equipment, fixtures, motors and drives, and piping connections.
   2. Testing Forms in accordance with industry standards. Submit example for engineer's approval.
   3. Testing, Adjusting and Balancing Report as specified in this Section.

1.04 QUALITY ASSURANCE (IN ADDITION TO 23 00 00)

A. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
AABC	Associated Air Balance Council, National Standards for Total System Balance
ASHRAE Standard 70	Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets
NEBB	National Environmental Balancing Bureau, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems

B. Testing Agency: Procure the services of an independent air balancing and testing agency, belonging to the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB), to perform balancing, testing and adjustment of systems. One organization shall perform the testing and balancing services.

C. Codes and Standards: Comply with applicable procedures and standards of the certification sponsoring association referenced above, in addition to the following:
   1. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.

D. Special Requirements:
   1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
   2. Participate in verification of the testing and balancing report, which will consist of repeating measurements contained in the testing and balancing reports. Assist in diagnostic purposes when directed.
   3. Tests and adjustments shall include the complete testing and balancing of heating, ventilating, and air conditioning systems and necessary adjustments to the heating, air conditioning, and ventilating equipment to accomplish the specified design flow rates.
   4. Should any apparatus, material or work fail to meet the specified requirements in these tests, make the necessary corrections and retest the apparatus, material, or work at no additional cost to the Owner.

E. Coordination: Section 23 00 00.
   1. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
   2. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.05 BALANCING

A. General: Characteristics to be tested and adjusted to conform to the values specified include the following:
   1. Total airflow rates delivered by fans and air-handling units adjusted to SCFM.
   2. Flow rates at all louvers, grilles, registers, diffusers, supply and exhaust, and return ducts adjusted to SCFM.
   3. Capacity and temperature rise or drop across each heating and cooling coil.
   4. Flow rates across all dampers in foul air ductwork adjusted to SCFM.
   5. Distribution patterns at air outlets.
   6. Adjustment Tolerances
      a. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
      b. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
      c. Adjust supply, return, and exhaust air quantities to maintain pressurization in spaces specified on plans. Note and document room-to-room pressurization and maintain these relationships. Adjust pressure controlled spaces to within plus or minus 0.01 in WC.

B. Airflow Rate Measurements:
   1. Airflow rates shall be obtained by adjustment of the fan speeds, dampers, or registers. All flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation and with all doors and windows closed.
   2. Flow rates at grilles, registers, branch ductwork, and air distribution patterns shall be tested in strict accordance with ASHRAE Standard 70.

PART 2 PRODUCTS

2.01 REPORT DATA

A. The final certified balancing report shall include the following actual field-verified data:
   1. Equipment data:
      a. Manufacturer and model, size, arrangement, class, location, and equipment number.
      b. Motor horsepower, voltage, phase, and full load amperage.
      c. Fan curves including ACFM, SCFM, Air Stream Temperature, Total static pressure, RPM, and operating motor BHP.
      d. Pump curves including GPM, TDH, RPM, efficiency, and operating motor BHP.
      e. Coil size, GPM, MBH, and differential pressure.
         1) Duct size, supply or exhaust recorded ACFM, SCFM, velocity, pressure measurements, and location of all measurements.

2) Pump size, GPM, pressure measurements, and locations of all measurements.
3) Differential pressure, GPM, inlet and outlet air and water temperatures at heating and cooling coils.

B. Report Requirements:
1. Each individual final reporting form must bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
2. All instruments which were used shall be listed and identified including the last date each was calibrated.

C. Final Report: Final report shall be submitted prior to Supplier's request for final inspection. In addition to providing all specified data and information on applicable reporting forms, report shall include the following:
1. A schedule for testing and balancing parts of the systems which must be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Supplier. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the Owner.
2. Due to delayed testing, reports shall be submitted after execution of those services.
3. A total balance report shall include the following components:
a. General Information and Summary
b. Instrument Calibration
c. Air and Hydronic Systems
1) Pump curves.
2) Fan curves.
3) Manufacturers' test data.
4) Field test reports prepared by system and equipment installers.
d. Other information relative to equipment performance.
e. Record drawings with specified and measured flow rates

D. Complete apparatus report sheets for all air or hydronic systems shall be accurately and completely filled out. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals section. A description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

E. The apparatus report sheets shall include the following information:
1. Title Page:
a. Company name
b. Company address
c. Company telephone number
d. Project name
e. Project location

f. Project Engineer
g. Project Contractor
h. Project altitude
i. Date

2. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model
   d. Serial number
   e. Range
   f. Calibration date
   g. Equipment type/style (e.g., Rotating Vane anemometer)
3. Air Moving Equipment:
   a. Unit number
   b. Location
   c. Manufacturer
   d. Model and serial number
   e. Airflow, design and actual (SCFM)
   f. Total static pressure (total external), design and actual
   g. Static pressure, inlet and discharge
   h. Total pressure
   i. Fan RPM, design and actual
4. Electric Motors:
   a. Manufacturer
   b. Motor type and frame
   c. HP/BHP
   d. Phase, voltage, amperage, nameplate, actual, no load.
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
5. Return Air/Outside Air Data:
   a. Unit number
   b. System airflow, design and actual (SCFM)
   c. Return airflow, design and actual (SCFM)
   d. Outside airflow, design and actual (SCFM)
   e. Return air temperature
   f. Outside air temperature
   g. Mixed air temperature, design and actual
   h. Outside/return air ratio, design and actual (SCFM)
6. Duct Traverse:
   a. System zone/branch
   b. Duct size

c. Area
d. Velocity, design and actual
e. Airflow, design and actual (SCFM)
f. Duct static pressure
g. Air temperature
h. Air correction factor

7. Outlet and Inlet Devices:
   a. Air outlet and inlet device number
   b. Room number/location
   c. Air outlet and inlet device type
   d. Air outlet and inlet device size
   e. Area factor
   f. Velocity, design, preliminary, and final
   g. Air flow, design, preliminary, and final (SCFM)
   h. Percent of design airflow
8. Sound Level Report:
   a. Location
   b. Octave bands - equipment off
   c. Octave bands - equipment on
9. Air Terminal Unit Data

F. Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Submittals section.

2.02 CERTIFICATE OF COMPLETION

A. At completion of testing and balancing, Supplier shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified conditions.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS: SECTION 23 00 00

3.02 INSPECTION

A. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

B. Before starting the hydronic system testing and balancing, all valves and control components shall be opened or set to direct flow through the heat transfer element.

C. A resistance shall be placed at all filter locations to simulate dirty filter conditions per 23 00 00 3.06 without incurring AMCA defined system effects

3.03 TESTING, TRAINING AND COMMISSIONING

A. Following completion of testing and balancing the system shall be left in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.04 PERFORMANCE OF WORK

A. General:
   1. Testing, adjusting, and balancing shall be performed after the system installation is complete but prior to acceptance of the project.
   2. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
   3. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish. Coordinate with mechanical contractor to identify locations prior to insulation to avoid re-work
   4. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

B. Airflow System Measurements:
   1. Measure and adjust air supply and exhaust units to deliver at least 100 percent of the design air volume at 100 percent cooling and heating.
   2. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
   3. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check amp draw of fans on initial startup. If running amps exceed nameplate, shut off motor immediately, notify Owner, and make necessary drive changes as directed.
   4. Airflow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between design values specified for clean and dirty filters, with auxiliary systems in operation.
   5. Airflow rates supplied, exhausted, or returned shall be within plus or minus 5 percent of the design values specified.
   6. Measure and adjust air exhaust dampers to deliver at least 100 percent of the design air volume. Measure static air pressure conditions on fans and total pressure across the fan.

C. Systems to be Balanced:
   1. All heating, ventilating, air conditioning, hydronic, and foul air equipment and systems shall be balanced.

3.05 FINAL INSPECTION

A. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection test made.

B. Following acceptance of the reports by the Owner's Representative, Supplier shall permanently mark all damper positions so that they can be restored to their correct position if disturbed at any time. Devices shall not be marked until after final inspection.

END OF SECTION

SECTION 23 34 13.13

AXIAL HVAC PROPELLER WALL FANS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies wall-mounted fans complete with fans, motors, dampers and accessories required for ventilation systems.

B. Equipment List:

Item	Equipment No.
EF-101	

C. Operating Requirements:
   1. Fan motors shall be nonoverloading on all points of the operating curve. Fans shall be designed for continuous duty service and to meet the scheduled requirements.

D. Sound and Vibration:
   1. Fans specified in this section shall operate at noise levels below 30 sones, as defined by AMCA Standard 300, and at tip speeds below 10,000 fpm.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AMCA Standard 210	Laboratory Methods of Testing Fans for Rating
AMCA Standard 300	Test Code for Sound Rating

B. Certification:
   1. Fans shall bear the AMCA rating seal.

1.03 SUBMITTALS

A. The following information shall be provided in accordance with the requirements of Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Fan performance curves for the specified operating conditions.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Fans shall be the wall mounted, V-belt or direct driven propeller type. Fans shall be manufactured by Aerovent, Greenheck, Penn Ventilator, or equal, modified to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Component	Material
Propeller	Aluminum
Venturi	Steel
Wall panel	Steel
Fan propeller shaft	Steel
Fasteners	Stainless steel
Pillow blocks	Cast iron
Sheaves	Cast iron

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 EQUIPMENT

A. Fan:
   1. The fan shall be V-belt or direct driven as specified in paragraph 1.01 Operating Requirements. The fan shaft, on belt-driven fans, shall be mounted in heavy-duty ball bearing pillow blocks with grease fittings. Bearings shall be rated for a minimum AFBMA L-10 bearing life of 50,000 hours.

B. Motor:
   1. Unless otherwise specified, motors shall operate at 1750 rpm and shall be Type 2Motors 1 HP and larger shall be the high efficiency type. Motors 1/12 HP and smaller shall be the fan manufacturer's standard motor.

C. Fan Panel:
   1. Each fan panel shall have a spun venturi to direct air smoothly to the propeller blades. The fan, drive motor and fan guard shall be securely attached to the fan panel by means of a four-legged angle or tubular frame and mounting pads. The fan panel, frame, and mounting pads shall receive the manufacturer's standard enamel coating unless otherwise specified.

D. Accessories:
   1. The fan shall be provided with a steel mounting collar, and a spring-loaded aluminum backdraft damper where specified. Mounting collars shall be protected with a baked epoxy finish. Fans shall be provided with inlet guards constructed of steel wire with lacquer finish. Inlet guards shall conform to OSHA standards and shall be removable to provide motor access.
   2. Where the motor and drive assembly are specified to be installed in a weather-exposed location, such as the exterior side of an exterior wall, a sheet metal shroud or weather hood shall be provided for the fan. This shroud shall protect the fan and drive assembly from direct exposure to the elements without restricting airflow to the fan. A bird screen shall be provided with the shroud.

2.04 SPARE PARTS

A. One set of V-belts shall be provided for each belt-driven fan.

2.05 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Certification that the units have been tested and rated in accordance with the applicable AMCA Standard Test Code and Certified Ratings Program.
   2. Applicable operating and maintenance data in accordance with Section 01 78 23.

PART 3 EXECUTION

3.01 INSTALLATION

A. Each fan shall be installed as specified and in accordance with manufacturer's recommendations.

3.02 FIELD TESTING

A. Each fan shall be completely field tested in accordance with Section 23 05 93 to guarantee compliance with the project manual.

END OF SECTION

SECTION 23 82 00

HEATING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies provisions for the selection, installation and testing of heating units, including:
   1. Electric Heaters

1.02 RELATED SECTIONS

A. As required by Section 23 00 00 and Division 01 - General Requirements.

1.03 QUALITY ASSURANCE (IN ADDITION TO 23 00 00)

A. Reference Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
AHRI 410	Standard for Forced Circulation Air-Heating and Air-Cooling Coils
AGA Z83.8	Gas Unit Heaters
IFGC	International Fuel Gas Code

PART 2 PRODUCTS

2.01 GENERAL

A. Thermostats shall be either 24-volt or 120-volt type for remote mounting unless noted otherwise.

2.02 ELECTRIC HEATERS

A. Electric Unit Heaters: Electric unit heaters shall be factory fabricated unit heater assembly bearing the UL label. Heaters shall be assembled in heavy gauge steel cabinets, shall have horizontal air flow discharge and shall be furnished with wall or ceiling mounting support brackets, disconnect switch, contactors, relays, transformers, thermostats, internal wiring, adjustable air flow louvers, and interwiring between the components. Unit heaters shall be Trane, Reznor, King, Chromalox, Qmark, or Approved Equal

B. Electric Wall Heaters: Electric wall heaters shall be factory fabricated assembly bearing the Underwriters Laboratories label. Units shall have horizontal airflow discharge and shall be suitable for either recessed wall mounting or surface mounting as shown on the Drawings, internal wiring, contactors relays, and transformers. Thermostats shall be integral, unit mounted. Unit heaters shall be Indeeco, Reznor, King, Chromalox, Qmark, or Approved Equal

PART 3 EXECUTION

3.01 INSTALLATION

A. General Requirements: Section 23 00 00.

B. Install in accordance with manufacturer's instructions. Comply with NEC and UL listings.

C. Install thermostat where shown on the Drawings or coordinate with the engineer. Provide control wiring from thermostat to unit.

D. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways. Check each piece of equipment for defects, verifying that items function properly and that adjustments have been made.

E. Damaged Coils: Make every effort to prevent damage to both built-up coils and coils of packaged equipment. Comb damaged coil fins to be straight.

F. Electric Unit Heaters: Suspend from structure with 5/8-inch diameter rods and per manufacturer instructions.

G. Electric Wall Heaters: Install heaters in place with box trim flush with finished wall.

3.02 TESTING

A. Procedures: Section 23 05 93.

3.03 WARRANTY

A. The heating units shall also be warranted by the Manufacturer for a minimum of 12 months from the date of start-up or 18 months from the date of delivery to the project site, whichever occurs first. Warranty shall cover the entire system, the equipment and the components provided as part of this system. Whenever available, longer warranties on subassemblies or individual equipment items shall be given. Wear items may be prorated for any warranty over one year.

END OF SECTION

SECTION 26 05 00.01

COMMON WORK RESULT FOR ELECTRICAL

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope: This section specifies general requirements for electrical work. Project Detailed requirements specified in other sections are subject to the general requirements of this section.

1. Furnish labor, equipment, tools, materials, supplies, and perform operations necessary to install a complete and operable electrical system. Furnish incidental material and perform work shown on the Drawings and in the Specifications.
2. Perform electrical work and provide material and equipment in compliance with applicable National, State, and Local codes, regulations, laws, and ordinances.
3. Obtain electrical permits, arrange for required inspections, correct deficiencies resulting from inspections, and pay permit fees and inspections charges. Pay fines and the cost of extra work incurred by action or inaction of the Contractor, at no additional cost to the Owner.
4. Furnish properly executed certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) at the conclusion of the work, before final acceptance.
5. Maintain a complete set of Contract Drawings in "Record" condition, available for review by the Owner or Engineer. Mark, initial, and date changes, modifications, or corrections, as they occur. Refer to the Record Drawing specification section requirements.
6. Field verify the exact locations of equipment or equipment terminations. Use accepted equipment submittals as the basis of the conduit openings and slab penetrations.

B. Power and Telephone Utility Coordination:

1. No changes are anticipated in the existing power utility service or existing telephone service on this project.
2. If power service changes are necessary:
    a. Coordinate the service entrance / metering equipment, and the utility service with the project electrical power utility during the submittal process and installation.
    b. Obtain electrical power utility installation requirement for power service for the project; obtain the power utility standards and installation details that apply to the project; apply for electrical service; request power utility inspection; and complete electrical equipment acceptance testing.
    c. Provide Electric Utility standard service entrance power equipment and utility billing meter equipment. Obtain power utility approval for the equipment prior to shipment.
    d. Coordinate primary and secondary electric service entrance underground or overhead installation with the electric power utility.
3. If telephone service changes are necessary, coordinate telephone underground or overhead service installation with the telephone utility.

C. Drawing Definitions and Requirements:

1. Elementary or Schematic Diagram: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement that facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
2. One-Line Diagram: Shows, by means of single lines and graphical symbols, the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.
3. Block Diagram: Diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
4. Wiring Diagram or Connection System: Includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. A panel layout diagram shows the physical location of devices and the wiring connections.
5. Interconnection Diagram:
    a. Shows external connections between terminals of equipment in panels or electrical assemblies and outside points, such as motors, auxiliary devices, control devices, and instruments. Provide references to connection diagrams that interface to the interconnection diagrams of the continuous line type.
    b. Show bundled wires as a single line with the direction of entry/exit of the individual wires clearly shown. Show each wire identification as actually installed. Wireless diagrams and wire lists are not acceptable.
    c. Provide wire identification for each end of the same wire for devices and equipment, indicate terminal blocks identification actually installed with individual terminal identification.
    d. Show jumpers, shielding and grounding termination details not shown on the equipment connection diagrams on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Show spare wires and cables.
6. Arrangement, Layout, or Outline Drawings: Shows the physical space and mounting requirements of a piece of equipment and may indicate ventilation requirements, space provided for connections, or the location connections are to be made.
7. Drawing Cross-Referencing:
    a. Reference each submittal drawing submitted to the associated Contract Document and indicate the one-line diagrams, schematics, control diagrams, block diagrams, and Process and Instrumentation Diagrams (P&IDs) cross-referenced on the submittal drawings.
    b. Internally cross-reference submittal drawings related to the same subject shall be referenced to other submittal drawings. Failure to cross-reference Contract Documents with the submittal shall be cause for rejection of the entire submittal with no further consideration.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1 / ASCE 7	Minimum Design Load in Buildings and Other Structures, 1982
ANSI C80.1	Rigid Steel Conduit - Zinc Coated, 1994
ASTM B3	Standard Specification for Soft or Annealed Copper Wire, 2001
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft, 1999
ASTM B33	Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes, 2000
ICEA S-68-516 / NEMA WC 70, 71, & 74	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
ICEA S-95-658	Standard for Non-Shielded Power Cables Rated 2000 Volts or Less, 2000
IEEE 81	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, 1983
IEEE 383	Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations, 1974 (1992)
JIC EMP-1	Electrical Standard for Mass Production Engineering, 1967
NEMA TC2	Electrical Polyvinyl Chloride (PVC) Conduit, 2003
NEMA 250	Enclosures for Electrical Equipment (1000 Volt Maximum)
NEMA WC-70	Non-Shielded Power Cable 2000V or Less (ICEA S-95-658), 1999 (2001)
NEMA WD-1	General Requirements for Wiring Devices, 1999
NFPA 70	National Electrical Code (NEC), 2024
UBC	Uniform Building Code
UL 6	Electrical Rigid Metal Conduit – Steel, 12th Edition, 2000 (2003)
UL 44	Thermoset-Insulated Wires and Cables, 15th Edition, 1999 (2002)
UL 67	Panelboards, 11th Edition, 1993 (2003)
UL 83	Thermoplastic-Insulated Wires and Cables, 13th Edition, 2003 (2004)
UL 263	Fire Tests of Building Construction and Materials, 13th Edition, 2003

Reference	Title
UL 360	Liquid-Tight Flexible Steel Conduit, 5th Edition, 2003
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, 10th Edition, 2002 (2003), Adopted: NEMA AB 1-1999
UL 1277	Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, 4th Edition, 2001 (2003)
UL 1283	Electromagnetic Interference Filter for Noise Attenuation
UL 1449	Surge Protective Devices

B. Listed or Labeled Products:
   1. All electrical products provided shall be inspected by an independent nationally recognized testing laboratory (NRTL) for compliance with nationally recognized electrical product safety standards.
   2. The NRTL must be acceptable to the inspection authority having jurisdiction (AHJ). Typical testing laboratories include Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), or Canadian Standards Association (CSA).
   3. Product safety standards include those recognized as American National Standards (ANSI) and published by ASTM International (ASTM), Factory Mutual (FM), National Electrical Manufacturers Association (NEMA), or Underwriters Laboratories (UL).
   4. Electrical products that comply with product safety standards shall either be *listed* in a document published by the NRTL and/or *labeled* on the product by an identifying NRTL symbol or mark.
   5. When an electrical product is not available as certified by an acceptable NRTL, all costs and expenses for special inspections shall be included in the contract price. Tests or inspections shall be at the manufacturer's place of assembly or at the installation location in a manner acceptable to the AHJ.

C. Factory Tests:
   1. Perform factory tests at the place of fabrication and on completion of manufacture or assembly where specified in the individual product specification section.
      a. Include the costs of factory tests in the contract price.
      b. Include the costs of Engineer witness of factory tests in the contract price.

1.03 SUBMITTALS

A. Submittals and transmittal procedures for submittals are defined in Section 01 33 00. Submittals should be required for the following conditions:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole.

2. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications.
3. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

B. The following information shall be provided for all electrical equipment and materials:
   1. Catalog cuts of equipment, devices, and materials requested by the individual specification sections.
      a. Catalog information with technical specifications and application information including ratings, range, weight, accuracy, and other pertinent product information.
      b. Edit catalog cuts to show only the items, model numbers, and information that apply.
      c. Assemble catalog cuts with a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
   2. Arrangement, layout, and outline drawings with dimensions and weight, as appropriate.
   3. Control schematics and interconnection wiring diagrams depicting internal and external wire and cable terminations. Drawing cross-reference to specification and Contract Document drawings.

1.04 DRAWINGS

A. Prepare specified drawings on 11-inch by 17-inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

B. Prepare drawings to reflect the final constructed state of the project installation or supplied equipment. Provide drawing quality, clarity, and size of presentation to permit insertion in operation and maintenance manuals.

1.05 PROJECT/SITE CONDITIONS

A. General:
   1. Unless otherwise specified, equipment and materials shall be sized and de-rated for the ambient conditions specified in Section 01 11 80, but not less than an ambient temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. The following areas are designated as corrosive:
   1. Outdoors
   2. Chemical Storage Rooms
   3. Sodium Hypochlorite Generation System

4. Sodium Hypochlorite Metering Pumps

C. Hazardous (Classified) Areas:
   1. None

D. Seismic:
   1. Electrical equipment and supports shall be braced in accordance with all applicable building codes.

E. Construction Materials:
   1. Refer to the individual specification section for each component for material composition and installation practices.
   2. Raceway construction materials required for each area classification are listed in the following table that specifies the type required for each location and application by RACESPEC sheet. Unscheduled conduit shall be RACESPEC type RMC-Steel.

Location	Application/Condition	RACESPEC
Indoor non-corrosive	Exposed	RMC-Steel
Indoor corrosive	Exposed	PVC coated RMC-Steel
Outdoor	Exposed	RMC-Steel
Hazardous	Exposed	RMC-Steel
Concealed	Embedded in concrete structure or beneath slab-on-grade	RMC-Steel, RNC40, or RNC80
Underground	Instrumentation, communications and data signals encased in concrete, ductbank	RMC-Steel, RNC40, or RNC80
Underground	Instrumentation, communications and data signals directly buried	RMC-Steel, RNC40, or RNC80
Underground	Power directly buried (Non-Power Utility)	RNC40
Nonhazardous	Final connection to equipment	RMC-Steel
Hazardous	Final connection to equipment	Fittings per NEC Article-500 for the Classified Hazardous Area identified.
Corrosive	Final connection to equipment	PVC coated RMC-Steel, NC40, RNC80, Flexible Steel Fittings, as appropriate

Notes:

1. *Install conduit connections to control stations, enclosures, and device boxes through threaded hubs.*
2. *Install flexible conduit for final connections to devices, equipment and motors not exceeding 18 inches. Limit length to 36 inches where flexibility is required.*
3. *Mount raceway systems with 1/4-inch (minimum) air space between the electrical system and supporting structure.*

3. Boxes, wireways or enclosures required for each area classification are listed in the following table that specifies the NEMA rating and material type required for each location and application:

Location	Application/Condition	Rating & Material
Indoor non-corrosive	Conditioned spaces	NEMA 12 – Steel
Indoor corrosive	Process areas	NEMA 4X – Stainless Steel
Outdoor	Stainless Steel	NEMA 4X – Stainless Steel

Notes:

1. *Avoid penetrations in the top of all outdoor enclosures.*
2. *Mount enclosures, device boxes, control stations, etc. with 1/4-inch (minimum) air space between the electrical system and supporting structure.*

1.06 STORAGE OF MATERIALS AND EQUIPMENT

A. Store equipment and materials in the factory-sealed container and protect with additional covering and materials to avoid physical damage or weather damage.

1.07 ELECTRICAL NUMBERING SYSTEMS

A. Raceway Numbers:
   1. Tag raceways with brass tags at the access locations including manholes, pull boxes, junction boxes, and at the terminations.
   2. Raceway numbers are derived from the “Cable and Conduit Schedule” or the ductbank cross-sections. Where raceway numbers are not provided, use the circuit number on the power and control single line diagrams.

B. Wire and Cable Circuit Numbers:
   1. Identify wire and cable circuit numbers at both ends. Refer to the circuit labeling method specified and shown in the drawings to label circuits.
   2. Identify lighting and receptacle branch circuits with the power source and circuit load, at source and destination locations. Identify the load, location, and circuit in typed panel schedules with corrections shown.
   3. Include copies of schematic diagrams, wiring connection diagrams, and interconnection diagrams inside of the equipment enclosure, protected in a plastic container in the equipment print holder.

PART 2 – PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Provide new equipment and materials free from defects. Provide material and equipment of the same or a similar type of the same manufacturer throughout the work. Use standard production materials wherever possible.

B. Paint Finish and Galvanizing:
   1. Paint installed and unpainted electrical construction materials as specified in Section 09 90 00. Galvanize products, supports, etc. as specified in the Hot-Dip Zinc Coating section.

2.02 RACEWAYS, BOXES, AND SUPPORTS

A. Raceways, Boxes and Wireways:
   1. Provide separate raceways for lighting, receptacles, power, control, instrumentation, and signaling systems.
   2. Provide wireways at locations above and below boxes, panels and groups of devices.
   3. Raceways, boxes and wireways shall match the location and area classification and equipment enclosure ratings in accordance with Section 1.05.
   4. Size raceways, boxes, wireways and conductor fill in accordance with the National Electrical Code.

B. Terminal Cabinets:
   1. Provide cabinets with hinged doors and 2 or 3-point stainless steel quick release latches with locking features via handle or latching clasps with provisions for padlocks.
   2. Provide adjustable terminal strip mounting accessories and with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Provide No. 8 minimum strap-screw type terminal strip, suitable for ring tongue, locking spade terminals. Provide Phoenix Contact products with capture feature and terminal identification method per terminal or equal, as specified.

C. Manholes, Handholes and Pullboxes:
   1. Manholes, handholes and pullboxes contain wires, cables, and conductors. Provide box dimensions where shown. Provide boxes per NEC sizing rules where the dimensions are not sized or shown.
   2. Provide concrete boxes with covers designed for H-20 loading in traffic areas. Engrave box cover: "ELECTRICAL". Provided boxes with hinged, aluminum checkered plate covers with pull-handle to open in non-traffic areas.
   3. Provide precast Quazite Compsolite cement/polymer products, or equal, for handholes, pullboxes, manholes, meter boxes, equipment pads, and vaults where allowed by the electric power utility and for projects where precast concrete is not specifically shown or specified.
   4. Electrical manholes and/or handholes shall be installed with gravity drain piping to daylight. No French drains or gravel bottoms will be acceptable.

D. Raceway and Box Supports:
   1. Provide stainless steel framing channel with end caps to support groups of conduit. Provide individual conduit supports that have one-hole stainless steel malleable iron pipe straps used with stainless steel clamp backs and nesting backs.
   2. Provide stainless steel supports, channel, fittings, all-thread, and fasteners in outdoor locations, in corrosive areas, and as shown. Provide factory end-caps for supports and channels.

3. Independently support boxes by stainless steel brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden or plastic plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

E. Underground Marking Tape:
   1. Provide low-density, polyethylene plastic, underground marking tape and install above and centered for early warning protection for digging near electrical ductbanks.
   2. Provide Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal. Provide tape with nominal dimension of 6 inches wide, 4-mil thickness.
   3. Provide underground marking tape 6-inch wide metallic-lined tape with red polyethylene film on top and with clear polyethylene film on the bottom of the tape for installation above and centered on direct buried cables and conduits without ductbank encasement.
   4. Provide black over red marking tape clearly printed with: "CAUTION ELECTRIC LINE BURIED BELOW", or provide OSHA approved marking tape.

F. Nameplates:
   1. Provide nameplates for all boxes and enclosures with nameplate wording as shown on the drawings. Provide the tag number or box number with device functional description on device nameplate. Nameplate wording may be changed without additional cost where changes are made during the submittal process or prior to commencement of engraving.
   2. Provide machine engraved laminated white phenolic nameplates with black lettering for panel-mounted equipment with the instrument tag number/description in 3/32-inch minimum size lettering and attach to the panel or enclosure with a minimum of two self-tapping 316 stainless steel screws. Provide nameplates for power sources indicating the power loads and nameplates for power loads that indicate the power sources, in accordance with these specifications and the NEC.

G. Raceway Markers:
   1. Provide raceway markers: 0.036-inch minimum thickness, solid brass tags or aluminum tags with raceway number or the circuit number, stamped in 3/16-inch minimum height characters and attach tags to the raceway with 316 stainless steel wire. Install raceway markers inside of pull boxes, handholes, manholes, and where entering electrical equipment enclosures.
   2. Provide raceway markers indicating the power source and circuit number for lighting and receptacle raceways to the associated panelboard. Interior lighting and receptacle raceways do not require raceway markers for conduit between components.

H. Identification Tags:
   1. Provide the following:
      a. Equipment: Typical size 1-inch x 3-inch wide, white with black engraved equipment number and equipment description.
      b. Raceway/Conduit: Tags with raceway or conduit number or circuit shown.

c. Instrument: 1.5-inch wide, aluminum tag with instrument number and description.

d. Conductor: Power, control, or instrument cable with the circuit identified as shown; power source or power/control panel identified; power load, equipment, instrument, or device identified; purpose of the conductors identified.

e. Fastener: nylon-coated 48-mil stainless steel wire. Manufacturer: Brady catalog number 23310 or equal with double ferrule type brass wire clamps. Manufacturer: Brady number 23312.

I. General Raceway Requirements:

1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes. The RACESPEC sheets with specified requirements begin on the next page.

2.03 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RMC-STEEL

A. Raceway Identification:

1. RMC-Steel

B. Description:

1. Rigid Steel Conduit

C. Compliance:

1. ANSI C80.1, UL 6

D. Finish:

1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

E. Manufacturers:

1. Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.

F. Minimum size:

1. Unless otherwise shown: 3/4-inch for exposed; 1-inch for concealed or embedded; 2-inch for ductbank encased.

G. Fittings:

1. Hubs:
   a. Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or equal.
2. Unions:
   a. Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.

H. Boxes:
   1. Indoor (non-corrosive):
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA-4 watertight. Boxes in corrosion areas shall be NEMA-4X.
      b. Conduit bodies: ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
   2. Indoor (corrosive) and Outdoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-4X stainless steel nonmetallic for 6 inches square and larger.

I. Elbows:
   1. (3/4" thru 2.5")
      a. Factory fabricated or field bent.
   2. (3" thru 6")
      a. Factory fabricated.

J. Conduit Bodies:
   1. (3/4" thru 4")
      a. Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
   2. (5" and 6")
      a. Electro-galvanized iron or cast iron box.

K. Expansion Fittings:
   1. Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

L. Manufacturers:
   1. Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.

M. Installation:
   1. Rigid steel conduit shall be made up tight and without thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
   2. Conduit entering boxes shall be terminated with a threaded hub as specified or standard fittings with grounding bushing.
   3. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.

2.04 RACEWAY SPECIFICATION SHEETS (RACESPEC) - LFSC

A. Raceway Identification:
   1. LFSC

B. Description:
   1. Liquid-Tight Flexible Steel Conduit

C. Application:
   1. Final connection to equipment subject to vibration or adjustment.

D. Compliance:
   1. UL 360

E. Construction:
   1. Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquid-tight plastic cover.

F. Minimum size:
   1. 3/4 inch

G. Fittings:
   1. Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.

H. Installation:
   1. Do not exceed 36-inch length.

2.05 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RNC40 AND RNC80

A. Raceway Identification:
   1. RNC40 and RNC80

B. Description:
   1. Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage. DZYR per NEC Article 352.

C. Compliance:
   1. NEMA TC2, UL 651

D. Construction:
   1. Schedule 40, high-impact, polyvinyl-chloride (PVC)
   2. Schedule 80, high-impact, polyvinyl-chloride (PVC)

E. Minimum size:
   1. 3/4 inch exposed; 2-inch embedded or encased

F. Fittings:
   1. PVC solvent weld type

G. Boxes:
   1. Indoor:
      a. NEMA Class 4, nonmetallic
   2. Outdoor and corrosive:
      a. NEMA Class 4X, nonmetallic

H. Installation:
   1. PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard PVC couplings.
   2. PVC conduit shall have bell ends where terminated at manholes, handholes, or building walls. Bell ends shall terminate flush at the walls and floors and not extend or protrude.

2.06 RACEWAY SPECIFICATION SHEETS (RACESPEC) - PVC COATED RMC-STEEL

A. Raceway Identification:
   1. PVC Coated RMC-Steel

B. Description:
   1. Rigid Steel Conduit, Corrosion-Resistant, Polyvinyl Chloride (PVC) Coated

C. Compliance:
   1. ANSI C80.1, UL 6

D. Finish:
   1. Hot-dip galvanized rigid steel conduit, to which a minimum 40-mil thick PVC coating has been bonded to the outside of the conduit. A 2-mil coat of urethane coating shall be bonded to the inside. Coating shall be free of pinholes. Bond strength shall exceed the tensile strength of the PVC coat. Elbows and fittings shall be factory made and coated.

E. Fittings: (includes unions, condulet bodies and expansion fittings)
   1. Refer to RACESPEC RMC-Steel for additional requirements. Similarly coated to the same thickness as the conduit and provided with type 316 stainless steel hardware. Conduit and fittings shall be manufactured by the same company.
      a. Hubs:
         1) Hubs for connection of conduit to junction, device, or terminal boxes shall be threaded with the same PVC coating as the conduit and provide a watertight connection.
      b. Boxes:
         1) Refer to RACESPEC RMC-Steel. FD boxes shall be PVC coated.
      c. Elbows:
         1) Refer to RACESPEC RMC-Steel.

F. Manufacturers:
   1. PVC coated conduit shall be by Robroy Industries, PLASTI-BOND RED; Occidental Coating Company (OCAL), or equal.

G. Installation:
   1. Plastic coated conduit shall be made up tight, threaded, and installed using tools approved by the conduit manufacturer.
   2. Conduit threads shall be covered by a plastic overlap which shall be coated and sealed per manufacturer's recommendations. Painted fittings are not acceptable.
   3. Pipe wrenches and channel locks shall not be used for tightening plastic coated conduits. Damaged areas shall be patched, using manufacturer's recommended material.

2.07 RACEWAY SPECIFICATION SHEETS (RACESPEC) - WW

A. Raceway Identification:
   1. WW

B. Description:
   1. Wireway and Auxiliary Gutter with hinged covers.
   2. Match the area classification enclosure type where installed.

C. Compliance:
   1. JIC EMP-1 and NEC Article 366

D. Minimum size:
   1. 4-inch x 4-inch
   2. Length as shown or determined by the installation requirements.

E. Maximum size:
   1. Sized in accordance with NEC-366 fill rules

F. Finish:
   1. Smooth finished surfaces.

G. Application:
   1. As shown on the drawings and where required.

H. Hardware, Supports, Fittings, and Fasteners:
   1. Stainless steel

I. Fasteners:
   1. Quick release 1/4 turn type or suitable for the area classification.

2.08 NOT USED

2.09 NOT USED

2.10 CONDUCTORS, WIRE, AND CABLE

A. Provide products specified.

B. Unscheduled Conductor Sizing:
   1. Size conductors, wire, and cables in accordance with the National Electrical Code where not specified on the Drawings, and install in the minimum size raceway as specified in the RaceSpecs herein.

C. Control Wire Color Coding:
   1. Provide control wires with the following colors for the shown voltage:

120 Vac Power, line and load	Black
120 Vac Control	Red
24 Vac	Orange
12 Vac	Brown
Foreign Voltage (AC) (Interlock)	Yellow
AC Neutrals	White
Ground	Green
24 VDC (+ & -)	Violet
12 VDC (+ & -)	Blue
Foreign Voltage (DC)	Violet/White or Blue/White

D. Power Conductors:
   1. Provide power conductors with following colors for the shown voltage:

Wire	480Y/277V, 3Ø	208Y/120V, 3Ø	240/120V, 3Ø
Phase A	Brown	Black	Black
Phase B	Orange	Red	Orange per NEC 408.3(E) and 215.8
Phase C	Yellow	Blue	Blue
Ground	Green	Green	Green
Neutral	White or Gray per NEC 210.4(D)	White	White

   2. Provide black insulation conductors larger than #10 AWG with colored 3/4-inch vinyl plastic tape to identify the phase color at each cable termination. Tape wrap with 25 percent overlay to provide minimum of 3 inches of coverage.

E. Scheduled and Unscheduled Wire and Cable:
   1. Provide the insulation and jacket material specified in the CABLESPEC sheets for scheduled and unscheduled (not shown) conductors. Provide stranded copper conductors for all wire and cable.

F. Electrical Enclosure Conductor Ratings:
   1. Provide conductors with 600-volt insulation ratings in panels and other electrical enclosures. Conductors with less than 600-volt insulation ratings are prohibited, unless specifically identified.
   2. Bundle and lace conductors in panels and electrical equipment at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Provide lacing using plastic cable ties that are tensioned and cut off using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are prohibited.
   3. Bundle conductors crossing hinges into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors and provide oversized plastic panel wiring duct within panels.
   4. Provide slack in junction boxes, pull boxes, handholes and manholes sufficient to allow cables or conductors to be routed along the walls with the amount of slack equal to largest dimension of the enclosure.
   5. Provide dedicated electrical wireways and insulated cable holders mounted and secured on stainless steel unistrut in manholes and handholes.

G. Instrument Signal Cable:
   1. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Provide twisted shielded cable with individual shield for each pair. Provide twisted shielded cable multi-pair with overall shield and jacket. Provide triads wherever 3-wire circuits are required. Circuits shall not be made using conductors from different pairs or triads.
   2. Install instrument, signal, and data communication circuits without splices between instruments, terminal boxes, or panels. Shields as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables are not acceptable. Common ground return conductors for two or more circuits are not acceptable.
   3. Bond shields to the signal ground bus at the control panel. Isolate shields from ground and other shields at other locations by cutting short or taping. Provide terminal strips for signal leads and shield drain wires.
   4. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run. Shields or drain wires for spare circuit cables shall be bonded at control panel only with the other end insulated by tape cover.
   5. Provide an instrument stand with terminal box mounted approximately 3 feet above grade to center or as shown. Provide terminal boxes for instrument cable with the cable and conductor labels specified.
   6. Install and terminate conductors for paging, security, data communication, voice communication, and telephone systems in compliance with the manufacturer and the system utility recommendations.

H. Splicing and Terminating Materials:
   1. Use a listed tool for the applied compression type of connectors with the correct size and type. Provide tin-plated high conductivity copper connectors. Mechanical clamp, dimple, screw-type connectors are prohibited.
   2. Provide polymeric insulating material over motor terminations with high dielectric strength mastic or material to seal the ends against ingress of moisture and contamination.

3. Cover splices with electrical products designed for the application, and insulate with a heat-shrinkable sleeve or boot.

I. Fire Stop Sealant Materials:
   1. Provide non-combustible silicone sealant for sealing apertures and cable through-penetrations for electrical conductors meeting UL 263 4-hour time-temperature requirements.
   2. Manufacturer: STI Inc., Pensil Silicone Sealants PEN300 SpecSeal Firestop, or equal.

J. Circuit Numbering Marking System:
   1. Identify each power, control, and signal conductor at each terminal connection. Machine print the letters and numbers with black on white alphanumeric characters representing the circuit numbering system.
   2. Identify conductors, including spares. Provide cable markers and wire markers for distribution and utilization equipment circuits identifying the power source and circuit source from which it is served.
   3. Provide the identification system of vinyl power cable strap-on cable markers, vinyl multi-conductor control cable strap-on cable markers, and vinyl or polyolefin wire slip-on sleeves and encircle the conductor.
   4. Provide conductor marker used in outdoor, damp, or wet locations on heat-shrinkable polyolefin shrinkable marking sleeves covered with clear heat-shrink sleeve or clear tape cover.
   5. Print conductor markers using the Brady Marker “XC PLUS”, the Brady LS2000 printer with the Brady sleeve wire marking system, or Engineer accepted equal.

K. Terminal Blocks:
   1. Provide terminal blocks with the following features:
      a. Voltage rated: 600 volts.
      b. Current rated: match largest conductor connected to the assembly.
      c. Integral marking strips.
      d. Terminal block assemblies: provide with mounting channels, barriers, and end clamps.
      e. Power and grounding terminal blocks: solderless box lug type.
      f. Control and signal terminal blocks. Manufacturer: Allen-Bradley 1492-HM1GY, NEMA type, 30-ampere.
      g. DIN-rail mount for direct wiring into terminal blocks.
      h. Pre-printed snap-in markers.

2.11 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. CABLESPEC Sheets
   1. The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
MIC	600	SP-OS: MULT-PR#16 Shielded (TC) with Individual Pair Shields and Overall Cable Shield	Instrument
SIC	600	P-OS: 1-PR#16SH OR 1-TR#16SH (TC)	Instrument
XHHW	600	XLP Insulated Industrial Grade Conductor	Power cable

Type	Volt	Product	Purpose
THWN-2	600	Building Wire, Control Wire	Lights, receptacles, control wire
MEPR/CPE	600	Multi-Conductor Jacketed Cable Power Cable Example: 3/C #500 KCMIL with NEC Size Ground	Power
CAT5E	300	Network communications <= 1Gbps that do not enter enclosures containing circuits operating at >300V	Communications

2.12 CABLE SPECIFICATION SHEETS (CABLESPEC) – MIC

A. Cable System Identification:
   1. MIC

B. Description:
   1. Multiple twisted, shielded pairs, #16 AWG, with overall shield instrumentation cable, UL listed, with number of pairs as shown, listed.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
   1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
   1. Twisted on a 2-inch lay

G. Shield:
   1. 100 percent, 1.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire

H. Overall Shield:
   1. 2.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

I. Jacket:
   1. 45 mil polyvinylchloride (PVC)

J. Flame Resistance:
   1. UL 1277

K. Manufacturer(s):
   1. Okonite, Okoseal-N type SP-OS; or Cooper Industries-Belden equal

L. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01

2. Testing:
    a. Megger test: use Form in Section 01 99 90

2.13 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
    1. SIC

B. Description:
    1. Single twisted, shielded pair or triad, #16 AWG, instrumentation and signal cable, listed

C. Voltage:
    1. 600 volts

D. Conductor Material:
    1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
    1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
    1. Twisted on a 2-inch lay

G. Shield:
    1. 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

H. Jacket:
    1. 45 mil polyvinylchloride (PVC)

I. Flame Resistance:
    1. UL 1277

J. Manufacturer(s):
    1. Okonite, Okoseal-N type P-OS; or Cooper Industries-Belden equal

K. Execution:
    1. Installation:
        a. Install in accordance with Section 26 05 00.01
    2. Testing:
        a. Megger Test: use Form in Section 01 99 90

2.14 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW

A. Cable System Identification:
    1. XHHW

B. Description:
   1. Industrial grade single conductor, listed
   2. Sizes: #14 AWG through 750 kcmil as shown

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. NEC Type XHHW-2, 90 degrees C dry or wet, Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44, Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue

F. Jacket:
   1. None

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, X-Olene; Cablec, Durasheath XLP; or equal.

I. Uses Permitted:
   1. Power, control, lighting and outlet circuits.

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01.
   2. Testing:
      a. Test in accordance with paragraph 26 05 00.01-3.02 and Section 26 05 00.01.

2.15 CABLE SPECIFICATION SHEETS (CABLESPEC) – THWN-2

A. Cable System Identification:
   1. THWN-2

B. Description:
   1. Single conductor lighting and receptacle type indoor branch circuit conductor, listed. Sizes: #12 AWG through as shown.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B3 or B8

E. Insulation:
   1. THWN/THHN, 90 degrees C dry, 75 degrees C wet, polyvinylchloride (PVC) with nylon jacket per UL 83.
   2. May substitute XHHW2 with XLP insulation without a jacket.

F. Jacket:
   1. Nylon

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, Okoseal-N, series 116-67; or equal.

I. Uses Permitted:
   1. Lighting, receptacle, appliance circuits and control, no other location permitted

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90

2.16 CABLE SPECIFICATION SHEETS (CABLESPEC) – MEPR/CPE

A. Cable System Identification:
   1. MEPR/CPE

B. Description:
   1. Multiconductor Power Cable with ground conductor sized for the circuit or NEC required custom larger ground conductor sized for multiple-sets of conductors in one circuit, listed
   2. Multiconductor Control Cable with #14 AWG minimum conductor size

C. Power Cable:
   1. Green ground conductor sized in accordance with the NEC

D. Ground Conductor Size:
   1. Multiple cable runs of multiconductor power cable shall have the ground conductor sized in accordance with NEC 250-95

E. Control Cable Type:
   1. ICEA Method 1, E-2:
      without white neutral conductor,
      without green ground conductor

F. Control Cable Identification:
   1. Conductors color coded per ICEA and conductors numbered

G. Voltage:
   1. 600 volts

H. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8, coated in accordance with ASTM B33

I. Insulation:
   1. For Power Cable: RWN/RHH, 90 degrees C dry, 75 degrees C wet, composite of ethylene propylene rubber (EPR) and chlorinated polyethylene (CPE) per ICEA S-68-516 and UL 44
   2. For Control Cable: FR-EP (XHHW-2), 90 degrees C dry or wet, ethylene propylene rubber based per ICEA s-68-516 and UL 44.

J. Jacket:
   1. Chlorinated Polyethylene (CPE)

K. Flame Resistance:
   1. IEEE 383

L. Manufacturer(s):
   1. Okonite; Cablec; or equal

M. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90

2.17 CAT5E

A. Cable System Identification:
   1. CAT5E

B. Description:
   1. IEC Category 5E UTP; TIA/EIA-568-B.2 Category 5E
   2. NEC CMR (riser) rated
   3. UL 444 – Standard for Safety Communications Cables compliant
   4. UL1685 flame rating compliant
   5. Insulation Rating: 300V

C. Conductor Material:
   1. Solid Bare copper
   2. 24AWG

D. Insulation:
   1. Material: Polyolefin

2. Color Coded conductor insulation

E. Jacket:
   1. LSZH PVC - Low Smoke Zero Halogen Polyvinyl Chloride
   2. Sequential Footage Marking: every two feet along jacket
   3. Color: Black or Blue

F. Manufacturer(s):
   1. Cooper Industries: Belden 7935A
   2. Commscope: Systimax 5061A
   3. Or equal.

G. Uses Permitted:
   a. Network communications <= 1Gbps that do not enter enclosures containing circuits operating at >300V.

2.18 WIRING DEVICES

A. Unless specified otherwise, provide UL approved wiring ivory devices for the current and voltage ratings specified and comply with NEMA WD-1 with provisions for back wiring and side wiring with captive held binding screws.

B. Heavy Duty 120v Receptacles:
   1. Single Phase: Duplex 20-amp, NEMA 5-20R accepting NEMA 5-15P and 5-20P plugs. Cooper 5362, Hubbell 5362, or equal.
   2. Ground Fault Interrupting: Ground fault interrupting (GFI) receptacles: duplex, 20 amp, NEMA 5-20R, specification grade that accepts NEMA 5-15P and 5-20P plugs. Provide GFI receptacles outdoors and as shown, UL listed with provisions for testing and resetting. Manufacturer: Hubbell GF-5352-I, or equal.
   3. Three-Phase Receptacles and Boxes: Cooper Series 309 watertight pin & sleeve receptacles, plugs, and back boxes, or equal.

C. Switches:
   1. Indoor Switches: Quiet AC type, heavy duty, specification grade in accordance with rated capacities as required. Match the switch color and the receptacles color. Manufacturer: Cooper, Hubbell, or equal.
   2. Switches for Outdoor and Corrosive Areas: Provide 20-ampere, push-type switches; Cooper Tap-Action, Hubbell PressSwitch, or equal.

D. Device Plates: Provide device plates with switches and receptacles that match the area classification location.
   1. Indoor, Architecturally Finished Areas: Provide switch and receptacle device plates of stainless-steel finish. Manufacturer: Crouse-Hinds, Appleton, or equal in.
   2. Indoor, Non-Finished, Non-Corrosive: Provide switch and receptacle device plates of stainless steel finish. Manufacturer: Appleton, Crouse-Hinds, or equal.
   3. Indoor, NEMA-12 Areas: In areas designated NEMA-12, or other areas specified provide hinged covers with neoprene gaskets. Manufacturer: Hubbell, Cooper, or equal.

4. NEMA 4X - Corrosive: In areas designated NEMA-4X, Corrosive, or other areas specified provide corrosion-resistant/marine-duty stainless steel type covers. Manufacturer: Hubbell, or equal.
5. In-Use Covers: In areas designated NEMA-4X, Corrosive, or other areas specified, and in outdoor areas, provide in-use type weatherproof lift covers that maintain weatherproof rating with plug installed for equipment that is cord connected with plug and receptacle. Covers shall be cast aluminum. Manufacturer: Outdoor, NEMA 4X areas: In-use covers shall be Hubbell WP7, WP8, WP26, or equal. Corrosive areas; Manufacturer: TayMac Corporation 20510, Carlon E9UXXXX, Hubbell WP826XXX, or equal.
6. Wet/Corrosive Switch Covers: In outdoor, areas, wet areas, areas designated NEMA-4X, Corrosive, or other areas specified, provide weatherproof, corrosion-resistant covers for switches to maintain weatherproof rating during operation of switch. Covers shall have flexible bubble of silicone or neoprene rubber for switch operation. Manufacturer: Cooper, Hubbell, or equal.
7. Hazardous Areas: Device plates in hazardous areas shall be, rated NEMA 7, suitable for use outdoors and in wet areas. Manufacturer: Appleton, Crouse-Hinds, or equal.

E. Pilot Devices:
1. Provide heavy-duty push buttons, selector switches and indicating lights: 30mm, oil-tight, NEMA 4X. Indicating lights shall be light emitting diode (LED) type lamps. Unless otherwise shown, provide push-to-test type indicating lights. Provide diode isolating type pilot indicating lights specified for remote-test. Provide red indicating lamps for “RUN” indication and green indicating lamps for “STOP”.
2. Provide 120VAC control units: heavy-duty type Allen-Bradley 800H, or equal. For 24VDC: Allen-Bradley 800T, Square-D Class 9001 Type J, or equal.

F. Load-Switching Control Relays:
1. Heavy-duty, machine tool type for switching load such as solenoids, actuators, contactors, motor starter coils, and other devices used for remote interlocking.
2. Contacts: 4-pole and field interchangeable to either normally open or normally closed and capable of accepting a 4-pole contact block adder.
3. AC relays: NEMA A600 contact ratings and electrical clearances for up to 600 volts.
4. DC relays: NEMA P300 contact ratings and electrical clearances of up to 250 volts.
5. Manufacturer: Allen Bradley Bulletin-700, Square D Class 8501 Type X, or equal.

G. Logic-Level Relays
1. Logic-Level switching solid-state logic and signal circuits:
   a. Minimum of three SPDT, silver cadmium oxide contacts rated 10-amperes-resistive at 120VAC or 28VDC.
   b. Plug-in type with heavy-duty, barrier-protected screw terminal sockets.
   c. Clear polycarbonate dust cover with clip fastener.
   d. AC models: neon lamp indicator wired in parallel with coil.
   e. Manufacturer: Idec Series RH, Square D Class 8501, or equal

H. Timing Relays:
1. Multi-function, micro-controller based, socket mounted timing relay.

2. Single functions:
    a. Delay on Make
    b. Delay on Break
    c. Recycle (on time first, equal recycle delays)
    d. Single shot
    e. Interval
    f. Trailing edge single shot
    g. Inverted single shot
    h. Inverted delay on break
    i. Accumulative delay on make
    j. Retriggerable single shot
3. Dual functions:
    a. Delay on make/delay on break
    b. Delay on make/recycle (on time first, equal recycle delays.)
    c. Delay on make/interval
    d. Delay on make/single shot
    e. Interval/recycle (on time first, equal recycle delays)
    f. Delay on break/recycle (on time first, equal recycle delays)
    g. Single shot/recycle (on time first, equal recycle delays)
    h. Recycle – both times adjustable (on time first)
    i. Recycle – both times adjustable (off time first)
    j. Interval/delay on make
    k. Accumulative delay on make/interval
4. Time delay range, switch selectable:
    a. Single function 0.1 second to 1,705 hours in 8 ranges.
    b. Dual function 0.1 second to 3,100 minutes in 8 ranges.
    c. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
    d. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.
5. Output: Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240VAC and 1/3-horsepower at 120 or 240VAC; double pole double threw: DPDT. Mechanical life: 10,000,000 operations and electrical life: 1,000,000 operations at full load.
6. Mounting: Magnal Plug 11-pin socket
7. Environment: -20 degrees C to +65 degrees C.
8. ABB/SSAC multifunction type TRDU time delay relay with dip-switch function setting with 12VDC, 24VAC, 120VAC, 240VAC inputs as required; Agastat, STA series; IDEC or Engineer accepted substitute.

I. Elapsed Time Indicators:
1. Elapsed time indicators shall be panel mounted, non-resettable five-digit, hour indicator, rated 120 volts, 60 Hz.

2.19 GROUNDING SYSTEM

A. Provide electrical system grounding electrode conductors, equipment grounding conductors for equipment grounding and raceways, grounding electrodes, grounding electrode conductors, connections, and bonding in compliance with the National Electrical Code-Article 250 and the National Electrical Safety Code.

B. Provide annealed bare copper, concentric stranded grounding conductors. Provide the minimum sizes per NEC Article 250 for grounding conductors or service entrance conductors, if not sized on the drawings.

C. Bond grounding conductors entering enclosures together to metallic enclosure and to metallic raceways terminating at the enclosure. Clean the conductor and enclosure metal surface at the point of connection prior to making equipment grounding connections or bond connections.

D. Provide ground grid components of #4/0 AWG bare copper conductors connected to 10-foot ground rods installed at the four corners of a building, an equipment pad, or as shown on the Drawings. Provide UFER, concrete-encased electrodes per NEC 250.52(3), by embedding conductors in concrete near bottom of footing.

E. Make connections grounding conductor connections to equipment and ground rods by bolted clamps, compression connectors, or exothermic weld connections in accordance with manufacturer's installation and testing instructions. Make connections to buried grounding connections using compression connectors or exothermic weld connections. Make connections at the ground grid test wells using bolted clamps.

F. Connect the ground grid to the following with grounding conductor specified herein or connect to the ground grid with grounding conductor as shown on the drawings:
   1. Building steel columns with #4/0 AWG bare copper
   2. Electrical ductbank #4/0 AWG embedded conductor with #4/0 AWG bare copper
   3. Electrical distribution or utilization equipment metal enclosures with #4/0 AWG green insulated copper
   4. Metal enclosure not containing electrical distribution with #4 AWG green insulated copper
   5. Pump/motor frames with #4 AWG bare or insulated
   6. Lightning and surge arresters using #4 AWG bare or insulated
   7. Fences and gates with #4 AWG bare or insulated
   8. Ground rods with #4/0 AWG bare copper
   9. Power utility service entrance equipment with #4/0 AWG bare copper
   10. Equipment ground plate with #4/0 AWG bare copper.
   11. Other equipment: provide #1 AWG green insulated copper. Provide ¾" conduit protection where subject to damage.

G. Ground Rods:
   1. Ground rods: copper-clad steel, 3/4-inch diameter and 10-feet long, with threaded end for connectors or installation tools.

H. Compression Connectors:
   1. Compression connections: cast copper.
   2. Manufacturer: Thomas & Betts Company, or equal.

I. Bolted Connectors:
   1. Bolted connectors: copper. Manufacturer: Burndy, O. Z. Gedney, or equal.

J. Exothermic Connectors:
   1. Exothermic connections copper products. Manufacturer: Cadweld process or equal.

K. Equipment Ground Plate:
   1. Provide equipment ground plates embedded flush in equipment pads to provide a bolted connection between a grounding conductor from the equipment frame to the ground grid.
   2. Provide ground plates of copper alloy construction and 1/2 inch, threaded bolt connections and integral #4/0 welding stud. Manufacturer: Cadweld Series B-162, or equal.

L. Raceway Ground:
   1. Install metallic conduits to provide a continuous ground path. Use insulated grounding bushings and bonded to the ground grid system in compliance with Article 250 of the National Electrical Code.
   2. Provide an equipment-grounding conductor with green insulation in all metallic and non-metallic conduit, raceway, wireway, gutter, or ductbanks.
   3. Provide an equipment grounding conductor with green insulation for size up to #6 AWG and provide green color insulation tape band for conductor size #4 AWG and larger.

2.20 POWER, CONTROL, AND METERING EQUIPMENT

A. Coordinate demolition of existing service equipment and installation of new service equipment with electric power utility company.

B. Comply with the power utility service entrance section standards that includes the power utility metering equipment. Coordinate the correct meter socket requirements. Submit proposed equipment to power utility for acceptance prior to submitting to the Engineer. Provide and install equipment according to power utility requirements.

C. Metering Equipment:
   1. Provide analog or digital power meter with monitoring and protection features shown or specified. Provide stainless steel sunshields for metering equipment mounted outdoors.

D. Surge Protective Devices:
   1. Provide SPD with electrical characteristics and ratings for service entrance equipment, switchgear, switchboards, motor control centers, and panelboards specified in the Division 26 electrical distribution equipment specification sections or indicated on the Drawings. Provide SPD with the same voltage, phase, 3 or 4 wire system as the host electrical equipment.

E. Panelboards:

1. Provide panelboards: circuit breaker, dead front type with bus bar construction composed of individually mounted circuit breakers with screw-connection, designed to be removed without disturbing other breakers. Provide lockable, hinged door-in-door construction for flush mounted panels and hinged-trim covers for surface mounted panels.
2. Provide tin-plated copper bus and with the current rating as shown on the panel schedules sized in accordance with UL 67 and withstand rating equal to the interrupting rating of the smallest circuit breaker in the panel. Series rated products are prohibited. Silver plated equipment is prohibited.
3. Provide panelboards with a separate ground bus and a full capacity neutral bus. Mount neutral bus on insulated standoffs. Provide removable link connector from the neutral bus to the ground bus. Provide listed and labeled panelboard for service entrance disconnect as shown.

F. Combination Motor Starters:

1. Provide NEMA rated for the horsepower for combination motor starters, minimum size 1, with motor circuit protector and solid-state type overload relay. Provide a reset button located on the unit door exterior.
2. Provide adjustable motor circuit protector with magnetic only trip setting adjustable over a range of 600 to 1300 percent of full load current of the motor served. Field adjust motor circuit protector setting per NEC and manufacturer's recommendations. Provide 22,000 symmetrical ampere interrupt rating, where not shown on the power single line diagrams.
3. Provide solid-state adjustable overload relay to latch in the open position. Provide adjustable trip settings with minimum adjustable range from 85 to 115 percent of full load current of motor served. Field adjust overload setting per NEC and manufacturer's recommendations.
4. Provide control power transformers with two primary fuses rated at 100,000 amperes at 600VAC and one secondary fuse rated at 10,000 at 250VAC and sized at 125 percent of the control circuit full load current. Ground the non-fused leg of the secondary circuit.
5. Provide switchboard type MTW or SIS control circuit conductors rated 90 degrees C above ambient temperature. Conductors shall be identified with tag numbers.
6. Provide motor contactor "Run" status contact and "Overload" alarm contact. Provide "Hand-Off-Auto" (HOA) and other shown selector switches with a "Auto Mode" status contact wired to terminal block.
7. Provide heavy-duty selector-switches and pushbutton and indicating lights with rating to match enclosure type. Provide control devices rated at 600VAC, 10-ampere continuous with
8. Provide start/stop pushbuttons with "Run" and "Stop" indicating lights including other control devices as shown. Provide push-to-test transformer type pilot lights or LED pilot lights. Lens color as shown on the drawings or specified herein.

G. Circuit Breakers:
   1. Provide circuit breakers: molded-case type provided for the current ratings and pole configurations as shown or as specified on the panelboard schedule and with a minimum interrupting current rating as shown on drawings or schedules, but not less than 22,000 AIC for 240 volt rated devices or 42,000 AIC for 480 volt rated devices. Series rated branch, main, or other devices are prohibited.
   2. Provide circuit breakers listed in accordance with UL 489 for the service specified and load terminals with solderless connectors. Provide bolt-on type circuit breakers. Provide circuit breakers with machine-printed, circuit number labels indicting the load served.

H. Manual Starters:
   1. Provide manual starters with horsepower rated, quick-make, quick-break, toggle mechanism with overloads in each phase. Provide NEMA-12 enclosures indoor and NEMA-4X stainless steel enclosures outdoor, process areas, and corrosive areas. Provide label for power source and load as shown.

I. Safety Disconnect Switches:
   1. Provide safety disconnect switches:
      a. Motor horsepower rated, heavy-duty, non-fusible
      b. Safety type rated 600 volts AC
      c. Ratings and fuse size as shown
      d. Rating and fuse size as required by the utilization equipment manufacturer
      e. Disconnect “open status” switch rated 1-ampere
      f. Switch operator with a positive, quick-make, quick-break mechanism
      g. NEMA-12 indoor-conditioned space, or as shown
      h. NEMA-4X stainless steel below grade, process areas, outdoors, corrosive areas, or as shown
      i. NEMA-7 aluminum hazardous classified areas.
      j. Tinplated copper products. Silver-plated products are prohibited.
      k. Manufacturer: Square-D, GE, Allen-Bradley and Cutler Hammer or approved equal.

J. Electrical Safety Matting
   1. Safety matting shall be provided for added protection of operations staff and workers to cover concrete surfaces in front of electrical equipment indoors.
      a. Matting shall meet ASTM D178 specifications for manufacture of Type II, Class 2: ¼” thickness matting.
      b. Flame and oil resistant tested per ASTM standards.
      c. ASTM certification engraved or stamped on the back surface of the matt.
      d. Matting shall be tested and certified for industrial use. Matt rolls shall be proof testing over the entire surface at 20,000 VAC, and a dielectric test voltage of 30,000 VAC.
      e. The Contractor shall provide matting in the existing electrical rooms in front of all new electrical enclosures.
      f. The Contractor shall provide matting in the front of all interior control panels.

g. Single piece rolls are preferred to be used in front of long sections of electrical equipment including, but not limited to, switchboards, switchgear, motor control centers, panelboards and control panels.

h. Matting shall be a minimum of 48" wide corrugated black for interior areas.

2.21 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:

1. Operating and maintenance information as specified in Section 01 78 23.
2. One 11" x 17" set of drawings in a protective covering and shipped with the equipment in the internal equipment pocket at the time of equipment delivery to the project site.
3. Record documents as specified in Section 01 78 39.
4. Certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) as specified in paragraph 26 05 00.01-1.01 A 4.

PART 3 – EXECUTION

3.01 GENERAL

A. Construction:

1. Perform the work specified by Contract Documents in accordance with these specifications.
2. Coordinate the location of electrical material or equipment with the work and adjust conduit location to accommodate equipment in accordance with the accepted submittal drawings from the manufacturer.

B. Housekeeping:

1. Protect electrical equipment from dust, water and damage. Cover the exterior to keep dry. Electrical distribution equipment such as motor control centers, switchgear, switchboards, panelboards, and other power source buses shall be clean and free of dust and dirt.
2. Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction as specified in Shipment, Protection, and Storage section. Touch up scratches on equipment as specified in Coating Systems section before final acceptance.
3. Wipe clean and vacuum equipment on the inside prior to acceptance testing and energization and again prior to detailed inspection and acceptance of the work.

C. Installation:

1. Perform the installation work specified in accordance with these specifications.
   a. Splices are not allowed except by permission. Submit proposed splice locations to the Engineer and Construction Manager for review prior to installation. Splices and terminations are subject to inspection prior to and after insulating and may require re-termination after inspection. Underground splices will not be allowed.
   b. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. Lighting and receptacle circuits in conduits with power or control conductors is prohibited.

c. Adhere to the NEC raceway fill limitations. Provide separate conduits for signal and instrument conductors and cables.
d. Install power conductors derived from uninterruptible power supply systems in separate raceways.
e. Provide terminations at 460-volt motors by bolt-connecting the lugged connectors and insulating. Alternately, provide Tyco Electronics GelCap Motor Connection Kit by Raychem.
f. Install pre-approved in-line splices and tees with tubular compression connectors and insulate. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits.
g. Provide self-insulating tubular butt-splice type of compression connectors for terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads.
h. Adjust motor circuit protectors in accordance with manufacturer's instructions and NEC requirements.
i. Adjust motor overload device in accordance with manufacturer's instructions and NEC requirements.

D. Conductors, Wire, and Cable Installation:
1. Identify conductors at each connection terminal and at splice points with the identification marking system specified.
2. Install wire and cable into raceways, conduit, cable trays, or wireways without damaging or putting undue stress on the insulation or jacket. Provide manufacturer's recommended and UL Listed pulling compounds lubricants for pulling wire and cable. Grease is prohibited.
3. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Provide wire or cable support where wire or cable exits a raceway. Provide reusable stainless steel Kellums grips or equal product where cable support is required and where loads are removable.
4. Scratch-brush the contact areas and tinplate the connection where flat bus bar connections are made with tinplated or unplated flat bus bar. Provide non-oxide material approved for the function. Torque bolts to the bus manufacturer's recommendations.
5. Adhere to raceway fill limitations defined by NEC and the following: Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits.
6. Install pre-approved in-line splices and tees made with tubular compression connectors and insulated as specified for terminations and for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or equal splicing kits.
7. Conductors in all handholes and manholes shall have adequate slack to be tied up around the perimeter of the vault and will be suspended by insulators around the vault's perimeter as needed to support the cable.

E. Raceway Installation:
   1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
   2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes.
      a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
      b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
      c. Install exposed conduit on supports spaced not more than 10 feet apart.
      d. Install conduits out from the wall using framing channel where three or more conduits are located in parallel run.
      e. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces. Verify installation method for conduits larger than 2-inch with Construction Manager prior to installation.
      f. Install conduit in slabs that have only a single layer of reinforcing steel, under the reinforcement.
      g. Install conduits with large radii under the slab in a one-sack concrete slurry.
      h. Route conduit clear of structural openings and shown future openings.
      i. Provide conduit roofs or wall penetrations with flashing sealed watertight and fire-stop, as required to maintain the structural rating.
      j. Grout conduit into any openings cut into concrete and masonry structures.
      k. Cap conduits during construction to prevent entrance of dirt, trash, and water.
      l. Terminate exposed conduit stubs for future use with pipe-caps and provide couplings and pipe-plugs where flush with the slab.
      m. Determine concealed conduit stub-up locations from the manufacturer's shop drawings.
      n. Terminate conduit in equipment with conduit couplings with pipe-plugs flush with structural surfaces for empty conduit.
      o. Install conduit horizontally with at least 7-feet headroom clearance.
      p. Terminate conduit with fittings that ensure that the NEMA rating of the enclosure and provide conduit hubs, as required heretofore.
      q. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence. Taped or painted RMC-Steel or RNC is prohibited.
      r. Provide conduit crossing structural joints with structural movement with O-Z "Type DX" or Crouse-Hinds "Type XJG-SA," aluminum, bonded, weather-tight expansion fitting of the same size and type as the conduit.
      s. Seal conduits in corrosive areas using removable mastic material.
      t. VFD motor feeder circuits shall be routed a minimum of 12 inches from any control conduits. Should they cross they shall cross at 90 degrees.

F. Underground Raceway Installation:
   1. Adhere to the Power Utility underground service entrance requirement for excavation, raceways installation and termination, pads and reinforcement, backfilling, and location criteria. Provide excavation, backfilling, and concrete work as specified and shown.
   2. Provide underground conduit installations that conform to the following requirements:
      a. Direct bury underground conduits that are not shown to be installed in an electrical ductbank.
      b. PVC coated RMC-steel elbows for underground to above ground transitions.
      c. Underground conduit bend radius: not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere for up to 2-inch diameter conduit.
      d. Determine conduit manufacturer's bending radius requirement for 3-inch and larger diameter conduit and use factory "long radius" ells.
      e. Underground ductbanks and direct-buried conduits: 2-feet minimum earth cover, except where shown otherwise.
      f. Concrete encased conduit:
         1) Minimum concrete thickness of 2 inches between conduits 2.5-inch and smaller.
         2) 3 inches between 3-inch conduit and larger or per NEC requirements.
         3) 1-inch between conduit and reinforcing.
         4) 3 inches over reinforcing.
         5) Embed #4/0 bare ground in the concrete encasement and installed with direct buried raceways.
         6) Standard detail or typical details shown supersede these general requirements.
         7) Provide 3-pounds of red-oxide dye-color per sack of cement for in the concrete encasement for electrical ductbanks.
         8) Provide 467-ASTM coarse aggregate size with 3-cement sacks per cubic yard concrete.
         9) Provide concrete with 28-day, 2000-psi compressive strength unless specified at higher value in the cast-in-place concrete specification.

G. Electrical Equipment Labeling – Arc Flash
   1. Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection. These labels will be provided by the Contractor.

3.02 TESTING

A. Provide electrical equipment acceptance tests in accordance with the latest version of NETA Acceptance Testing Specification for electrical distribution and utilization equipment to demonstrate that all electrical equipment is functioning as designed.

B. Test lighting system for proper function. Test wiring devices for correct connections. Test outlet grounding and polarity using a plug-in test device. Test motor control stations and control devices for proper function.

C. Test power, control, instrument, and signal conductors to verify free from grounds. Megger test all conductors with the test voltage appropriate to the conductor insulation voltage. Use a 600 or 1,000-volt megohmmeter for resistance measurements for 600VAC rated insulation and all motors. Test between conductors and from conductor to ground. Insulation with resistance of less than 10-megohms is not acceptable. Record the insulation resistance measurements in a format similar to or on the Form 26 05 00.01-A in Section 01 99 90.

D. Pre-test conductors prior to installation, as appropriate. Replace damaged conductors. Test all conductors after installation.

E. Measure motors insulation resistance before they are connected. For 50-horsepower and larger motor, measure the motor insulation resistance at the time of delivery and after they are connected. Insulation resistance values less than 10 megohms are not acceptable. Complete the Installed Motor Test Form: 26 05 00.01-B in Section 01 99 90, for each motor after installation.

3.03 FUNCTIONAL CHECKOUT

A. Prior to energization of equipment, perform a functional checkout of the control circuit. Prior to functional testing, adjust and make protective devices operative. Energizing each control circuit and operating each control, status, alarm, protective device, and each interlock to verify that the specified action occurs. Submit a description of his proposed functional test procedures prior to the performance of functional checkout.

B. Verify motors are connected to rotate in the correct direction by momentarily energizing the motor. Prior to motor rotation test, confirm that the motor, the driven equipment, nor personnel will be damaged by reverse operation.

3.04 GROUNDING SYSTEM TESTS

A. Test each grounding connection to determine the ground resistance per the IEEE Standard 81. Submit a plot of ground resistance readings for each isolated ground rod or ground mat to the Construction Manager on 8-1/2 x 11-inch size graph paper.

B. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. Make measurements at 10-foot intervals, beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than 2-ohm resistance, for the flat portion of the plotted data, is considered inadequately grounded. Add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2-ohm requirement. Additional ground rods and ground grid work will be paid for as extra work. Use of salts, water, or compounds to attain the specified ground resistance is prohibited.

3.05 PROTECTIVE DEVICE COORDINATION

A. The Engineer will provide protective device settings to the Contractor for field setting of trips on overcurrent devices.

3.06 RECORD DOCUMENTS

A. Provide Record Drawings and documents maintained and annotated during construction. Submit drawings in accordance with Section 01 78 39 and the following.

B. Include addendum items, requests for information, change orders, and field changes posted or drawn on the Record Drawings. Include the following drawings with the Record Drawings:
   1. Interconnection Diagrams specified herein.
   2. Original Submittal Drawings specified herein.

C. Schedule a meeting with the Engineer in the Engineer's office to review the Record Drawings at the end of the project. Make corrections to the Record Drawings prior to re-submitting the Record Drawings to the Engineer.

D. Submit Record Drawings and Operations and Maintenance (O&M) Manuals as specified in Sections 01 78 23 and 01 78 39, to be included in the completed project Record Document Set for the Owner.

END OF SECTION

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SECTION 26 05 73

POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 DESCRIPTION

A. General:
   1. This section specifies that Owner's Engineer, Brown and Caldwell, shall be the Study Firm (SF) and shall provide the following:
      a. An evaluation of the site Electrical Distribution System (EDS) for:
         1) Short circuit current values
         2) Arc flash energy levels
         3) Coordination of overcurrent devices
   2. Brown and Caldwell shall use software of their choice to create and develop the power system model and Power System Study (PSS) for all new and existing EDS equipment as indicated:
      a. Request updated Utility information from the power company for short circuit current available at the incoming services.
      b. Perform a site survey to gather data on the electrical equipment necessary for the PSS.
      c. Perform Protective Device Coordination Study (PDCS) report for all equipment in the facility electrical distribution power system.
      d. Perform a short circuit study (SCS) for all facility new and existing equipment.
      e. Create an Arc Flash Hazard Analysis Report (AFHAR) for the site EDS.
   3. Results of the AFHAR will be used to define the arc flash protection boundary and the incident energy levels when working on energized electrical equipment. Personal Protective Equipment (PPE) will be suggested based on guidelines in the National Fire Protection Association (NFPA) Standard 70E.
   4. Power distribution equipment labels will be installed identifying the hazard levels, working distances and PPE required to perform work on the energized equipment by a qualified person.
   5. Existing and modified electrical equipment includes:
      1) WTP MCC – Furnas System 89, service entrance equipment
      2) Well 1 MCC – Siemens tiastar including new vertical section and feeder breakers
      3) Well 2 MCC – Siemens tiastar
      4) Well 3 MCC – Siemens tiastar

B. The Testing Firm shall be as described in Section 26 08 00 and shall also be responsible for the electrical testing described therein.

C. Scope:
   1. The Short Circuit and Protective Device Coordination Report shall include analysis including electric utility equipment that affect the installed equipment's short circuit ratings, protective device ratings and protective device settings.

2. Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.
3. Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.
4. Work shall include the fabrication of warning labels with the arc flash hazard analysis results and the installation of the labels on the equipment in accordance with NFPA 70E Article 130.5 that includes nominal system voltage, arc flash boundary, and at least one of the following: Available incident energy and corresponding working distance or the arc flash personnel protective equipment (PPE) level but not both, the minimum arc rating of clothing, site specific level of PPE.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 14 19 Use of Site
   2. Section 26 05 00 Common Work Results for Electrical
   3. Section 26 08 00 Commissioning of Electrical Systems

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
IEEE 141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
IEEE 1584	IEEE Guide for Performing Arc-Flash Hazard Calculations
ANSI C37.010	IEEE Application Guide for AC High-Voltage Circuit Breakers > 1000 VAC Rated on a Symmetrical Current Basis
NETA ATS	Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
NFPA 70E	Standard for Electrical Safety in the Workplace

NFPA 70	National Electrical Code

1.04 SCHEDULE

A. The report shall be completed, submitted to the Construction Manager for acceptance and reworked to include the Construction Manager comments and corrections, as required. The report shall be approved by the Construction Manager prior to purchase and fabrication of electrical equipment including switchgear.

B. A copy of the Construction Manager accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

1.05 SUBMITTALS

A. Procedures: As specified in Section 01 33 00.

B. Action Submittals:
   1. The report specified in this Section.

C. Closeout Submittals:
   1. Electronic copies of the electrical system model used to develop the report in the model's native software format (e.g. SKM, ETAP, EasyPower), including all custom libraries or support files used to create the report.

PART 2 PRODUCTS

2.01 REPORT

A. The Study Firm product shall be a certified report summarizing the short circuit and coordination study and conclusions or recommendations which may affect the integrity of the electric power distribution system. As a minimum, the report shall include the following:
   1. The equipment manufacturer's information used to prepare the study.
   2. Electric utility system information applicable to the project, including dated copies of correspondence from the utility providing the required information.
   3. Short circuit calculations listing short circuit levels at each bus. Provide a sketch of the bus and use both the project term and the bus-code-name to identify the bus, branches, sources, loads. Base the system on the Project One-Line diagram.
   4. Coordination study time-current curves including the instrument transformer ratios, model numbers of the protective relays, and the relay settings associated with each breaker.
   5. Comparison of short circuit duties of each bus to the interrupting capacity of the equipment protecting that bus.
   6. Data used as input to the report that includes cable impedances, source impedances, equipment ratings for the equipment being purchased for the project, etc.
   7. Arc flash hazard calculations listing incident energy levels at each bus.
   8. Copy of the Arc flash warning labels displaying information in accordance with NFPA 70E requirements.

9. Assumptions made during the study.

PART 3 EXECUTION

3.01 GENERAL

A. Study Firm shall provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010.

B. The studies shall be performed using actual equipment data for both existing and new equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

C. For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.

D. For existing equipment, the Study Firm shall provide [three] separate one man-day trips of onsite investigation to identify loads and power distribution equipment data.

E. Any power distribution equipment outages shall be scheduled in advance and coordinated with the Owner to limit process outages as required per plant process capacities, refer to Section 01 14 19 and Section 26 05 00.

3.02 QUALIFICATIONS

A. The short circuit and coordination report shall be performed by the Study Firm and as described in Section 26 08 00. The studies shall be signed by the professional electrical engineer responsible for the studies and registered to practice engineering in the state in which the project is located.

3.03 SHORT CIRCUIT STUDY

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:
   1. One-Line Diagram
      a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
      b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
      c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
      d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
      e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
      f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.

g. Circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
h. Emergency as well as normal switching conditions, as applicable.
i. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. Calculations
1. Determine the paths and situations where short circuit currents are the greatest.
2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
3. Calculate the maximum and minimum fault currents.

3.04 ARC FLASH HAZARD ANALYSIS

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash analysis study shall include the following IEEE Standard 1584 nine step analysis process:
1. Collect system and installation data.
2. Determine modes of operation.
3. Determine bolted fault current.
4. Determine arc fault current.
5. Determine protective device characteristic and arc fault duration.
6. Document system voltages and equipment class.
7. Select working distances.
8. Calculate incident energy.
9. Calculate the arc flash protection boundary.

3.05 PROTECTIVE DEVICE COORDINATION STUDY

A. As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:
1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the complete protective relay settings shall be specified.
2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Construction Manager shall be notified as to the cause.
3. Time-current curves and points for cable and equipment damage.
4. Circuit interrupting device operating and interrupting times.
5. Indicate maximum fault values on the graph.
6. Sketch of bus and breaker arrangement.

3.06 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

A. The Study Firm shall work with the Contractor to implement the protective device coordination study settings on new and existing equipment as required in Section 26 08 00, based on the Protective Device Coordination Report specified herein and submit a

final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

B. The Study Firm shall work with the Contractor for implementing the Arc Flash Hazard warning labels installation requirements for electrical equipment as specified in NEC Article 110.16 Arc-Flash Hazard Warning , and NFPA 70E requirements.

END OF SECTION

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 DESCRIPTION

A. Perform acceptance testing of all electrical materials and equipment shown in the Contract Documents and as specified in this Section.

B. Tests shall be witnessed by the Owner's Representative. Provide the Construction Manager 30-day advanced notice for Testing Firm tests. Insulation tests by the Contractor typically will not be witnessed. Critical equipment witness testing may be requested by the Construction Manager.

1.02 REFERENCES:

A. General:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

B. ANSI/NETA ATS – International Electrical Testing Association (NETA) – Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.03 SUBMITTALS

A. Procedures: in accordance with Section 01 33 00.

B. Action Submittals:
   1. Pre-Test Submittals:
      a. Description or samples of specified test procedures.

C. Sample test report forms for the specified tests, demonstrating that the forms document the testing requirements of NETA ATS. Where equipment tested has adjustable settings, test reports must show as tested and as left settings.
   1. Preliminary Schedule listing equipment to be tested.

2. Notification form for the work scheduled.
3. Pre-Functional test procedures and testing schedule.
4. Functional test procedures and testing schedule.
5. Post-Test Submittals:
    a. Test reports for all test reports performed under this Section.

D. Closeout Submittals:
1. Final copies of all test reports performed under this Section, incorporating all submittal review comments, combined into a single volume that includes all testing performed in different phases over the course of the project.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT AND MATERIALS

A. Test instruments shall be calibrated to references traceable to the National Institute of Standards and Technology and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

PART 3 EXECUTION

3.01 TESTING

A. Insulation Resistance Measurements:
1. Insulation resistance measurements shall be made on conductors and electrical equipment that will carry current. Minimum acceptable values of insulation resistance shall be in accordance with the applicable NETA-ATS, ICEA, NEMA, or ANSI standards for the equipment or material being tested. The ambient temperature at which insulation resistance is measured shall be recorded on the test form.

B. Conductor and Cable Tests:
1. The phase-to-ground insulation resistance shall be measured for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other load equipment connected. Insulation resistance measurements shall be recorded in a format similar to Form 26 05 00-A contained in Section 01 99 90, and submitted for acceptance. Insulation with resistance of less than 10 megohms is not acceptable.

C. Motor Tests:
1. The Installed Motor Test Form, Form 26 05 00-B, contained in Section 01 99 90, shall be completed for each motor after installation and submitted for acceptance. All motors shall have their insulation resistance measured before they are connected.
2. Motors 50 HP and larger shall have their insulation resistance measured at the time of delivery and when they are connected. Insulation resistance values less than 50 megohms are not acceptable.
3. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor

confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

4. Motor running current shall be measured on each phase with the motor operating under load. Current imbalance shall be less than 5-percent difference between phases.

D. Power Distribution Equipment:
   1. Transformers, panelboards, and other power distribution equipment shall have their insulation resistance measured phase-to-phase and phase-to-ground.

E. Outlets:
   1. Test outlets using a device to verify polarity, grounding, and the correct wiring connections.

F. Signal and Network Cable Tests:
   1. Signal Cables: Test signal conductors and shield drain for insulation resistance with the other conductors in the cable grounded. Each shield drain conductor shall be tested for continuity. Insulation resistance measurements shall be recorded on Form 40 61 13-A contained in Section 01 99 90 or Testing Firm's equivalent form, and submitted.
      a. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt or 1000-volt meg-ohmmeter shall be used for insulation resistance measurements as appropriate.
   2. Network Cables (CAT5/5E/6/6A): Test network cables in accordance with TIA-568-C.2.

G. Pre-Functional Checkout:
   1. Prior to energizing equipment, the Contractor shall perform a pre-functional checkout of the power and the control circuit. Protective devices shall be installed and available for service and calibrated or adjusted with specified setpoints installed. Contractor selected initial setpoints shall be installed and recorded, when specified setpoints are not required from the manufacturer or the Engineer.
   2. Contractor shall submit a description of proposed test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of pre-functional testing.
   3. Pre-functional checkout shall consist of energizing each control circuit and operating each control device, protective device, monitoring or alarm device, and each interlock and verify the specified action or response occurs. Coordinate testing with the requirements specified in Section 01 91 00.

H. Functional Testing:
   1. Contractor shall submit a description of proposed functional test and checkout procedures conforming to the following requirements, including a schedule for conducting these procedures, not less than 30 days prior to the performance of functional testing.
   2. Prior to functional testing, all protective devices shall be adjusted and made operative.

3. Prior to energization of associated equipment, perform a functional checkout of all electrical and instrumentation control circuits as specified in the following and in Division 40. Checkout shall consist of energizing each control circuit and operating each control, alarm, safety device, and each interlock, in turn, to verify that the specified action occurs.

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Section Includes:
   1. Dry-type transformers with primary winding rated 600 volts and less used for power distribution, lighting and control purposes as specified or shown.
   2. Mini-power centers that include the primary transformer protection, transformer, secondary protection and a circuit breaker panel in one package.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/IEEE C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
ANSI/UL 506	Specialty Transformers
DOE 10 CFR Part 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment
NECA 409	Standard for Installing and Maintaining Dry-type Transformers
NEMA ST20	Dry-Type Transformers for General Application
UL 5085	Low-Voltage Transformers

1.03 SUBMITTALS

A. Procedures: in accordance with Section 01 33 00 and 26 05 00.01.

B. Action Submittals:
   1. Ratings:
      a. Voltage (primary and secondary)
      b. kVA

c. Design impedance
d. Insulation class and temperature rise
e. Taps

2. Dimensional drawings

C. Informational Submittals:
1. Manufacturer’s product cutsheets
2. Manufacturer's verification that the unit has been built and tested in accordance with the specified ANSI standards.
3. Manufacturer's verification of the sound levels conform to NEMA ST20 standards.
4. Wiring/connection diagram
5. Seismic certificates: provide certification that the submitted equipment is constructed to withstand the design seismic event and function after experiencing the design seismic loading, in accordance with Section 01 73 24.
6. Anchorage calculations: provide anchorage calculations for all submitted equipment in accordance with Section 01 73 24.

D. Closeout Submittals:
1. Operations and maintenance manual in accordance with Section 01 78 23.

1.04 QUALITY ASSURANCE

1. All electrical products provided shall be inspected by an independent nationally recognized testing laboratory (NRTL) for compliance with nationally recognized electrical product safety standards.
2. The NRTL must be acceptable to the inspection authority having jurisdiction (AHJ). Typical testing laboratories include Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), or Canadian Standards Association (CSA).
3. Product safety standards include those recognized as American National Standards (ANSI) and published by ASTM International (ASTM), Factory Mutual (FM), National Electrical Manufacturers Association (NEMA), or Underwriters Laboratories (UL).
4. Electrical products that comply with product safety standards shall either be *listed* in a document published by the NRTL and/or *labeled* on the product by an identifying NRTL symbol or mark.
5. When an electrical product is not available as certified by an acceptable NRTL, all costs and expenses for special inspections shall be included in the contract price. Tests or inspections shall be at the manufacturer's place of assembly or at the installation location in a manner acceptable to the AHJ.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The Owner and Construction Manager believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include:
   1. ABB
   2. Eaton
   3. Hammond Power Solutions
   4. Siemens
   5. Schneider Electric
   6. Or equal.

2.02 TRANSFORMERS

A. Standards:
   1. Conforming to the standards referenced in this Section.

B. Ratings:
   1. Voltage, frequency, number of phases and kVA as indicated on the Drawings.

C. Components:
   1. Coils:
      a. 10 kVA and below:
         1) Encapsulated.
      b. 15 kVA and above:
         1) Impregnated with varnish.
   2. Windings:
      a. Configuration: as indicated on the Drawings
      b. Material: Copper
      c. Electrically isolated primary and secondary windings.
      d. Provisions to permit separate grounding of the neutral conductor and the enclosure.
      e. Single-phase transformers shall be the four-winding type.
   3. Insulation
      a. Class: 220 degree C insulation system
      b. Temperature Rise (based on 40 degree C ambient temperature):
         a) Less than below 15 kVA: Not to exceed 115 degree C temperature rise.
         b) 15 kVA and above: Not to exceed 150 degree C temperature rise.

4. Taps:
    a. Transformers 15 kVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.
5. Terminal compartments:
    a. Sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for the cable specified.
6. Enclosures:
    a. 15 kVA and smaller:
        1) Weatherproof, nonventilated enclosures.
    b. Indoor over 15 kVA:
        1) Drip-proof, ventilated enclosures.
    c. Outdoor:
        1) Weatherproof enclosures.
    d. Mounting:
        1) Transformers 25 kVA and below shall be suitable for wall mounting and include mounting brackets and hardware. Transformers over 25 kVA shall be floor mounting type.

2.03 MINI-POWER CENTERS

A. Provide Mini-power center (MPC) consisting of an encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.

B. Ratings:
    1. KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown on the Drawings.

C. Branch Circuits:
    1. Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown on the Drawings.

D. Enclosure:
    1. Weatherproof, NEMA 3R.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install transformers in accordance with NECA 409.

B. Install transformers on walls or floors at locations shown on the Drawings. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for ready and safe operation and maintenance.

C. Mount transformers so that vibrations are not transmitted to the structural parts of the building or to other equipment. Make connections to transformers with flexible conduit.

D. Adjust tap settings to provide proper voltage at panelboards.

E. Ground and bond transformer in conformance with the National Electrical Code.

F. Provide a nameplate on each transformer with its project-specific identifier(s) in accordance with Section 26 05 00.01

3.02 FIELD QUALITY CONTROL

A. Test transformers in accordance with Section 26 08 00.01.

END OF SECTION

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SECTION 26 24 19

MOTOR-CONTROL CENTERS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies a freestanding, factory assembled Motor Control Center (MCC) vertical section for installation on an existing motor control center.
   2. Contractor to verify new vertical section matches existing MCC specification.

B. Equipment List:
   1. MCCs specified herein shall be furnished by a single manufacturer.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/NEMA ICS 1	Industrial Control Systems: General Requirements
ANSI/NEMA ICS 18	Motor Control Centers
UL 845	Motor Control Centers

B. Codes And Standards:
   1. All electrical products provided shall be inspected by an independent nationally recognized testing laboratory (NRTL) for compliance with nationally recognized electrical product safety standards.
   2. The NRTL must be acceptable to the inspection authority having jurisdiction (AHJ). Typical testing laboratories include Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), or Canadian Standards Association (CSA).

3. Product safety standards include those recognized as American National Standards (ANSI) and published by ASTM International (ASTM), Factory Mutual (FM), National Electrical Manufacturers Association (NEMA), or Underwriters Laboratories (UL).
4. Electrical products that comply with product safety standards shall either be *listed* in a document published by the NRTL and/or *labeled* on the product by an identifying NRTL symbol or mark.
5. When an electrical product is not available as certified by an acceptable NRTL, all costs and expenses for special inspections shall be included in the contract price. Tests or inspections shall be at the manufacturer's place of assembly or at the installation location in a manner acceptable to the AHJ.
6. Motor Control Centers and all components shall be NRTL listed to UL 845 and shall conform to NEMA ICS-1 and ICS-18 standards.

1.03 SUBMITTALS

A. Procedures: in accordance with Section 01 33 00.

B. Action Submittals:
1. Elementary connection and interconnection diagrams in accordance with NFPA 79 and/or NEMA ICS 18 Part 1 standards.
2. List of starters and feeder tap compartments indicating the size and type of circuit protection.
3. Interrupting, withstand, and continuous current rating of:
   a. Bus bars
   b. Feeder tap units
   c. Starter units
   d. Main incoming units
4. Nameplate schedule.
5. Dimensioned drawings showing conduit access locations.
6. Front view elevation with starter and component schedule.

C. Informational Submittals:
1. Seismic certificates: provide certification that the submitted equipment is constructed to withstand the design seismic event and function after experiencing the design seismic loading, in accordance with Section 01 73 24.
2. Anchorage calculations: provide anchorage calculations for all submitted equipment in accordance with Section 01 73 24.

D. Closeout Submittals:
1. Operations and maintenance manual in accordance with Section 01 78 23.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. A single MCC vertical section will be added to an existing MCC in Well 1. Motor Control Centers shall be as manufactured by Siemens tiastar, no equal.

2.02 SERVICE

A. Motor control center vertical section shall be rated 480Y/277 volts, 60 Hertz, 3 phase, 4 wire to match existing as specified or indicated, suitable for operation at the specified voltages and short circuit capacities. Existing housekeeping pad includes space for this section, however a small dry transformer will need to be relocated.

2.03 STRUCTURE AND CONSTRUCTION

A. Structure:
   1. Motor control centers shall be made of No. 14 gage steel minimum and, unless otherwise shown, each section shall be 90 inches high by 20 inches wide by 20 inches deep.
   2. Each section shall have 72 inches for stacking starter units into the sections.
   3. The compartments shall have pan-type doors with a minimum of two quarter-turn hold-down latches; and neoprene gaskets.
   4. A full height vertical wireway, 4 inch wide minimum, but not less than 30 square inches in cross section, shall be provided for each vertical motor control center section. The wireway shall contain full height removable doors. Horizontal wireways shall be provided top and bottom, extending the length of motor control centers.
   5. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full length of the motor control center lineup. A removable lifting angle shall be mounted on top and shall extend the width of the motor control center lineup.

B. Construction:
   1. Motor control centers located indoors shall have NEMA 1, gasketed enclosures.
   2. Starter units, size 4 and smaller, and feeder tap units less than 225 amperes shall be drawout plug-in construction with hardened, tin-plated copper free-floating stabs, steel spring backups. The door shall have interference tabs which prevent door closure if unit is improperly installed.
   3. Units shall be latched in the position to assure proper bus contact. The unit disconnect device shall be interlocked to prevent removal or reinsertion of a unit when the disconnect is in the "ON" or "TRIPPED" positions.
   4. Fusible switch or circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "OPEN" position.
   5. Hardware for mounting future starter and feeder tap units shall be provided at compartments specified as "FUTURE."

2.04 NOT USED

2.05 SEISMIC BRACING

A. Motor control centers and related equipment shall conform to the seismic anchorage and bracing requirements of Section 01 73 24.

2.06 NOT USED

2.07 FINISH AND COLOR

A. The finish and color shall match existing.

2.08 BUS

A. General:
   1. Bus shall be silver-plated copper with bolted connections between vertical and horizontal bus bars. Access for tightening these connections shall be from the front, without the need for tools on the rear of the connection. Insulated horizontal and vertical bus barriers shall be provided. Barriers shall be fabricated from high-strength, glass-filled polyester resin.
   2. The bus shall be braced to withstand a fault current of 42,000 amperes, RMS, symmetrical.

B. Horizontal Bus:
   1. Unless otherwise specified or shown, the main horizontal bus shall be rated a minimum 600 amperes continuous.

C. Vertical Bus:
   1. Unless otherwise specified or shown, the vertical bus shall be insulated and rated a minimum 300 amperes continuous.

D. Neutral Bus:
   1. The neutral bus shall be provided and have the same rating as the main horizontal bus, where specified or shown.

E. Ground Bus:
   1. A 300-ampere rated silver plated horizontal copper ground bus shall be provided. Provide a 6-300kcmil lug to terminate a bare 4/0 AWG copper ground conductor.

2.09 WIRING

A. General:
   1. Motor control centers shall be provided with NEMA ICS 18 Class I, Type B wiring. All starter units shall have terminal blocks for control wiring. Terminal blocks shall be provided for power wiring for starters size 2 and smaller.
   2. Motor control centers shall be provided with all necessary interconnecting wiring and interlocking.
   3. Provide elementary and connection diagrams for each starter unit and an interconnection diagram for the entire motor control center.

B. Power Wire:
   1. Power wire shall be copper 90 degrees C insulated, sized to suit load; minimum power wire size shall be No. 12 AWG copper stranded.

C. Control Wire:

1. Control wire shall be No. 16 AWG stranded copper wire, rated 90 degrees C machine tool wiring (MTW) and UL listed for panel wiring.

D. Terminations and Cable Connections:

1. Terminals:
   a. Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.
2. Cable Connectors:
   a. Cable connectors for use with stranded copper wire, sizes No. 8 AWG to 1000 kcmil shall be UL listed. Dished conical washers shall be used for each bolted connection. Connectors shall be reusable and shall be rated for use with copper conductors. Incoming line and outgoing feeder compartments shall be provided with crimp type lugs, 3M Company, Burndy Company, or equal.

E. Conductor Markers:

1. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.
2. Adhesive strips are not acceptable.
3. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink with figures 1/8 inch high. Sleeves shall be yellow or white tubing and sized to fit the conductor insulation. Shrink the sleeves with hot air after installation to fit the conductor.

2.10 MAIN AND FEEDER CIRCUIT PROTECTION

A. General:

1. Feeder tap units shall consist of circuit breakers, as specified or shown. Series ratings for overcurrent devices to meet specified short circuit withstand ratings is prohibited.

B. Circuit Breakers (Thermal Magnetic):

1. Thermal-magnetic circuit breakers shall be molded case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 42,000 amperes symmetrical.

C. Circuit Breakers (Magnetic Only):

1. Magnetic circuit breakers shall be molded-case equipped with toggle type handle, quick-make, quick-break over center switching mechanism that is trip-free so that breaker cannot be held closed against short circuits and abnormal currents. The tripped position shall be clearly indicated by breaker handle maintaining a position between "ON" and "OFF." All poles shall open, close, and trip simultaneously. Minimum short circuit capacity shall be 42,000 amperes symmetrical.

2.11 MOTOR STARTER UNITS

A. General:

1. Motor starter units shall be combination type with contactor and motor circuit protector, and overload unit as indicated on the drawings or specified in the MCC schedule. The starter units shall have a minimum combination UL listing of 42,000 amperes RMS symmetrical or as indicated or specified in the schedule.

B. Not Used

C. Motor Circuit Protectors:

1. The molded case motor circuit protector (MCP) shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the MCP. The motor circuit protector shall be set at its lowest position at the factory.

D. Control Transformers:

1. Each control transformer shall be rated 480/240-120V, single phase, 2-wires, 60 Hertz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

NEMA starter size	Minimum transformer volt-ampere rating
1	100
2	150
3	200
4	300

2. Each control transformer shall be provided with time-delay, slow-blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters.
3. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

E. Contactors:

1. Unless otherwise specified or shown, contactors shall be full voltage, 3-pole, 600-volt AC, NEMA Size-1 minimum. Contacts shall be double break, silver-cadmium oxide, and weld resistant. Contacts shall be isolated to prevent arcing. Coils and magnets shall be capable of being removed or replaced without special tools. IEC contactors are prohibited.
2. Reversing, multispeed, and reduced voltage starters shall have additional contactors, overload relays, and auxiliary relays as required, and shall have mechanically interlocked contactor coils to prevent simultaneous engagement.

F. Transient Voltage Surge Suppressor:

1. Provide a factory selected transient surge suppressor rated for each motor starter and power contactor encapsulated in a small module and mounted directly to the starter or contactor coil.

G. Auxiliary Contacts:
   1. Contactors shall be equipped with auxiliary contacts, rated 10 amperes at 120 volts AC. Refer to drawings for actual quantities required. As a minimum, each contactor shall be equipped with two normally open and two normally closed electrically isolated auxiliary contacts with the used and auxiliary contacts wired out to terminal blocks.

H. Overload Relay:
   1. The overload relay shall protect the power wiring and motor from excessive overcurrents. The relay shall be ambient compensated and have adjustment from 90 to 110 percent of the normal rating.
   2. The sensing element shall be adjustable Class 20 tripping time of 20-seconds at 600-percent of current setting. The faster overload trip Class 10 (10-seconds at 600-percent of current setting) and the longer overload trip Class 30 (30-seconds at 600-percent of current setting) shall be field set by the installer during the driven equipment startup with the overload settings that are required by the type of motor driven load.

I. Terminal Blocks:
   1. Terminal blocks shall be screw type rated 600 volts; 20 amperes for control wiring and 30 amperes power wiring with starters Size 3 and larger shall terminate the power leads directly to the contactor.
   2. The number of terminal blocks shall be specified on the drawings. Terminal blocks shall be provided with integral marking strips and shall be permanently marked with the conductor number as specified on the drawings. Internal wiring shall be connected on one side of the terminal block; outgoing conductors shall be connected to the other side.

2.12 MISCELLANEOUS

A. General:
   1. Control devices such as pushbuttons, selector switches, indicating lights and overload reset pushbuttons shall be mounted on the unit compartment door.

B. Not Used

C. Nameplates:
   1. Nameplates shall be provided in accordance with the requirements of Section 26 05 00.01. Nameplates shall be provided for all cubicles and compartments and identify the load per NEC. A Nameplate shall be provided identifying the motor control center. Provide equipment tag numbers and descriptions as shown on the drawings.
   2. Not Used

2.13 NOT USED

2.14 NOT USED

2.15 NOT USED

2.16 NOT USED

2.17 NOT USED

2.18 SPARE PARTS

A. One set consisting of the following spare parts shall be provided:
   1. 1--set each fuse size and type
   2. 10--indicating light bulbs

2.19 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00 and Section 26 05 00.01:
   1. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:
      a. Bus bar bracing
      b. Feeder tap units
      c. Starter units
   2. Operation and maintenance information.
   3. Dimensions and weights.
   4. Installation instructions.
   5. Manufacturer's product data.
   6. Manufacturer's certification and calculations confirming that the equipment complies with the seismic anchorage and bracing requirements of Section 01 73 24 and paragraph 2.03 Seismic Bracing.

PART 3 EXECUTION

3.01 GENERAL

A. The motor control centers shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG which hang from their vertical connections shall be supported within 2 feet of the connection.

C. Overload relay settings shall be implemented by the Contractor with the settings selected based on the actual full load amperes of the motor connected to the starter and the requirements of the motor driven equipment. Refer to the manufacturer’s literature for setting the overload relays.

D. The motor circuit protectors shall be adjusted by the Contractor to the lowest setting not causing false tripping.

E. Install motor control centers level and plumb on 3-1/2-inch concrete housekeeping pads per the manufacturer's installation instruction.

F. Seismic anchorage shall be per Section 01 73 24.

3.02 FIELD TESTS

A. Motor control centers shall be tested in accordance with Section 26 05 00.01.

3.03 NOT USED

END OF SECTION

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SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies light emitting diode (LED) indoor lighting fixtures, features and installation. Exterior LED lighting is specified in Section 26 56 19 LED Exterior Lighting.

B. Terminology used in this Section conforms to the following definitions: Nomenclature and Definitions for Illuminating Engineering as defined in Illuminating Engineering Society IES LS-1.

1.02 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents as part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. References to documents shall are in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall be the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document, before it was discontinued.

Reference	Title
IES LS-1	Nomenclature and Definitions for Illumination Engineering
NFPA 70	National Electrical Code (NEC)

B. SPECIAL WARRANTY: Provide a Special Warranty for LED lightings that shall include the following:

1. The written 5-year on-site replacement includes parts, material, fixture finish and workmanship. Provide on-site fixture replacement includes transportation, removal, and installation of new products.
2. The fixture finish shall include failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.
3. The replacement material warranty shall include defective or non-starting LED source assemblies and on power supply units.
4. The replacement warranty shall include lighting fixtures producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.
5. The warranty period shall begin on the date of Substantial Completion.
6. The Contractor shall provide the Owner with appropriate signed 5-year warranty certificates.
7. The Owner shall receive these certificates prior to final payment.

1.03 SUBMITTALS

A. PROCEDURES: Section 01 33 00 – Submittal Procedures.

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
2. Manufacturer's descriptive catalog literature for all lighting fixtures and accessories being installed under this section. Catalog information describing fixture make, materials, and dimensions.
3. Information shall include manufacturer, wattage, voltage, mounting configuration, and lamp type. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
4. Submit applicable data as specified in Section 01 78 23 – Operation and Maintenance Data.
5. Lighting fixture model numbers are provided on the drawings in the lighting fixture schedule. The manufacturer's catalog numbers listed are examples of the basic model or series.
6. Referenced catalog numbers may not include voltage, mounting style, modifications, and other special features that are specified. The Contractor, supplier, and manufacturer shall provide the specified requirements.
7. The Contractor may propose an alternate luminaire for approval; however, sufficient information shall be provided as a part of the submittal for the Engineer and the Owner to review and compare the listed luminaire and the proposed alternate.
    a. The Contractor and lighting supplier shall provide a photometric, energy usage (efficiency), approvals/listings and materials comparison between the two fixtures.
    b. If an alternate lighting fixture layout is required, the Contractor and lighting fixture supplier shall provide all illuminance calculations as part of the submittal to verify minimum illuminance levels are met by the proposed revisions.
    c. Proposed alternates shall be shown to be equivalent or superior to the fixture listed. It shall be the Contractor’s responsibility to provide sufficient information to the Engineer and the Owner to verify and approve alternates.

PART 2 PRODUCTS

2.01 GENERAL

A. Lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified on the Lighting Fixture Schedule on the project drawings.

B. Lighting fixtures shall be provided where shown on the drawings. The drawing’s light fixture placement is diagrammatical. The fixture layout shall be coordinated with the various trades to provide access to the fixture and to avoid installed equipment interference.

2.02 LIGHTING CONTROLS

A. Per Section 26 09 16 – Electrical Controls and Relays - that includes control switches, selector switches, relays, lighting contactors and other devices.

B. The project drawings indicate the operation and control methods and the circuits for the lighting systems.

2.03 LED LIGHTING

A. LED lighting shall be a functioning unit with all components including light source, lamps, power supply, control interface and components required for operation and shall be assembled by the lighting manufacturer or supplier.

B. Lighting fixtures shall be listed and/or labeled by nationally recognized testing laboratory (NRTL). Lighting testing shall be per IESNA LM-79 AND LM-80 procedures.

C. Lighting fixtures shall comply with ANSI chromaticity standard for classifications of color temperature. Refer to the specified LED lamp color and color temperature or the manufacturer's literature.

D. LED drivers shall have reversed polarity protection, open circuit protection and require no minimum load. Drivers shall operate at a minimum 80 percent efficiency and have a class A noise rating.

E. Where LED systems are specified to be dimmable, the LED system shall be capable of full and continuous dimming.

PART 3 EXECUTION

3.01 GENERAL

A. The location and type of light fixtures and control are shown on the drawings.

B. Lighting circuit raceways and conductors shall be sized by the contractor, where the circuits are not shown on the drawings.

C. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.

D. Raceways shall be provided in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.

E. Circuit wire shall be provided in accordance with Section 26 05 19 – Low Voltage Power Conductors.

F. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

G. Labels and marks, except the NRTL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

H. Where recessed fixtures are required, the fixture shall be provided with mounting hardware for the ceiling system specified.

I. A concealed latch and hinge mechanism shall be provided for access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture from ceiling panels.

J. Fixtures recessed in concrete shall have protective coating of bituminous paint.
   1. Fixtures shall be aligned and directed to illuminate an area as specified.
   2. Fixtures shall be directly and rigidly mounted on their supporting structures.
   3. Conduit system shall not be used to support fixtures.
   4. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

K. Tighten electrical connectors and terminals according to manufacture's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

L. Verify normal operation of each fixture.

M. Interrupt the power supply to demonstrate emergency lighting operation to battery power source or alternate power source. Retransfer to normal power supply.

N. Replace damaged fixtures.

3.02 LIGHTING FIXTURE SPECIFICATIONS

A. GENERAL: Lighting fixtures, including their related accessories, options, and hardware are specified on the drawings.

B. LIGHTING FIXTURE IDENTIFIER: Each lighting fixture type shown on the drawings may be identified with a unique acronym of two to four digits, as indicated below:
   1. FAMILY MEMBERS: Family members share the same primary physical characteristics, appearance, construction or function. The first digit as follows:
      a. A = Area light
      b. B = Bare lamp holder or strip light
      c. C = Corrosion-resistant
      d. D = Downlight
      e. E = Emergency
      f. F = Floodlight
      g. G = Grid mounted troffer
      h. H = Hazardous location
      i. I = Industrial
      j. L = Louver lens
      k. M = High/Low Bay
      l. N = Sign

m. O = Pool, or fountain, underwater
n. P = Patterned plastic lens
o. R = Roadway/parking lot
p. S = Suspended (architecturally finished areas)
q. T = Track-mounted
r. U = Under-cabinet
s. V = Vapor tight
t. W = Wraparound lens
u. X = Exit sign

2. LAMP SOURCES: The second digit of the fixture type indicates the lamp source from which the light is produced: L = Light Emitting Diode (LED)
3. OPTIONAL VARIANT: The third digit of the fixture type indicates variant of the same lighting type noted numerically.
4. Last Digit: Modifier to provide fixture information, as needed.

END OF SECTION

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SECTION 26 51 19.11

LED INTERIOR LIGHTING LIGHTSPEC

3.03 LIGHTING FIXTURE SPECIFICATION SHEET–LIGHTSPEC

Identifier:	AL1
Fixture description:	Area type LED Wall mount performance sconce, wet locations.
Construction:	Housing: Single piece die-cast aluminum. Door Frame: Single piece die-cast aluminum, gasket seal to housing. Finish Color: Oven cured polyester black paint.
Lighting:	Distribution: Type 3, full cutoff. Shielding: Flat glass lens.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1 55W, lensed LED array, neutral white 4,000°K.
Mounting:	Wall.
Special features:	Distribution: Type 3, full cutoff. Lens: Flat glass lens.
Acceptable products:	Philips Gardco 101L, Lithonia WST LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL2
Fixture description:	Area type LED round surface mount low profile.
Construction:	Baseplate: Single piece die-cast aluminum, integral heat sink. Reflector: full reflector with wire cover. Lens: UV-stabilized, high impact resistant molded polycarbonate or acrylic, full-face. Lens base: Molded polycarbonate, closed-cell neoprene gasket. Finish Color: Integral black.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1 22W, LED array, neutral white 4,000°K.
Mounting:	Wall or ceiling as shown on drawings.
Special features:	Housing: Single stainless steel center pin lens fastener. Distribution: Full. Lens: High impact-resistant lens.
Acceptable products:	Kenall Millennium MR13FL series, Prisma Lighting Magiclick 25 PC, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL1E
Fixture description:	Area Type LED round surface mount low profile, emergency backup.
Construction:	Baseplate: Single piece die-cast aluminum, integral heat sink. Reflector: full reflector with wire cover. Lens: UV-stabilized, high impact resistant molded polycarbonate or acrylic, full-face. Lens base: Molded polycarbonate, closed-cell neoprene gasket. Finish Color: Integral black.
Lighting:	Distribution: Full. Shielding: High impact-resistant lens.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1, 22W LED array, neutral white 4,000°K Alt. Source: Emergency Battery Backup with surface adapter.
Mounting:	Wall or ceiling as shown on drawings.
Special features:	Housing: Single stainless steel center pin lens fastener. Distribution: Full. Lens: High impact-resistant lens.
Acceptable products:	Kenall Millennium MR13FL/LEL/SA series, Prisma Lighting Magiclick 25 PC, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	DL1
Fixture description:	Recessed ceiling downlight LEDs that is not in contact with insulation
Construction:	Module: 6" dia. Die-cast and extruded aluminum with paint finish. Trim ring: Die-cast trim ring, specular clear aluminum with white trim, Housing: Listed by same manufacturer as compatible with this module, IC listed for contact with insulation.
Electrical:	Input voltage: Universal 120-277VAC, with 0-10VDC dimming control. Lamps: LED array, 4,000°K. LED driver: high efficiency, better than 0.9 power factor, integral thermal protection.
Mounting:	Ceiling, recessed.
Special features:	Control: 1-10VDC dimming control. Distribution: 50% cutoff, low glare. Open specular reflector.
Acceptable products:	Cooper Lighting Halo 1200 Series module with 49x Series trim and H750TD010/H570T housing, Liton Lighting Architectural Downlight LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	DL1E
Fixture description:	Recessed ceiling downlight LED that is not in contact with insulation with emergency backup
Construction:	Module: 6" dia. Die-cast and extruded aluminum with paint finish. Trim ring: Die-cast trim ring, specular clear aluminum with white trim, Housing: Listed by same manufacturer as compatible with this module, IC listed for contact with insulation.
Electrical:	Input voltage: Dual voltage 120/277VAC, with 0-10VDC dimming control. Lamps: LED array, 4,000°K. LED driver: high efficiency, better than 0.9 power factor, integral thermal protection. Alt. Source: emergency battery backup, remote test switch and indicator.
Mounting:	Ceiling.
Special features:	Control: 1-10VDC dimming control. Distribution: 50% cutoff, low glare. Open specular reflector.
Acceptable products:	Cooper Lighting Halo 1200 Series module with 49x Series trim and H750TD010/H570T housing, Liton Lighting Architectural Downlight LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	DL2
Fixture description:	Downlight Recessed can, ceiling mount, LED dead-front shower light
Construction:	Module: 6" dia. 16-gauge galvanized steel construction with light engine and driver accessible through aperture. Trim ring: Dead (non-conductive) front drop, Housing: Listed by same manufacturer as compatible with this module, IC listed for contact with insulation.
Electrical:	Input voltage: Dual voltage 120/277VAC, Lamps: LED array, 4,000°K. LED driver: high efficiency, better than 0.9 power factor, integral thermal protection.
Mounting:	Recessed can.
Special features:	Distribution: 50% cutoff, low glare.
Acceptable products:	Gotham 6" EVO Non-Conductive Shower Light, Philips Lightolier Revelation 0M6LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	IL1
Fixture description:	Industrial Type Enclosed LED; low profile, surface or pendant industrial strip .
Construction:	Housing: 7 inch wide, one piece fiberglass, continuous gasket. Finish: White.
Electrical:	Input voltage: Multi-voltage Ballasts: Electronic rapid-start only. Less than 10% THD. Lamps :4' LED, 4000 lumens, 4,000°K.
Mounting:	Surface, Pendant, cable, chain.
Special :	Distribution: Spread downlight, Aluminum reflector Molded UV-stabilized polycarbonate or acrylic diffuser, mounted with stainless steel cam latches.
Acceptable products:	Holophane EMS, Philips Day-Brite Vaporlume LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	ML1
Fixture description:	High Bay LED Industrial surface or pendant, high performance.
Construction:	Housing: Cast aluminum, integral heat sink. Sealed optic. Finish Color: Black
Electrical:	Input voltage: 120VAC Lamps: High performance 72 LED array, 5,000°K.
Mounting :	Surface or pendant.
Special Features:	Distribution: Wide.
Acceptable products:	Hubbell HBL LED Highbay Series, Philips Day-Brite HBL, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	ML1E
Fixture description:	High Bay LED Industrial surface or pendant, high performance with emergency backup.
Construction:	Housing: Cast aluminum, integral heat sink. Sealed optic. Finish Color: Black
Lighting:	Distribution: Wide.
Electrical:	Input voltage: 120VAC Lamps: High performance 72 LED array, 5,000°K. Alt. Source: Emergency lighting inverter
Mounting:	Surface or pendant.
Special Features:	Distribution: Wide.
Acceptable products:	Hubbell HBL LED Highbay Series, Philips Day-Brite HBL, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	ML2
Fixture description:	High Bay LED Industrial pendant, high performance.
Construction:	Housing: Cast aluminum, integral heat sink. Sealed optic. Finish Color: Black
Electrical:	Input voltage: Auto sensing (120-277) Lamps: High performance Lumen LED array, 5,000°K.
Mounting :	Pendant.
Special Features:	Distribution: Wide. Control: Dimmable, motion sensor
Acceptable products:	Holophane LED High Bay Phuzion Series, Philips Day-Brite LED High Bay FBX, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	ML2E
Fixture description:	High Bay LED Industrial pendant, high performance with emergency backup.
Construction:	Housing: Cast aluminum, integral heat sink. Sealed optic. Finish Color: Black
Electrical:	Input voltage: Auto sensing (120-277) Lamps: High performance Lumen LED array, 5,000°K. Alt. Source: Remote emergency battery pack
Mounting :	Pendant.
Special Features:	Distribution: Wide. Control: Dimmable, motion sensor
Acceptable products:	Holophane LED High Bay Phuzion Series, Philips Day-Brite LED Hight Bay FBX, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	SL1
Fixture description:	Suspended type Indoor pendant mounted LED, indirect/direct lighting.
Construction:	Nominal 49-5/8" x 8-1/4" x 1-3/4" rectangular cold-rolled steel housing with mechanically attached die-cast end caps.
Electrical:	Input voltage: Universal 120-277VAC Lamps: LED array, 4,000°K. Output: 4800 nominal delivered lumens
Mounting:	Pendant.
Special features:	Distribution: 40% uplight, 60% downlight.
Acceptable products:	Peerless Bruno LED Softshine, Philips Ledalite Sync, Pinnacle Linero, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	TL1
Fixture description:	Track light LED pivoting head.
Construction:	Housing: Die-cast and extruded aluminum Heat sink: die-cast aluminum. Support arm: Provide +/- 90°tilt and +/- 90° pivot to lamp housing, lockable. Track adapter: provide mechanical and electrical connection to track. Finish Color: Integral black.
Electrical:	Input voltage: 120VAC, 8 watts, P.F 0.92 min. Lamps: three 3 watt LEDs, white 4,000°K.
Mounting:	Ceiling mounted Halo Power track.
Special features:	Distribution: Narrow flood. Control: Dimmable with optional electronic dimmer.
Acceptable products:	Halo Stasis LED SML, WAC Imulse LED810, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	UL1
Fixture description:	Under-cabinet mount task light LED.
Construction:	Housing: 24-inch, extruded aluminum low profile Finish Color: Matte White
Electrical:	Input voltage: 120V Lamps: 18 watt LED, 4,000°K.
Mounting:	Surface, under counter.
Special features:	Distribution: general downlight, even distribution. Lens: DR Acrylic with smooth exterior. Control: Rocker Switch.
Acceptable products:	Kenall AUCLED Series, Philips Day-Brite LINCS, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	XLEH
Fixture description:	LED exit sign, green lettering, Hazardous Class I Division 2 rated. Wet or dry locations.
Construction:	Housing: Fiberglass reinforced Polyester Finish Color: Grey Faceplate: Green lettering on black stencil.
Electrical:	Input voltage: 120 or 277V Lamps: LED Battery: Sealed, maintenance free nickel cadmium battery
Mounting:	Universal, top, end or back mounted.
Special features:	UL Listed Class I Division 2 rated, wet locations. Meets UL 924 and UL 844
Acceptable products:	Lithonia LZ, Philips Chloride HZ, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	XLE
Fixture description:	LED exit sign, green lettering, wet or dry locations with battery backup.
Construction:	Housing: Cast Aluminum with Polycarbonate cover Finish Color: Black Faceplate: Green lettering on Black.
Electrical:	Input voltage: 120/277V Lamps: LED. Battery: Sealed, maintenance free nickel cadmium battery
Mounting:	Universal, top, end or back mounted.
Special features:	NEMA 4X rated, wet locations. Meets UL 924 NFPA 101
Acceptable products:	Lithonia LV, Philips Chloride 60 Line Max, or equal.

END OF SECTION

SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies light emitting diode (LED) exterior lighting fixtures features and installation. Interior LED lighting is specified in Section 26 51 19 LED Interior Lighting.

B. Terminology used in this Section conforms to the following definitions: Nomenclature and Definitions for Illuminating Engineering as defined in Illuminating Engineering Society IES LS-1 (formerly IES RP-16).

1.02 QUALITY ASSURANCE

A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents as part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. References to documents shall are in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall be the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document, before it was discontinued.

Reference	Title
IES LS-1 (formerly RP-16)	Nomenclature and Definitions for Illuminating Engineering
NFPA 70	National Electrical Code (NEC)

B. SPECIAL WARRANTY: Provide a Special Warranty for LED lighting that shall include the following:

1. The written 5-year on-site replacement includes parts, material, fixture finish and workmanship. Provide on-site fixture replacement includes transportation, removal, and installation of new products.
2. The fixture finish shall include failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.
3. The replacement material warranty shall include defective or non-starting LED source assemblies and on power supply units.
4. The replacement warranty shall include lighting fixtures producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.
5. The warranty period shall begin on the date of Substantial Completion.
6. The Contractor shall provide the Owner with appropriate signed 5-year warranty certificates.
7. The Owner shall receive these certificates prior to final payment.

1.03 SUBMITTALS

A. PROCEDURES: Section 01 33 00 – Submittal Procedures.

B. ACTION SUBMITTAL ITEMS FOR THIS SECTION:

1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
2. Manufacturer's descriptive catalog literature for all lighting fixtures and accessories being installed under this section. Catalog information describing fixture make, materials, and dimensions.
3. Information shall include manufacturer, wattage, voltage, mounting configuration, and lamp type. Catalog cuts shall be edited to show only the items, model numbers, and information which apply.
4. Submit applicable data as specified in Section 01 78 23 – Operation and Maintenance Data.
5. Lighting fixture model numbers are provided on the drawings in the lighting fixture schedule. The manufacturer's catalog numbers listed are examples of the basic model or series.
6. Referenced catalog numbers may not include voltage, mounting style, modifications, and other special features that are specified. The Contractor, supplier, and manufacturer shall provide the specified requirements.
7. The Contractor may propose an alternate fixture for approval; however, sufficient information shall be provided as a part of the submittal for the Engineer and the Owner to review and compare the listed luminaire and the proposed alternate.
    a. The Contractor and lighting supplier shall provide a photometric, energy usage (efficiency), approvals/listings and materials comparison between the two fixtures.
    b. If an alternate lighting fixture layout is required, the Contractor and lighting fixture supplier shall provide all illuminance calculations as part of the submittal to verify minimum illuminance levels are met by the proposed revisions.
    c. Proposed alternates shall be shown to be equivalent or superior to the fixture listed. It shall be the Contractor’s responsibility to provide sufficient information to the Engineer and the Owner to verify and approve alternates.

PART 2 PRODUCTS

2.01 GENERAL

A. Lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified on the Lighting Fixture Schedule on the project drawings.

B. Lighting fixtures shall be provided where shown on the drawings. The drawing’s light fixture placement is diagrammatical. The fixture layout shall be coordinated with the various trades to provide access to the fixture and to avoid installed equipment interference.

2.02 EXTERIOR LIGHTING POLES

A. Provide lighting poles with pole cap, hand holes, ground lug, and the necessary fixture mounting hardware.

B. TYPE:
   1. Site/Area poles as shown on the contract drawings:
      a. Shape: round, square, tapered, straight
      b. Material: Steel, concrete, aluminum, wood
      c. Finish: galvanized, powder coated
      d. Height: 6', 10', 15', 20', 30' examples
   2. Options (where noted):
      a. Tall pole breakaway
      b. Selector switch such as HOA where Auto may be a photocell or motion sensor
      c. GFI receptacle may also be required on a pole where shown.
   3. Stanchion poles:
      a. In Class I, Div. 1 areas provide pole as detailed and specified on the drawings.
      b. In Class I, Div. 2 and unclassified areas provide a telescoping light pole. Pole shall meet the sub-sequent requirements.
      c. Construction:
         1) Telescoping; factory sealed and pre-wired
         2) Adjustable 360 deg. pole rotation
         3) Adjustable height
         4) Spring assist for controlled lowering and assist to raise
      d. Height: As shown; adjustable raised height
      e. Swivel:
         1) 45 deg lowering
         2) Height as shown
         3) Pole shall be Swivelpole, Echalon, Pivotpole or approved equal.
      f. Certifications:
         1) UL 1598
         2) CSA C22.2 No. 250.0-08
         3) Suitable for use in Class I, Division 2 and Class I, Zone 2 areas
      g. Wind Rating: AASHTO standard; 310 mph aluminum; 230 mph stainless steel
      h. Vibration: IEC 60068-2-6
      i. Material: Aluminum T6061 or Stainless Steel 316 grade, as specified
      j. Hardware: Xylan 1400 coated for corrosion protection
      k. Cable:
         1) 12/3 AWG UL/CSA Listed
         2) 600V, -40 deg C to 105 deg C
         3) Sun and oil resistant
         4) ROHS II Reach
         5) Internal conduit for cable protection

l. System shall be factory assembled and wired
m. Coordinate with fixture mounting requirements
n. Poles shall not to be handrail mounted
o. Pole shall be Eaton/Crouse Hinds V-Spring system or approved equal.
p. Model V65BA –A; top hat and fitting mounts shall be provided as required for fixtures;
q. Provide optional “J” bolts as required for wind requirements in the area.

2.03 SITE JUNCTION BOXES

A. Provide a minimum of one junction box for the distribution of outdoor lighting circuits within ten feet of building and as required. Boxes shall be precast concrete, set flush with the ground. Size shall be approximately 10 x 16 x 12 inches deep.

B. Lid shall be cast iron with permanent inscription: "LIGHTING". Boxes shall be Brooks Products, Oldcastle Precast, Forni Corporation, Utility Vault Company, Christy Concrete Products, or equal.

C. Examples: Jensen Precast Pull Boxes 10” x 17”, Oldcastle, Brooks Products, Christy, J&R, Caltrans. HT = High Traffic Pull Box.

D. Circuit’s raceways and conductors shall be terminated and spliced, respectively at new junction box. Provide watertight U.L. Listed splices for the circuits.

2.04 PHOTOELECTRIC CELL UNITS

A. Photoelectric cell units shall in a plug receptacle assembly.

B. The plug receptacle assembly shall be three-prong polarized locking type.

C. Assembly shall be suitable for outdoor mounting.

2.05 LIGHTING CONTROLS

A. Per Section 26 09 16 – Electrical Controls and Relays - that includes control switches, selector switches, relays, lighting contactors and other devices.

B. The project drawings indicate the operation and control methods and the circuits for the lighting systems.

2.06 LED LIGHTING

A. LED lighting shall be a functioning unit with all components including light source, lamps, power supply, control interface and components required for operation and shall be assembled by the lighting manufacturer or supplier.

B. Lighting fixtures shall be listed or labeled by a national recognized testing laboratory (NRTL). Lighting testing shall be per IESNA LM-79 AND LM-80 procedures.

C. Lighting fixtures shall comply with ANSI chromaticity standard for classifications of color temperature. Refer to the specified LED lamp color and color temperature or the manufacturer's literature.

D. LED drivers shall have reversed polarity protection, open circuit protection and require no minimum load. Drivers shall operate at a minimum 80 percent efficiency and have a class A noise rating.

PART 3 EXECUTION

3.01 GENERAL

A. The location and type of light fixtures and control are shown on the drawings.

B. Lighting circuit raceways and conductors shall be sized by the contractor, where the circuits are not shown on the drawings.

C. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.

D. Raceways shall be provided in accordance with Section 26 05 33 – Raceways and Boxes for Electrical Systems.

E. Circuit wire shall be provided in accordance with Section 26 05 19 – Low Voltage Power Conductors.

F. Fixtures labeled to require conductors with a temperature rating exceeding 75 degrees C shall be spliced to circuit conductors in a separately mounted junction box. Fixture shall be connected to junction box using flexible conduit with a temperature rating equal to that of the fixture.

G. Photoelectric cells, where specified, shall be oriented toward the north.

H. Labels and marks, except the NRTL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.

I. A concealed latch and hinge mechanism shall be provided for access to the lamps and ballasts and for removal and replacement of the diffuser without removing the fixture.

J. Fixtures recessed in concrete shall have protective coating of bituminous paint.
   1. Fixtures shall be aligned and directed to illuminate an area as specified.
   2. Fixtures shall be directly and rigidly mounted on their supporting structures.
   3. Conduit system shall not be used to support fixtures.
   4. Where brackets or supports for lighting fixtures are welded to steel members, the welded area shall be treated with rust-resistant primer and finish paint.

K. Underground and outdoor wire splices shall be in accordance with Section 26 05 19.

L. Tighten electrical connectors and terminals according to manufacture's published torque-tightening values or use torque values specified in UL 486A and UL 486B.

M. Verify normal operation of each fixture.

N. Interrupt the power supply to demonstrate emergency lighting operation to battery power source or alternate power source. Retransfer to normal power supply.

O. Replace damaged fixtures.

3.02 LIGHTING FIXTURE SPECIFICATIONS

A. GENERAL: Lighting fixtures, including their related accessories, options, and hardware are specified on the drawings.

B. LIGHTING FIXTURE IDENTIFIER: Each lighting fixture type shown on the drawings may be identified with a unique acronym of two to four digits, as indicated below:

1. FAMILY MEMBERS: Family members share the same primary physical characteristics, appearance, construction or function. The first digit as follows:
   a. A = Area light
   b. B = Bare lamp holder or strip light
   c. C = Corrosion-resistant
   d. D = Downlight
   e. E = Emergency
   f. F = Floodlight
   g. G = Grid mounted troffer
   h. H = Hazardous location
   i. I = Industrial
   j. L = Louver lens
   k. M = High/Low Bay
   l. N = Sign
   m. O = Pool, or fountain, underwater
   n. P = Patterned plastic lens
   o. R = Roadway/parking lot
   p. S = Suspended (architecturally finished areas)
   q. T = Track-mounted
   r. U = Under-cabinet
   s. V = Vapor tight
   t. W = Wraparound lens
   u. X = Exit sign
2. LAMP SOURCES: The second digit of the fixture type indicates the lamp source from which the light is produced: L = Light Emitting Diode (LED)
3. OPTIONAL VARIANT: The third digit of the fixture type indicates variant of the same luminaire type noted numerically.
4. Last Digit: Modifier to provide fixture information, as needed.

END OF SECTION

SECTION 26 56 19.11

LED EXTERIOR LIGHTING LIGHTSPEC

3.03 LIGHTING FIXTURE SPECIFICATION SHEET–LIGHTSPEC

Identifier:	AL1
Fixture description:	Area type LED Wall mount performance sconce, wet locations.
Construction:	Housing: Single piece die-cast aluminum. Door Frame: Single piece die-cast aluminum, gasket seal to housing. Finish Color: Oven cured polyester black paint.
Lighting:	Distribution: Type 3, full cutoff. Shielding: Flat glass lens.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1 55W, lensed LED array, neutral white 4,000°K.
Mounting:	Wall.
Special features:	Distribution: Type 3, full cutoff. Lens: Flat glass lens.
Acceptable products:	Philips Gardco 101L, Lithonia WST LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL2
Fixture description:	Area type LED round surface mount low profile.
Construction:	Baseplate: Single piece die-cast aluminum, integral heat sink. Reflector: full reflector with wire cover. Lens: UV-stabilized, high impact resistant molded polycarbonate or acrylic, full-face. Lens base: Molded polycarbonate, closed-cell neoprene gasket. Finish Color: Integral black.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1 22W, LED array, neutral white 4,000°K.
Mounting:	Wall or ceiling as shown on drawings.
Special features:	Housing: Single stainless steel center pin lens fastener. Distribution: Full. Lens: High impact-resistant lens.
Acceptable products:	Kenall Millennium MR13FL series, Prisma Lighting Magiclick 25 PC, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL1E
Fixture description:	Area Type LED round surface mount low profile, emergency backup.
Construction:	Baseplate: Single piece die-cast aluminum, integral heat sink. Reflector: full reflector with wire cover. Lens: UV-stabilized, high impact resistant molded polycarbonate or acrylic, full-face. Lens base: Molded polycarbonate, closed-cell neoprene gasket. Finish Color: Integral black.
Lighting:	Distribution: Full. Shielding: High impact-resistant lens.
Electrical:	Input voltage: 120VAC Lamps: High performance Class 1, 22W LED array, neutral white 4,000°K Alt. Source: Emergency Battery Backup with surface adapter.
Mounting:	Wall or ceiling as shown on drawings.
Special features:	Housing: Single stainless steel center pin lens fastener. Distribution: Full. Lens: High impact-resistant lens.
Acceptable products:	Kenall Millennium MR13FL/LEL/SA series, Prisma Lighting Magiclick 25 PC, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL3
Fixture description:	Area type pole mounted walkway light, LED lamp
Construction:	Housing: Die-cast round, aluminum housing, mounts directly to a post-top mounted pole, black painted finish.
Electrical:	Input voltage: 120VAC (Universal). Lamps: 55LA LED array, 4,100°K, neutral/white color.
Mounting:	Post-top mounted
Special features:	Distribution: Type V wide optical system.
Acceptable products:	Phillips Gardco Slender Form Round SFR, Luminis MA14 Series or approved equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL4
Fixture description:	Area Type Semi-recessed wall light, LED lamp
Construction:	Housing: One-piece marine grade die-cast aluminum with polyester black paint finish. Bezel: One-piece marine grade die-cast aluminum with black paint.
Electrical:	Input voltage: 120VAC. Lamps: 26W LED array, 4,000°K.
Mounting:	Wall.
Special features:	Distribution: 50% cutoff, low glare. Lens: Polycarbonate lens.
Acceptable products:	Kenall Millennium MR17EL Series, Cooper Lighting Solas, or equal. (No 50% cutoff: Prosma Lighting Magiclick 25 PC)

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL4E
Fixture description:	Area Type Semi-recessed wall light, LED lamp with emergency back-up
Construction:	Housing: One-piece marine grade die-cast aluminum with polyester black paint finish. Bezel: One-piece marine grade die-cast aluminum with black paint.
Lighting:	Distribution: 50% cutoff, low glare. Shielding: Polycarbonate lens. Alt. Source: Emergency battery back-up with surface adapter.
Electrical:	Input voltage: 120VAC. Lamps: 26W LED array, 4,000°K.
Mounting:	Wall.
Special features:	Distribution: 50% cutoff, low glare. Lens: Polycarbonate lens.
Acceptable products:	Kenall Millennium MR17EL Series, Cooper Lighting Solas, or equal. (No 50% cutoff: Prosma Lighting Magiclick 25 PC)

3.02 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	AL5
Fixture description:	Stanchion mount pole walkway light for Classified Space
Construction:	Housing: Factory sealed, copper free aluminum housing with baked on powder coating for corrosion protection. Fixture is Class I, Div 1 Group C and D listed, NEMA 4X (IP66) construction.
Electrical:	Input voltage: 120VAC (Universal). Lamps: 96W LED array, 4,100°K.
Mounting:	25 degree stanchion (Rig-A-Lite – SXPS) on 1-1/4" rigid conduit.
Special features:	Distribution: general area diffused by prismatic globe. Prismatic glass globe with guard.
Acceptable products:	AZZ - Rig-A-Lite SXPJ-10-L-U-GG-S with FB1 fuse block, Crouse Hinds EV LED, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	RL1
Fixture description:	Roadway Type Pole mount square LED array.
Construction:	Housing: Extruded aluminum top and sidewalls, mitered corners, sealed against moisture. Finish Color: Black anodized.
Electrical:	Input voltage: 480VAC Lamps: 21 LED bars, Neutral White 4,000°K. Ballast: Integral LED driver.
Mounting:	Cast aluminum 6 inch arm with pole arm adapter. See plans for height requirement.
Special features:	Distribution: See drawing for distribution type [Type II, III, IV, V]. Lens: Tempered flat glass lens. Number of fixtures: see drawing for number of fixtures per pole.
Acceptable products:	Cooper Lighting Lumark RV LED Ridgeview Area/Roadway, Philips Eco-Form series, or equal.

3.03 LIGHTING FIXTURE SPECIFICATION SHEET--LIGHTSPEC

Identifier:	RL2M
Fixture description:	Roadway Type Pole mount square LED array, with motion sensor.
Construction:	Housing: Extruded aluminum top and sidewalls, mitered corners, sealed against moisture. Finish Color: Black anodized.
Electrical:	Input voltage: 480VAC Lamps: 21 LED bars, Neutral White 4,000°K. Ballast: Integral LED driver with motion sensor for Bi-Level switching.
Mounting:	Cast aluminum 6 inch arm with pole arm adapter. See plans for height requirement.
Special features:	Distribution: See drawing for distribution type [Type II, III, IV, V]. Lens: Tempered flat glass lens. Number of fixtures: see drawing for number of fixtures per pole. Control: Motion sensor for on/off controls
Acceptable products:	Cooper Lighting Lumark RV LED Ridgeview Area/Roadway, Philips Eco-Form series, or equal.

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SECTION 28 13 00

SECURITY SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Equipment Requirements:
      a. CCTV network video recorder/server operating system and application software.
      b. CCTV cameras.
   2. Security system integration and startup, including CCTV cameras, server, and integration of new equipment to existing security system and network components located offsite.

B. Design Intent
   1. CCTV System: Provide and install CCTV cameras where shown on Drawings.
   2. Provide Network Video Recorder (NVR) with Power over Ethernet (PoE) switch in the maintanence room of the Storage and Restroom Building and load video administration software to display video and transmit to existing offsite system for recording.
   3. Match existing offsite software for compatibility. Provide completely functional system including any necessary updates and configuration of existing offsite system.
   4. Cameras shall be individually accessible via standard web browser when accessed from computers on the network. Cameras are not intended to be accessible from anywhere on the internet and will only be accessed by secure connection via VPN through a firewall.
   5. Streaming of video to recorder is via limited bandwidth upstream connection. Configure system to only record cameras when motion is detected. Configure camera streaming resolution and frame rate for best possible quality without exceeding available upstream bandwidth (nominally 8 Mbps).

C. Design Requirements
   1. The Security System Supplier shall design, install, calibrate, program, and calibrate a complete and functional security system as described in this section and as shown on Drawings:
      a. Provide security components at locations shown on Drawings. The components shown on Drawings are a minimum. Provide any additional components required to make a complete and functional system that meets the functional intent of Drawings and Specifications.
      b. Size and select the appropriate wire and cable types to provide a fully functional system. Conduit paths are shown on Drawings for representative coordination purposes only. Ensure that adequate raceways and boxes are provided before equipment installation. Additional conduit requirements must be coordinated with other trades and submitted to Owner/City for review prior to start of Work.
      c. Provide all power supplies required for the security system, sized and located where needed.

2. If and where shown, some security system network equipment may be mounted in plant control panel. Provide mounting hardware, terminal blocks, wiring, connectors, and other equipment needed for complete and functional installation. Do not install any equipment in panel beyond designated space and designated circuits. Perform all work for neat and finished appearance. Do not interfere with other panel-mounted equipment.
3. The CCTV solution shall be compliant with ONVIF and PSIA.
4. The CCTV solution shall function on any standard TCP/IP Ethernet Network.
5. The CCTV solution shall have a number of existing third-party integrations such as video analytics, intercoms, access control, public address, and so on.
6. Support for MJPEG, MPEG-4 SP, MPEG-4 ASP, MxPEG and H.264 compression formats.
7. Microsoft Active Directory Support: The software solution shall support Active Directory to add users and groups.
8. Archiving:
    a. Archiving of recordings.
    b. Keep online access to archives.
    c. Parallel archiving and recording.
    d. Hourly archiving schedules.
    e. Dynamic archiving (disk spanning).
    f. Archiving to network drives.
    g. Storage overview (used versus available space) of available storage drives.
9. Export: Export to AVI, MKV and still images.
10. Integration:
    a. Video content analysis support.
    b. Open integration platform and/or Software Development Kit.
    c. Application programming interface (API).
    d. Client plug-in support.
    e. Generic events via TCP/IP.
11. Coordination:
    a. Access to Existing System: Coordinate and schedule with Owner dates and times for access to the existing offsite equipment. If remote access to existing system from project site is required, submit request to have access privileges configured.
    b. Coordinate with Owner for required IP addresses for each network- connected device.

1.02 RELATED SECTIONS

A. Drawings and general provisions of the Contract, including Contract Documents and Division 01, General Requirements Sections, apply to this section.

1.03 REFERENCES

A. This section contains references to documents listed below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
IEEE 1100	Recommended Practice for Power and Grounding Electronic Equipment
NECA 1	Good Workmanship in Electrical Construction
NEMA 250	National Electrical Manufacturers Association Enclosures for Electrical Equipment (1000 Volts Maximum)
NFPA 70	National Electrical Code (NEC)
SIA	Security Industry Association
TIA	Telecommunications Industry Association

1.04 DEFINITIONS

A. Abbreviations:
   1. ACS: Access Control System.
   2. CCTV: Closed circuit television.
   3. GFCI: Ground fault circuit interrupter.
   4. I/O: Input/output.
   5. LAN: Local area network.
   6. NVR: Network video recorder.
   7. ONVIF: Open Network Video Interface Forum.
   8. PLC: Programmable logic controller, serves the plant control system. Not provided as part of the security system.
   9. PSIA: Physical security Interoperability Alliance.
   10. PTZ: Pan/ tilt/ zoom.
   11. SCADA System: Plant operating, PLC control system. Not provided as part of the security system.
   12. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
   13. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.
   14. UPS: Uninterruptible power supply.
   15. USB: Universal serial bus.
   16. VPN: Virtual Private Network.
   17. WAN: Wide area network.
   18. WAV: The digital audio format used in Microsoft Windows.
   19. WMP: Windows media player.
   20. Windows: Operating system by Microsoft Corporation.

21. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.05 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Product Data: Provide manufacturer’s cut sheets for each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings.
   3. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
      a. Diagrams for cable management system.
      b. Detailed Point to Point Wiring Diagrams. Showing all power, signal, and control wiring including routing and termination points on each device.
      c. Programming Matrix: Showing how all components will operate.
      d. Details of surge protection device installation.
      e. Panel layout.
   4. Bill of material including miscellaneous items, cables, spare parts, that will be provided.

C. Closeout Submittals:
   1. Completed test forms: Section 01 99 90.
   2. Operation and Maintenance Data:
      a. For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23, Operation and Maintenance Data, include the following:
         1) Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.
         2) System installation and setup guides with data forms to plan and record options and setup decisions.
   3. Test Reports: Final test reports showing that the system has been programmed calibrated and operates as intended.

1.06 QUALITY ASSURANCE

A. Unit Responsibility:
   1. The Contractor or security sub-Contractor specified in this Section shall provide a complete security system:
      a. CCTV cameras where shown on Drawings.
      b. Panel-mounted recorder/ server/ PoE switch in the new Maintenance Building and load video administration software and Network Video Recorder (NVR) software to display video and transmit to existing offsite system for recording.

c. Match existing offsite software for compatibility. Provide completely functional system including any necessary updates and configuration of existing offsite system.

d. Cameras shall be individually accessible via standard web browser when accessed from computers on the network. Cameras are not intended to be accessible from anywhere on the internet and will only be accessed by secure connection via VPN through a firewall.

e. Streaming of video to recorder is via limited bandwidth upstream connection. Configure system to only record cameras when motion is detected. Configure camera streaming resolution and frame rate for best possible quality without exceeding available upstream bandwidth (nominally 8 Mbps).

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70, National Electrical Code.

D. Comply with SIA DC-01, SIA DC-03, and SIA DC-07.

E. Identification of Listed Products: Provide instrumentation listed for the purpose for which they are to be used, by an independent nationally recognized testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent nationally recognized testing laboratory acceptable to the inspection authority having jurisdiction and is recognized by OSHA.

F. The Contractor or security sub-Contractor shall be a licensed security contractor with a minimum of five (5) years experience installing and servicing systems of similar scope and complexity. The Contractor shall provide three (3) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. The technicians shall have a minimum of three (3) continuous years of technical experience in electronic security systems.

1. Installer Qualifications: An employer of workers trained and approved by manufacturer within the last 2 years.

a. Cable installer must have on staff a registered communication distribution designer certified by Building Industry Consulting Service International.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Electronic Components:

1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 degrees F and 85 degrees F (10 degrees C and 30 degrees C), and not more than 80 percent relative humidity, noncondensing.

2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

3. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.08 PROJECT CONDITIONS

A. Environmental Conditions:
   1. System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
      a. Indoor, Controlled Environment: NEMA 250, Type 12 enclosure. System components installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 degrees F to 122 degrees F (2 degrees C to 50 degrees C) dry bulb and 20 percent to 90 percent relative humidity, no condensing.
      b. Outdoor, Controlled Environment: IP66 enclosure. System components installed in outdoor environments shall be rated for continuous operation in ambient conditions of 0 degrees F to 122 degrees F dry bulb and 20 percent to 100 percent relative humidity, no condensing.

1.09 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this section found defective during a period of 1 year after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1.10 MAINTENANCE

A. Maintenance Service: For 1 year after Correction Period, provide maximum of two service calls, at Owner's request, to make adjustments or repairs required to keep system in satisfactory, full operation.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Closed Circuit TV System: Network type system, fixed and PTZ color IP cameras, CCTV server/network video recorder/PoE switch interface, with ability to display video on operator's workstation.

2.02 SECURITY FRONT END

A. Compatible with Owner's existing system. Coordinate all connectivity with Owner.

B. Software Manufacturer and Product:
   1. Technology partner with Milestone Xprotect Professional, to match existing system.
   2. Provide additional camera licenses for all cameras.

C. CCTV/NVR Server:
   1. Hardware Requirements: Server specifications shall meet or exceed manufacturer's minimum requirements and Owner standards in all cases. The following performance characteristics are provided as a minimum:
      a. CPU: Intel® Core iMX.
      b. Integrated PoE switch.
      c. Video Recording: Up to 8 video sources
      d. Storage: Surveillance class HDD: Minimum 6 TB.
      e. Network: Ethernet 100Mbit.
      f. Graphics: Support camera resolution with ulra-high definition and frame rate.
      g. Mounting: Panel including a mounting bracket.
      h. Compact size for panel mounting.
      i. Operating System: Microsoft® Windows® 10 Professional or later, compatible with CCTV/NVR software.
      j. Power Source: 120 Vac, 60 Hz
      k. Accessories:
         1) Laptop computer for setup and testing cameras with the NVR/Server/PoE switch.
   2. Capable of administrating CCTV system, display of CCTV camera video, detecting camera motion and streaming video to remote storage.
   3. Compatible with the cameras and video software being provided.
   4. Software Requirements: Provide fully functional software packages on the CCTV server. Ensure that the software being installed is compatible with the hardware and operating systems being provided.
   5. Configuration:
      a. Record video locally to storage hard drive when motion is detected. Make recorded video available to view remotely from existing offsite security system.
      b. Cameras configured for H.264 or H.265 compression. Configure resolution and frame rate for best quality without exceeding available bandwidth.
      c. Cameras individually accessible from standard web browser from computers that have secure access to the network.
   6. Provide lockable wall mounted NEMA 250, Type 12 enclosure housing CCTV/NVR/PoE Switch, PoE media converter for using fiber optic cabling, 15 amp DIN rail circuit breaker for service power, DIN rail 120 Vac power strip, and any other ancillories needed.

2.03 CCTV CAMERAS

A. Manufacturers:
   1. Axis, Q6135-LE (to match existing system).
   2. Bosch.
   3. Pelco.
   4. Samsung.
   5. Sony.

B. Cameras:
   1. IP Exterior Day/Night PTZ:
      a. 1080P resolution.
      b. 30 frames per second.
      c. H.264 and MJPEG compression.
      d. Power over Ethernet.
      e. Wide Dynamic Range.
      f. Day/Night with mechanical cut filter.
      g. Slip ring for 360-degree continuous rotation.
      h. Presets and autotrack feature.
      i. Vandal Resistant Housing.
      j. Camera is compatible with IR illuminator selected.
   2. Include mounting hardware appropriate for the location and type of materials used at the camera location.

2.04 INFRARED ILLUMINATOR (NOT USED)

2.05 CAMERA ACCESSORIES

A. Power Over Ethernet Injector:
   1. Quantity: One for each camera.
   2. Power Input: 120V ac.
   3. Power Output: dc voltage compatible with cameras.
   4. Injector: Apply dc voltage to Ethernet cable with RJ45 input and output connectors.

B. Fiber Optic Media Converter:
   1. Quantity: As shown on Drawings, two for each camera using fiber optic cable.
   2. Function: Convert copper Ethernet to OM3 multi-mode fiber optic.
   3. Power: 120V ac.
   4. Fiber Optic Port: LC Connector, OM3 fiber optic cable.
   5. Ethernet Copper Port: RJ45.
   6. Speed: 1,000 Mbps.

C. Security Panels:
   1. As shown on Drawings.
   2. Enclosure:
      a. Type 304 or Type 316 stainless steel.
      b. NEMA 4X.
      c. Size: Sufficient to house camera accessories for outdoor locations.
      d. Back Panel: For mounting equipment and accessories.
      e. Lockable door.
   3. Power:
      a. 120V ac power to panel.
      b. Input power circuit breaker.

c. Provide 120V ac power receptacle mounted on back panel.
d. Provide power supplies if and as necessary for cameras and accessories.

4. Terminals: For termination of input power and field wiring.

2.06 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 exterior wiring of each conductor-entry connection to components.

1. Minimum Protection for Power Connections; 120-volt: Provide auxiliary panel suppressors complying with requirements in Section 26 43 00, Surge Protective Devices.
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 26 43 00, Surge Protective Devices, as recommended by manufacturer for type of line being protected.

2.07 CABLES

A. General Cable Requirements: Comply with requirements in Section 26 05 05, Conductors, and as recommended by system manufacturer for integration requirement. Submit information only on cable types intended to be used on this Project.

B. LAN Cabling: Comply with requirements in Section 26 05 05, Conductors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA/EIA 606-A, Administration Standard for Commercial Telecommunications Infrastructure.

3.03 CABLING

A. Comply with NECA 1, Good Workmanship in Electrical Construction.

B. Install cables and wiring according to requirements in Section 26 05 05, Conductors.

C. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

3.04 CABLE APPLICATION

A. Comply with TIA 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 feet (15 m).

D. TIA 485-A Cabling: Install at a maximum distance of 4,000 feet (1,220 m).

3.05 GROUNDING

A. Comply with Section 26 05 26, Grounding and Bonding for Electrical Systems.

B. Comply with IEEE 1100, Recommended Practice for Power and Grounding Electronic Equipment.

C. Bond shields and drain conductors to ground at only one point in each circuit.

D. Signal Ground:
   1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   2. Bus: Mount on wall of main equipment room with standoff insulators.
   3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.06 IDENTIFICATION:

A. In addition to requirements in this Article, comply with applicable requirements in Section 26 05 05, Conductors, and with TIA/EIA 606-A.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. At completion, cable and asset management software shall reflect as-built conditions.

3.07 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software, including upgrades or modifications needed to interface with new devices being supplied under this Contract. Coordinate all requirements with Owner.

B. Assign software licenses to Owner.

3.08 FIELD QUALITY CONTROL

A. Perform Tests and Inspections - Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standards - Part 1, General Requirements. Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
   2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
   3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports and submit to Engineer for prior approval.

3.09 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in Article Preparation, and with manufacturer's written instructions.

3.10 WORKMANSHIP

A. Appearance and workmanship shall meet or exceed industry, product manufacturer, and Owner's published standards.

3.11 ADJUSTING AND CLEANING

A. Clean and touch up components to the satisfaction of the Owner.

B. Lenses, equipment enclosures, windows, and monitors shall be clean and free from scratches, mars, and installation debris.

3.12 COMMISSIONING

A. Commissioning work is a joint team effort to ensure that all security, electrical, and mechanical equipment and systems have been completely and properly installed and put into service. The team is made up of representatives from the Owner's, the Engineer's, and the Contractor's organization.

B. The Contractor and Security System Supplier shall be responsible for writing the commissioning checklists and performance test plans. Acceptance of these items is subject to the approval of the Engineer. The Contractor shall make any changes to these items as requested by the Engineer. A copy of the commissioning documents is to form a part of the Operation and Maintenance submittal.

C. The Contractor and Security System supplier shall be responsible for the actual system performance testing. Documentation of this testing and any changes to the approved test procedures must be approved by the Engineer.

D. Test each camera for both day and night operation.

E. Pan/tilt/zoom (PTZ) Cameras:
   1. Visual and Mechanical Installation Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Compare device and wire tagging with Drawings and Specifications.
      c. Inspect appropriate anchorage, required area clearances, physical damage, and missing hardware.
   2. Performance Tests:
      a. Demonstrate Pan/Tilt/Zoom functions.
      b. Demonstrate Camera has home position.
      c. Demonstrate camera presets.
      d. If the PTZ is a day/night camera demonstrate it switches to black and white under low light conditions.

e. Demonstrate the camera IR illuminator is working at night and does not negatively affect the camera performance (blooming, reflections, etc.).
f. Demonstrate that the camera does not switch from black and white to color prematurely upon use of IR illuminator or reflected light sources.
g. Demonstrate correct operation and sequencing of all interlocked systems.
h. Demonstrate offsite video recording.
i. Power Supply: Demonstrate proper operation occurs during removal of incoming line voltage and subsequent switch to generator. Demonstrate that generator operation does not interfere with camera system operation.

3.13 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the computer server shall be locked.

END OF SECTION

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SECTION 31 05 19

GEOTEXTILES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies woven and nonwoven geotextile sheet materials used for soil stabilization, filtering, and drainage for site improvements.
   2. Geotextiles for erosion and sediment control measures are specified in Section 01 57 13.

B. Definitions:
   1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.
   2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.
   3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.
   4. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.
   5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.
   6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AASHTO M-288	Standard Geotextile Specification for Highway Applications

Reference	Title
AAASHTO R50-09	Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles
ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D5261	Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
ASTM D6193	Standard Practice for Stitches and Seams

1.03 SUBMITTALS

A. Submittals For Approval:
   1. Shop Drawings:
      a. Manufacturer material specifications and product literature including geotextile dimensions (roll width, length), physical properties demonstrating compliance with specified requirements.
      b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
      c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

B. Informational Submittals:
   1. Certifications from each geotextile manufacturer that furnished products have specified property values and are suitable for the intended use - soil stabilization, filtering, and/or drainage for site improvements. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Notify the City whenever geotextiles are to be placed. Do not place geotextile without the City's approval of underlying materials.

PART 2 PRODUCTS

2.01 WOVEN GEOTEXTILE FOR STABILIZATION OF GRADE AND SUBGRADE

A. Fabrication:
   1. Composed of polymeric yarn interlaced to form planar structure with uniform weave pattern.

B. Polymeric Yarn:
   1. Long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. Sheet Edges:
   1. Selvage or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width:
   1. Minimum 6 feet.

E. Physical Properties:
   1. Conform to requirements in Table No. 1.

Table No. 1

Physical Property Requirements for Woven Geotextile for Paved Areas and Ground Stabilization

Property	Requirement	Test Method
Apparent Opening Size (AOS)	40 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	0.9 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Hydraulic Flow Rate	75 gpm/sq ft, MinARV	ASTM D4491 (Falling Head)
Base Course MR Improvement Factor	1.3	AASHTO R50-09
Tensile Strength MD (2% strain)	600 lb/ft	ASTM D4595
Tensile Strength MD (5% strain)	1800 lb/ft	ASTM D4595
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D4355

F. Woven geotextile shall meet AASHTO M-288 requirements for Class I geotextile used in separation and stabilization applications.

2.02 NONWOVEN GEOTEXTILE FOR FILTERING AND DRAINAGE INSTALLATIONS

A. Fabrication:
   1. Geotextiles shall be polypropylene, needle punched, non-woven geotextiles manufactured from continuous filaments, or approved equal, and having properties that comply with the required properties shown in Table 2.

B. Geotextile Edges:
   1. Selvage or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width:
   1. Minimum 6 feet.

D. Physical Properties:
   1. Conform to requirements in Table No. 2.

Table No. 2

Physical Property Requirements for Non-Woven Geotextile for Drainage

Property	Requirement	Test Method
Mass/unit area	8 oz/yd2, MinARV	ASTM D 5261
Apparent Opening Size	50 US. Std. Sieve Size	ASTM D 4751
Hydraulic Conductivity	>0.1 cm/sec, MinARV	ASTM D 4491
Puncture Strength	100 Lbs., MinARV	ASTM D 4833
Tensile Strength	215 Lbs., MinARV	ASTM D 4632

2.03 GEOTEXTILES FOR PIPELINE TRENCHES

A. Geotextiles shall be polypropylene, needle punched, non-woven geotextiles manufactured from continuous filaments, or approved equal, and having properties that comply with the required property values in Paragraph 2.02:

B. The Geotextile Manufacturer and/or Fabricator shall furnish materials whose “MinARV", meet or exceed the properties specified, as well as a certification that the material properties meet or exceed the specified values. The geotextiles shall be stock products.

C. In addition to the property values specified in the table above, the geotextiles shall:
   1. Retain their structure during handling, placement, and long-term service.
   2. Be capable of withstanding direct exposure to sunlight for a minimum of 30 days with no measurable deterioration.

2.04 SECURING PINS

A. Steel Rods or Bars:
   1. 3/16-inch diameter.
   2. Pointed at one end.
   3. With head on other end sufficiently large to retain washer.
   4. Minimum Length: 12 inches.

B. Steel Washers for Securing Pins:
   1. Outside Diameter: Not less than 1.5 inches.
   2. Inside Diameter: 1/4 inch.
   3. Thickness: 1/8 inch.

C. Steel Wire Staples:
   1. U-shaped.
   2. 10 gauge.
   3. Minimum Length: 6 inches.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

B. For paved areas, unroll in the direction of traffic and direction of base course placement.

C. On curves, the geotextile may be folded or cut and overlapped to conform to the curve. If site conditions require geotextile seaming, the geotextile shall be cut and seamed on the curve. All seams shall be in accordance with ASTM D4884.

D. The geotextile shall be gently placed and not dragged across the subgrade.

E. Orient geotextile with long dimension of each sheet parallel to direction of slope.

3.02 JOINTS

A. Unseamed Joints:
   1. Overlapped.
   2. Overlap, unless otherwise shown:
      a. Foundation/Subgrade Stabilization: Minimum 30 inches.
      b. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
      c. Paved Areas: Minimum 18 inches.
      d. Other Applications: Minimum 12 inches.

B. Seamed Joints:
   1. Seamed joints shall be prepared in accordance with ASTM D 4884.
   2. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

3.03 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by the Engineer.

B. Secure Geotextile with Securing Pins or Staples:
   1. Insert securing pins with washers through geotextile.
   2. Securing Pin Alignment:
      a. Midway between edges of overlaps.
      b. 6 inches from free edges.

3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	4 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in, to secure geotextile firmly to subgrade.

3.04 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify the Engineer. Do not cover installed geotextile until after the Engineer provides authorization to proceed.

B. Sandbags or other temporary measures used to secure the geotextile in place shall be removed for placement and spreading of material on the geotextile.

C. The aggregate base or sub-base shall be placed in a manner to avoid traffic or equipment running over placed, uncovered geotextile.

D. The aggregate shall be placed on the geotextile in lifts not less than 6 inches thick.

E. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Paragraph 3.06.

3.05 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile for full width of trench bottom and up the trench walls to the top of the pipe zone, or base material for miscellaneous structures in a way that will completely envelope granular drain material to be placed in trench and with a minimum of 24-inch overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. Anchor geotextile to trench walls prior to placing trench stabilization or bedding material.

C. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.06 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Damaged geotextile that in the opinion of the construction inspector or testing agency is severe enough to require it shall be repaired as described below.

B. Repair Procedure:
   1. Place patch of undamaged geotextile over damaged area and at least 36 inches in all directions beyond damaged area, unless otherwise recommended by the geotextile manufacturer.
   2. Remove interfering material as necessary to expose damaged geotextile for repair.
   3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above, or by other means approved by Engineer.

END OF SECTION

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SECTION 31 10 00

SITE PREPARATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This section specifies site preparation which consists of clearing and grubbing and site demolition including fencing removal, pavement removal, concrete curb and gutter removal, and flatwork demolition.

B. Existing Conditions: The Contractor shall determine the actual condition of the site as it affects this portion of work.

C. Protection: Site preparation shall not damage structures, landscaping, or vegetation outside the limits of work. The Contractor shall repair or replace any damaged property.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

A. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

B. Material that is removed and is not to be incorporated in the work shall be disposed of off the site, at a location approved by the Owner.

3.02 DEMOLITION AND REMOVAL

A. Structures: Demolition and removal of structures consists of removal of pavement, fencing, surface structures within the work zone, and structures in the subgrade that must be removed to complete the work. Excavations shall be cleared of waste, debris, and loose soil, and refilled and compacted with Type C material, as specified in Section 31 23 00.

B. Protection: Existing features such as piping and underground conduit encountered in the construction areas that must remain in service shall be protected. Similarly, surface features at existing grade that can remain in place inside or adjacent to the construction area shall be protected from damage.

C. Repair and Replacement: Any privately- or publicly-owned improvements not shown on the Drawings to be removed or demolished that are damaged or removed shall be replaced in kind or repaired, at no cost to the owner of those structures. Replacement shall meet or exceed current standard requirements.

D. Pavement: When portions of asphalt pavements/sidewalks and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face or edge of the impacted feature.

E. Salvage: The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Owner five (5) working days prior to any salvage or demolition work to determine the disposition of items to be removed. The Owner will identify and/or mark items to be salvaged. Such items shall be properly disconnected, removed, and stored at a location on the site as directed by the Owner.

F. Pipe abandonment and demolition: Where Work is specified to abandon a pipeline, the Contractor shall fill with grout slurry the entire segment of abandoned pipeline and plug both ends with concrete cap. Where Work specifies demolition of pipeline the Contractor shall remove entirely the pipeline. Prior to any demolition or abandonment of pipelines, the Contractor shall coordinate with operations.

3.03 UTILITY INTERFERENCE

Where existing utilities interfere with the prosecution of the work, the Contractor shall coordinate with operations to relocate the utility.

END OF SECTION

SECTION 31 21 33

TRENCHING, BEDDING, BACKFILLING, AND COMPACTING FOR BURIED PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope: This section provides specifications for trenching, bedding and backfill. Also see Section 31 23 00, Excavation and Fill.
   1. Furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary to perform all trenching, bedding and backfill to the lines and grades as specified and as necessary to complete the Work.
   2. Be prepared to perform work specified herein in conjunction with other construction activities (e.g., earthwork, dewatering, access road construction, etc.).

B. Definitions: This section contains references to the following definitions, in addition to Section 31 23 00, Excavation and Fill.
   1. Trench Over-Excavation: Area of the excavation that is beneath the pipe bedding. Where applicable over-excavation depth shall be as shown on the Drawings. Depending on conditions encountered during construction, further excavation may be required to provide a suitable trench foundation.
   2. Controlled Low Strength Material (CLSM): A mixture of Portland cement, fly ash, aggregates, water, and admixtures proportioned to provide a non-segregating, self-consolidating, free-flowing, and excavatable material that will result in a hardened, dense, non-settling fill.

1.02 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with Section 31 23 00, Excavation and Fill.

B. During the course of the work specified in this Section the Owner will contract a material testing laboratory and field-testing service to perform such tests as are required to determine compaction characteristics, moisture content, in-place density of backfill, and compressive strength of CLSM provided in trenching, bedding and backfill.

C. Provide safe access to the trench or excavation for the soil compaction testing technician or inspector. This shall include providing all safety equipment and temporary shoring to enable compaction testing in the trench or excavation as directed by the Owner's Representative.

D. Reference Specifications, Codes and Standards:
   1. The contents and references in Section 31 23 00, Excavation and Fill, shall apply to work under this Section.
   2. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ACI 229	Report on Controlled Low-Strength Materials
APWA	Uniform Color Code for Temporary Marking of Underground Utility Locations
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D6024	Standard Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application

1.03 SUBMITTALS

A. The following shall be submitted in accordance with the project submittal procedures:
   1. Submittals for backfill materials shall be made in accordance with Section 31 23 00, except for Type E trench stabilization material, which will be submitted prior to material delivery to the site. Use of stabilization material does not relieve the Contractor of meeting specified requirements for materials and work.
   2. Submit not less than 14 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
   3. Submit certified performance of mix design and test results, including cylinder breaks, for CLSM Backfill. Include material types and weight per cubic yard for each component of mix. Include manufacturer's catalogue and product data for all admixtures.
   4. Submit manufacturer's descriptive literature for marking tapes.

PART 2 PRODUCTS

2.01 SUITABLE FILL AND BACKFILL MATERIAL AND REQUIREMENTS

A. Backfill materials shall conform to requirements in accordance with Section 31 23 00, unless otherwise shown or specified.

B. Bedding And Pipe Zone Material:
   1. Bedding and Pipe zone backfill shall be clean, fine gravel-sand material in accordance with ASTM D2774, conforming to Type A1 material as defined in Section 31 23 00.

C. Controlled Low Strength Material (CLSM):
   1. CLSM may be used in-lieu of the bedding materials specified above, where indicated on the Drawings or were approved by the Engineer.
   2. CLSM or flowable fill shall consist of a fluid mixture of Portland cement, water, aggregate, fly ash, and approved admixtures conforming to the following requirements:
      a. Portland Cement: ASTM C 150, Type I/II.

b. Aggregate: ASTM C33. Aggregate shall be clean, imported sand and gravel or selected materials from excavation, imported material, or a combination thereof as approved by the Engineer.
   1) To promote flowability into the annular space between the pipe and the soil, CLSM Backfill mixes shall be batched with aggregate having a maximum size of ½ inch.
   2) The minus No. 200 sieve fraction shall be non-plastic.
   3) The soluble sulfate content of aggregate shall not exceed 0.3 percent by dry weight.
c. Fly Ash (IF USED): ASTM C618, Class C or approved alternative.
d. Water: Clean, potable, containing less than 500 ppm of chlorides.
e. The resulting CLSM material shall be a non-segregating, free-flowing, low shrink slurry in accordance with ACI 229, with a maximum unconfined compressive strength of 150 psi at 28 days.

D. Geotextiles For Pipeline Trenches
   1. See Part 2 of Section 31 05 19.

2.02 DETECTABLE WARNING TAPE

A. Provide Detectable Warning Tape for all buried piping:
   1. Detectable Warning Tape shall be 6 inches wide, colored per ANSI Z535.1 and made of inert plastic material suitable for direct burial with solid aluminum foil core. Minimum 5 mil laminate thickness.
   2. Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or approved equal.
   3. Print message on buried Detectable Warning Tape: **"CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. Fill the blank with the Process Service name. Message to be printed at maximum intervals of 2 feet.

PART 3 EXECUTION

3.01 PIPELINE AND UTILITY TRENCH EXCAVATION

A. Existing Utilities:
   1. Locate all piping, duct banks, cables and other existing utility lines and facilities within the disturbed areas defined on the Drawings prior to trenching for new pipeline and utility installation. All existing piping and utilities in the vicinity of construction activities shall be protected from damage during completion of the work. Damage to existing facilities caused by construction work shall be repaired by the Contractor at no additional cost to the Owner.

B. Trench Shoring:
   1. The use of trench boxes and/or trench shoring is required for trenches 5 feet deep or greater, in accordance with Section 31 41 00. Shallow trenches less than 5 feet deep may use laid back trench slopes, except for areas where there is potential loss of subgrade support, traffic disruption, and/or excess pavement removal and patching.

2. Provide water control until trench backfill is complete as specified in the Control of Water paragraphs in Section 31 23 00, and in Section 31 23 19. Remove water in a manner that minimizes soil erosion from trench sides and bottom.

C. Open Trench:
   1. The maximum length of open trench, including a trench in which the pipeline has been laid but not fully backfilled to the design elevation shall not exceed 500 feet.
   2. Where trenches are to be left open for more than 48 hours, the trench shall be clearly marked as a hazard and secured from entry.

D. Existing Utilities:
   1. All existing piping and utilities in the vicinity of construction activities shall be protected from damage during completion of the work. Damage to existing facilities caused by construction work shall be repaired by the Contractor at no additional cost to the Owner.

E. Trench Bottom:
   1. The bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding. Excavations for pipe bells and welding shall be made as required.
   2. Grade as required, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material shown or specified.
   3. If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer for instructions on over-excavation and placement of suitable trench stabilization backfill to pipe subgrade elevation.

F. Trench Over-Excavation:
   1. If subgrade is encountered that may require removal to prevent pipe settlement, notify the Engineer. The Engineer will determine depth of over-excavation required. Where trenches are indicated to be over-excavated, excavation shall be to the depth indicated and backfill shall be installed to the grade of the bottom of the pipe bedding.
   2. When directed by the Engineer, trenches shall be over-excavated beyond the depth and/or width shown. Such over-excavation shall be to the dimensions directed. The trench shall then be backfilled to the grade of the bottom of the pipe bedding.

G. Replacing Over-Excavated Material
   1. Replace excavation carried below grade lines shown or established by Engineer as follows:
      a. Trenches: Foundation stabilization material fully encased in geotextiles as specified in Part 3 of Section 31 05 19.

H. Geotextile Installation
   1. See Part 3 of Section 31 05 19.

3.02 TRENCH EXCAVATION IN FILLS AND BACKFILLS

A. Where pipelines are to be installed in fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

3.03 PIPE BEDDING

A. General
   1. The pipe bedding is defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of the bedding shall be as follows unless otherwise shown on the drawings or otherwise described in the specifications for the particular pipe installed.
   2. Bedding shall be laid on a prepared, graded trench bottom after excavation and installation of stabilization material, if required, but before installation.

3.04 PIPE AND UTILITY TRENCH BACKFILL

A. General:
   1. Avoid dropping backfill directly onto the pipe from heights exceeding 8 feet.
   2. Except for drain rock materials being placed in over-excavated trenches, backfill shall be placed after all water is removed from the trench and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.
   3. Immediately prior to the placement of backfill materials, the bottoms and sidewalls of the trenches shall have loose sloughing or caving soil and rock materials and foreign material removed. Trench sidewalls shall consist of excavated surfaces in undisturbed condition before placement of backfill materials.
   4. Notify the Engineer immediately when the following conditions exist:
      a. Soft or loose subgrade materials are encountered wherever fill material is to be placed.
      b. Fill material appears to be deviating from the specification requirements.

B. Placing And Spreading of Backfill Material:
   1. General:
      a. Backfill materials shall be placed and spread evenly in lifts. When compaction is achieved using mechanical equipment, the lifts shall be evenly spread with the depth of each uncompacted lift shall not exceed the specified lift thickness.
      b. During spreading, the material in each lift shall be thoroughly mixed as necessary to promote uniformity.
      c. Where the backfill moisture, content is below optimum moisture content, water shall be added before or during spreading until optimum moisture content is achieved.
      d. Where backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with suitable material to achieve moisture content within specified limits prior to placement in trench.

2. Subsequent Backfill:
    a. General: After pipe has been properly bedded, backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the Engineer.
    b. Improved Areas: Unless otherwise specified, select granular backfill (Class B1, or C1) shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public rights-of-way and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface or paving. Paving shall be as specified in Section 32 12 16. Other surfaces shall be restored, including compaction, to the condition existing prior to construction including restoration of yard areas.
    c. Unimproved Areas: Class C1 backfill shall be used for all trenches in undeveloped land and for other unimproved areas where specified. Class C1 backfill shall not be used in any public right-of-way. Trench excavation which meets the requirements of Type C material may be used. Maximize the use of fine-grained materials (e.g., sand, silty sand, sandy silt) as Class C1 backfill.

C. Compaction Of Backfill Materials:
    1. Each layer of backfill material shall be compacted to the indicated relative compaction. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

D. Compaction Requirements:
    1. Compaction requirements shall be in accordance with Table A in Section 31 23 00.

E. Settlement Of Backfill:
    1. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

3.05 BEDDING AND PIPE ZONE

A. The bedding is defined as that portion of pipe zone material between the bottom of the trench and the bottom of the pipe.

B. The pipe zone is defined as that portion of the vertical trench cross-section from a plane at the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe.

C. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 12 inches above the top surface of the pipe.

D. Excavation for pipe bells and welding shall be made as required. Pipe zone bedding material shall be spread around the pipe so that the compacted pipe zone bedding will provide uniform bearing and pipe support.

E. After bedding beneath the pipe and laying the pipe to alignment and grade, additional bedding material shall be placed to fill the pipe zone that are the full width of the trench. Placement of material in the pipe zone above the pipe bedding layer shall be completed with lift thicknesses not exceeding 6 inches.

F. Bedding material shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. The material shall be carefully placed around the pipe to ensure that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during backfilling.

G. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

H. If a moveable trench shield is used during backfill/bedding operations the shield shall be lifted to a location above each layer of backfill/bedding material prior to compaction of the layer. Do not displace the pipe or backfill/bedding while the shield is being moved.

3.06 SUBSEQUENT BACKFILL

A. After the pipe zone bedding material has been placed, backfilling of the trench zone may proceed. Subsequent backfill is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

B. Continuously install detectable warning tape per Section 2.02.

C. Compaction of backfill adjacent to walls or existing structures may impose an excessive lateral load on the structure. Only compaction equipment shall be allowed inside a line extending upward from the base of the wall at 0.5 H:1V, or 3 feet, whichever is greater. Other heavy equipment is not allowed inside this zone until backfilling operations are complete.

3.07 FINAL BACKFILL

A. Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

B. Prepare roadway subgrade in accordance with Section 31 23 00.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in area of backfilled trench across unpaved or access road areas unless shown otherwise on the Drawings. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 CLSM BEDDING MATERIAL AND BACKFILL

A. General:
   1. CLSM may be used by the Contractor in areas where adequate compaction of backfill may be difficult to achieve. Care shall be taken to protect all exposed pipelines in the trench and prevent them from being uplifted during placement of the CLSM. CLSM shall not be used as bedding or backfill around asbestos cement pipe.
   2. Prevent CLSM Backfill from entering bell holes before joint welding, coating, and testing are complete and in locations where temperature control joints are required.
   3. Place protective blankets over joints to keep CLSM spatter of joint prior to coating of joints.

B. CLSM Placement:
   1. Place CLSM on one side of the pipe and allow to flow under the pipe and up the other side. Place in lifts, as necessary, to prevent uplift (flotation) or movement of pipe.
   2. If any movement occurs, the CLSM material shall be removed, and the pipe placed back online and grade. Any damage to the pipeline system caused by movement of the pipe shall be repaired or replaced in full conformance with these Contact Documents at no additional cost to the Owner.
   3. In traveled areas, fill entire trench section to pavement finish grade for a new temporary driving surface and screed off excess and finish with a float. In other areas, fill trench section as shown on drawings and as specified.
   4. Allow CLSM to set before placing backfill above the pipe zone. Prior to placing backfill over CLSM, CLSM shall achieve an indentation diameter less than or equal to 75 mm (3 inches) as determined in accordance with ASTM D6024.

3.10 CONCRETE ENCASEMENT

A. Trench backfill and final backfill for pipelines under structures shall be Type B in accordance with Section 31 23 00. If required, concrete encasement shall be provided as shown in in the Drawings.

3.11 FILL CONTROL TESTING

A. The compaction of fill and backfill shall be tested at a rate of at least one (1) test per 200 cubic yards of fill material or portions thereof per day, and at least one (1) test per 200 lineal feet of trench or roadway subgrade for each lift, at various locations. A minimum of one test is required for each structure constructed, including manholes and concrete slabs.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

B. Definitions:
   1. Compaction: The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.
   2. Excavation Slope: Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM C136	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3017	Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

Reference	Title
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Tests:

1. The materials testing laboratory and field-testing service under contract with the Owner will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. Remove surface material at locations designated by the Owner and provide such assistance as necessary for sampling and testing. The Owner may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications. Payment for inspection trenches shall be as specified in the General Conditions of the Contract Documents.
2. Tests will be made by the Owner in accordance with the following:

Test	Standard Procedure
Moisture content	ASTM D3017
Gradation	ASTM C136
Density in-place	ASTM D6938
Moisture-density relationships	ASTM D1557
Relative Density	ASTM D4254

1.03 SUBMITTALS

A. Submit product data on materials per 01 33 00.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Type A material shall be a clean, fine gravel-sand mixture, free from organic matter and shall conform to one of the following gradations.

1. For use with all pipelines and conduits 24 inches in diameter and larger:

U.S. Standard Sieve Size	Percent by Weight Passing
3/4 inch	100
1/2 inch	90-100
3/8 inch	40-70
No. 4	0-15
No. 8	0-5

2. For use with all pipelines and conduits 20 inches in diameter and smaller:

U.S. Standard Sieve Size	Percent by Weight Passing
3/8 inch	100
No. 200	0-3

B. Type B:

1. Type B material shall be a select granular material free from organic matter and of such size and gradation that the specified compaction can be readily attained. Material shall have a sand equivalent value determined in accordance with ASTM D2419 of not less than 20 and shall conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
3 inch	100
No. 4	35-100
No. 30	20-100

2. The coefficient of uniformity shall be 3 or greater.
3. The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. Type C:

1. Type C material shall be unclassified material, which is free from peat, wood, roots, bark, debris, garbage, rubbish, or other extraneous material. The maximum size of stone shall not exceed 6 inches. If the material excavated from the site meets these requirements, it may be classified as Type C.

D. Type D:

1. Type D material shall be granular material commonly known as pea gravel and shall conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
1/4 inch	100
No. 8	0-5

E. Type E:

1. Type E material shall be crushed rock commonly known as drain rock and shall conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
1-1/2 inch	100
3/4 inch	30-75
1/2 inch	15-55
1/4 inch	0-5

2. Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

F. Type F:

1. Type F material shall be crushed rock and shall conform to the following gradation:

U.S. standard sieve size	Percent by weight passing
3/4 inch	87-100
3/8 inch	45-90
No. 4	20-50
No. 30	6-29
No. 200	0-7

2. Type F material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

G. Type G:

1. Type G material shall be pervious backfill. Pervious backfill material shall conform to the following gradation:

U.S. Standard Sieve Size	Percent by Weight Passing
2 inch	100
No. 50	0-100
No. 100	0-8
No. 200	0-4

H. Type H:

1. Type H material shall be 6-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of Stone	Percent Smaller by Weight
10 pounds	100
5 pounds	80-100
2 pounds	45-80
1 pound	15-45
1/2 pound	5-15
Below 1/2 pound	0-5

2. Specific gravity shall be between 2.5 and 2.82.

I. Type I:

1. Type I material shall be 12-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

Weight of Stone	Percent Smaller by Weight
160 pounds	100
100 pounds	80-100
50 pounds	45-80
20 pounds	15-45
5 pounds	5-15
1 pound	0-5

2. Specific gravity shall be between 2.5 and 2.82.

J. Type J:
   1. Type J material shall be unclassified material and may be obtained from excavation on site. The material may contain extraneous material such as demolition waste, unsuitable material excavated from beneath structures, and clearing and grubbing debris up to 50 percent by volume. Extraneous material shall be thoroughly mixed, and the maximum size of organic particles shall be 6 inches.

PART 3 EXECUTION

3.01 GENERAL

A. Control of Water:
   1. Keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 2 feet below the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. Have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate until backfill has been completed to 2 feet above the normal static groundwater level.
   2. Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. Control surface runoff to prevent entry or collection of water in excavations.
   3. Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

B. Over-excavation:
   1. Over-excavation shown on the plans shall be completed and backfilled as shown on the structural drawings.
   2. In other areas, where the undisturbed condition of natural soils is inadequate for support of the planned construction, the Engineer will direct the Contractor to over-excavate to adequate supporting soils. The excavated space shall be filled to the specified elevation with backfill. The over-excavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.
   3. If undocumented fill material is encountered during excavation for structure foundations, excavate the fill to competent natural material a minimum of two feet on all sides around the structure foundation. Inspection of the excavation to verify that the over-excavated surface has reached competent, native material shall be completed by the geotechnical engineer or the materials testing organization prior to backfilling. Over-excavation shall be performed beyond the proposed foundation limits so that the zone that is within a 1H:1V line extending from the exterior of the foundation is encompassed. Backfill of the over-excavation area shall be filled to the specified foundation subgrade elevation with Class F1 structural backfill, placed as specified herein.

C. Surplus Material:
   1. Unless otherwise specified, surplus excavated material shall be disposed of off-site in accordance with applicable ordinances and environmental requirements.

2. If the quantity of surplus material is specified, the quantity specified is approximate. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any material inside or outside the site. Shortage of material, caused by premature disposal of any material by the Contractor, shall be replaced by the Contractor.
3. Material shall be stockpiled in accordance with the Excavation Plan prepared by the Contractor and approved by the Owner.

D. Borrow Material:
1. If the quantity of acceptable material from excavation is not sufficient to construct the embankments required by the work, the quantity of material needed to complete the embankments shall consist of imported borrow conforming to specified requirements.

E. Hauling:
1. When hauling is done over highways or city streets, the loads shall be trimmed, and the vehicle shelf areas shall be cleaned after each loading.

F. Haul Roads:
1. Construct haul roads required to transport materials on site. Alignment of haul roads shall be selected to avoid interference with plant operations. Haul roads shall be removed after completion of embankment construction.

G. Finish Grading:
1. Finished surfaces shall be smooth, compacted, and free from irregularities.
2. Finished grade shall be as specified by the contours plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.
3. When the work is an intermediate stage of completion, the lines and grades shall provide adequate drainage.
4. If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots, and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

H. Control Of Erosion:
1. Maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, provide fill or excavate as necessary to return earthwork surfaces to the grade and finish specified.

3.02 CLASSIFICATION OF FILL

A. Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer depth, relative compaction, and general application are specified in Table A. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

Table A, Fill Classifications

Fill class	Material type	Maximum uncompressed layer depth, inches	Minimum relative compaction, percent[d]	General application
A1	A	6	95	Bedding for pipe, initial pipeline backfill; pipe zone backfill (see paragraph 2.01 A for gradation by pipe size)
A2	A	8	95	Subsequent/Backfill Zone pipeline backfill; Slabs on grade (other than specified for Class E1)
B1	B	8	95	Structure backfill and subsequent pipeline backfill
B2	B	8	90	Site fill
C1	C	8	90-95	Subsequent pipeline backfill; compaction specified as 95% under improved/paved areas and 90% in open areas
C2	C	8	90	Site fill and embankments
D1	D	-	95	Bedding for tanks, initial and subsequent tank backfill
E1[a]	E	8	-	Trench bottom stabilization, compacted to a firm, dense mass to provide a stable base for subsequent backfill
F1[b]	F	12	95	Fill under slabs for structures, pipeline bedding, initial and subsequent pipeline backfill
G1	G	6		Plastic pipe only – Bedding for pipe and pipe zone backfill
G2	G	8	95	Plastic pipe only - Subsequent/Backfill Zone pipeline backfill
H1[c]	H	-	-	Embankment slope face, channel lining
I1[c]	I	-	-	Embankment slope face, channel lining

a. Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the field

b. Material shall not be used for bedding or initial backfill for plastic pipe.

c. Where indicated on the plans, fill material shall be grouted as specified in paragraph 3.08.

d. Moisture content of fill for different applications shall be as specified in Part 3 of this Section.

3.03 EARTHWORK FOR STRUCTURES

A. Structure Excavation:

1. The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade unless the excavation is in rock where the maximum variation shall be 2 feet.
2. Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require over-excavation and backfill, refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the Contractor.
3. Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

B. Foundation Treatment:

1. A 36-inch-thick reinforced crushed rock mat should be installed under the PFAS vessel concrete pad, and the rinse water tank concrete pad as noted below under Reinforced Crushed Rock Mat Installation.

2. A 6-inch-thick crushed rock pad should be installed under the Restroom/Storage building footings and vaults.
3. All crushed rock beneath foundation should be compacted to not less than 95 percent of the maximum dry density as determined by ASTM D1557.
4. Foundation Preparation:
    a. All subgrades beneath the crushed rock sections should be neatly and carefully prepared. Any deleterious, loose, or soften material should be removed from the subgrade and replaced with crushed rock and any loose subgrade compacted prior to placing crushed rock.
    b. Prior to the placement of crushed rock for the construction of foundation, structural slab, or pavements, the subgrade should be proof rolled with a 10-to-12-ton roller operating in the static mode to identify any areas of excessive yielding. The proof rolling should be observed by the Geotechnical Engineer or their representative who will evaluate the subgrade. If areas of excessive yielding are identified, the material in the yielding subgrade should be removed and replaced with compacted granular fill (Type A or B).
    c. Areas that cannot be accessed with proof rolling compaction equipment should be evaluated by probing by the Geotechnical Engineer or their representative.
    d. The footing excavation should be observed by the Geotechnical Engineer or their representative prior to placing steel or concrete to evaluate the stability of the exposed subgrade, and to verify that the recommendations of geotechnical engineering report have been followed and that conditions encountered are as anticipated.
5. Reinforced Crushed Rock Mat Installation:
    a. After the subgrade has been approved by the Owner's Representative, a layer of non-woven geotextile should be placed. The non-woven geotextile should be conforming to the properties provided in Table 3, Section 9-33.2(1) of the Washington Department of Transportation Standard Specifications, such as Mirafi 180N. The non-woven geotextile layer should be immediately overlain by a geogrid such as Tensar InterAx NX750 or NX850 Geogrid or an approved alternative.
    b. An alternative to having separate geotextile layers (i.e., separate non-woven and geogrid materials) overlying the subgrade is to use a geotextile with both separation and reinforcing properties such as Mirafi RS580i.
    c. All geotextile and geogrid layers should be placed over the entire surface of the subgrade and joints overlapped and/or tied (in the case of geogrid) in accordance with the manufacturer's recommendations. The geogrid described above should not be placed along uneven surfaces or along localized low areas created by additional over-excavations. As shown on Civil Detail 4/C-000-805, the geogrid should be placed as a horizontal layer.
    d. The backfill placed over and between the geogrid layers should be structural fill material Type F. Within the crushed rock fill, a layer of geogrid should be placed at 12-inch intervals during backfill placement, as shown on Civil Detail 4/C-000-805.

C. Structure Backfill:
    1. Unless otherwise specified, structure backfill shall be Class B1.

2. Moisture content for pipeline backfill shall be -2% to +3% of optimum soil moisture content per ASTM D1557.
3. After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed, and the excavation shall be cleaned of debris.
4. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing structures to the satisfaction of the Owner's Representative.
5. Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.
6. Compaction of fill or backfill material by ponding or jetting methods is not allowed. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

3.04 EARTHWORK FOR PIPELINES AND CONDUITS

A. General:

Earthwork for pipelines and conduits is specified in Table A; in the standard details; and in the following paragraphs. Moisture content for pipeline backfill shall be -2% to +3% of optimum soil moisture content per ASTM D1557.

B. See Section 31 21 33 – Trenching, Bedding, Backfilling, and Compacting for Buried Piping for pipeline and conduit excavation and backfill requirements.

3.05 SUBGRADE FOR PAVEMENT

A. The prepared subgrade shall be scarified to a depth of at least 12 inches and recompacted to at least 95 percent of the maximum density. Moisture content for the natural subgrade or fill shall be -1% to +3% of optimum soil moisture content per ASTM D1557.

B. The surface of the road section foundation shall not contain standing water and shall be free of loose material, foreign objects, and rocks greater than 6 inches in maximum dimension.

C. The surface of the foundation shall be maintained to permit travel of construction equipment. Ruts in the surface of any layer shall be filled and leveled before compacting.

D. If the foundation surface is damaged, repair the surface to the specified condition. In any areas where materials become soft or yielding, such materials shall be removed, disposed of, and replaced with specified material.

E. Vertical alignment tolerances permitted on the roadway surface shall not exceed plus or minus 0.20 feet from the vertical alignment specified by the spot elevations on the Grading Plan, and assuming straight grading between the spot elevations shown. Horizontal alignment tolerances permitted shall not exceed plus or minus 1 foot.

3.06 SITE FILL

A. Unless otherwise specified, site fill shall be Class C2 fill. If the existing slope in an area to be filled is greater than 5:1, bench the area prior to filling.

B. Unless otherwise specified, the fill shall be raised to form an approximately horizontal plane extending transversely to the final slopes. The fil shall be crowned at all times during construction so that water will drain off readily.

3.07 FILL CONTROL TESTING

A. The compaction of fill and backfill shall be tested at a rate of at least one (1) test per 200 cubic yards per day of fill material or portions thereof and at least one (1) test per 200 lineal feet of trench or roadway subgrade for each lift, at various locations. A minimum of one test is required for each structure constructed, including manholes and concrete slabs.

B. Per Section 01 45 23, the Owner will be responsible for contracting with a testing agency to perform fill control testing for Quality Assurance. The Contractor may, at their option, perform or have performed for them additional fill control at no cost to the Owner. However, the results from the Owner-contracted testing agency will be the official and only results recorded to document adequate fill control for the project.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section provides specifications for dewatering systems and appurtenances to be used during construction, if required.

B. Type:
   1. This specification covers the use of site sump pumping, well pointing, vertical sand drains, and deep well drainage systems.

1.02 QUALITY ASSURANCE

A. Before dewatering is commenced, obtain the acceptance of the Engineer for the method, installation and details of the dewatering system proposed. To that end, submit plans setting forth the details of its proposed dewatering systems. The dewatering system plans shall be in sufficient detail to indicate sizes of pumps, piping, appurtenances, the ultimate disposal point for water, and to permit the Engineer to judge the overall completeness and effectiveness of the proposed system.

B. The control of groundwater shall be such that softening of the bottom of excavations, or formation of "quick" conditions or "boils," is minimized. Dewatering systems shall be designed and operated so as to prevent removal of the natural soils.

C. Select the particular method of dewatering to be employed after having become familiar with the information provided in Section 31 23 00 and Section 31 21 33.

D. Before dewatering is started, obtain written acceptance for the method, installation and details of the dewatering system proposed. Open and case pumps shall not be used for excavations deeper than 3 feet below the static water level.

E. The Contractor shall be solely responsible for proper design, installation operation, and maintenance, and for any failure of any component of the dewatering system. Acceptance of the method, installation and operation and maintenance details submitted shall not in any way be considered to relieve the Contractor from full responsibility for errors therein, or from the entire responsibility for complete and adequate design and performance of the system in controlling the water level in the excavated areas, and for control of the hydrostatic pressures to the depth specified.

PART 2 METHODS

2.01 GENERAL

A. Furnish, install, operate, and maintain all machinery, appliances, and equipment to maintain all excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property, or to cause a nuisance or menace to the public.

B. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent which would cause damage or endanger adjacent structures.

C. The static water level shall be drawn down a minimum of one foot below the bottom of the excavation in order to maintain the undisturbed state of the foundation soils and to facilitate the placement of fill or backfill compacted to the required density.

2.02 SUMP PUMPING

A. Sumps shall be no deeper than 5 feet and shall be at the low point of excavation. Excavation shall be graded to drain to the sumps. Measures shall be taken to minimize disturbance of the foundation soils from water running through the excavation of the sumps.

2.03 WELL POINTS

A. The annular space between the pipe and the borehole of the well point shall be sealed near the top of the well point to prevent vacuum leaks. Installation shall be carried out in such a way so as not to excessively disturb in situ material, especially claystone bedrock.

PART 3 EXECUTION

3.01 GENERAL

A. If dewatering systems are required during construction, 100% standby pumping capacity shall be available to be on-site and operational within 4 hours. Standby equipment shall include emergency power generation.

B. Dewatering systems shall not be shut down between shifts, on holidays, on weekends, or during Work stoppages.

C. Control surface water to prevent entry into excavations.

D. Dewatering shall be continued until the structures have been completed and backfilled.

E. The Contractor shall be responsible for, and shall repair without cost to the Owner, any damage to work in place, equipment, and the excavation, including damage to the bottom due to heave which may result from his negligence, inadequate or improper installation, maintenance, and operation of the dewatering system. This also includes responsibility for removal of material and pumping out of the excavated area due to failure, without cost to the Owner.

3.02 RELEASE OF GROUNDWATER

A. Incorporate the release of groundwater into the dewatering plan for approval. The plan shall address means for release of groundwater to avoid damage to the Work or the environment.

B. Straw bales are not acceptable for providing filtering of released groundwater.

C. If a National Pollutant Discharge Elimination System permit is required for disposal of water from construction dewatering activities, it shall be obtained by the Contractor prior to any dewatering activities.

END OF SECTION

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SECTION 31 41 00

SHEETING, SHORING, AND BRACING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

This section specifies requirements for sheeting, shoring, and bracing of trenches greater than 5 feet in depth.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWS D1.1	Structural Welding Code
WAC 296-155	Washington Safety Standards for Construction Work
WAC 296-155 Part N	Excavation, Trenching, and Shoring

1.03 DESIGN REQUIREMENTS

A. The Contractor shall design sheeting, shoring, and bracing in accordance with Article 6 of OSHA Labor Code and the Washington Safety Standards for Construction Work, WAC 296-155, Part N.

B. Horizontal strutting below the barrel of a pipe and the use of pipe as support are not acceptable.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Qualifications of Shoring Contractor, Professional Engineer, and welders.

C. Submit design calculations and method of installation and removal of all sheeting, sheet piling, shoring, and bracing. Information to be provided shall include the following:
   1. All calculations, methods, and installation and removal procedures shall be stamped, dated, and signed by a currently registered Professional Engineer in the state of Washington.
   2. Comply with applicable requirements of the Washington State Administrative Code and the rules of the WISHA Department of Labor and Industries with respect to excavation and construction.
   3. When the construction sequence of structures requires the transfer of bracing to portions of any new structure or to any existing structure, provide a complete design analysis of the expected impact of that bracing on the structure. This action shall in no way absolve the Contractor of responsibility of damage resulting from said bracing.

D. Provide information required by WAC Chapter 296-155, Part N. Engineer will only review Contractor's shoring submittal for completeness, without reviewing or approving means and methods.

E. Provide procedures for drilling or driving shoring including any tie-backs required for installation and removal of the excavation support system.

F. Vibration and movement monitoring results.

1.05 QUALIFICATIONS

A. Excavation Support Systems Designer: Professional Engineer currently registered in the state of Washington with a minimum of three years' experience in the design of earth retaining structures for temporary construction of similar type and depth proposed in similar soil and groundwater conditions in this Contract.

B. All welders shall hold current certification by AWS (American Welding Society).

1.06 DESIGN REQUIREMENTS

A. EXCAVATION AND TRENCHING PLAN
   1. Prepare excavation and trenching plan addressing following topics:
      a. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
      b. Design assumptions and calculations signed and sealed by a Professional Engineer registered in the State of Washington and qualified to design and evaluate shoring and trenching plans.
      c. Methods and sequencing of installing excavation support.
      d. Proposed locations of stockpiled excavated material.
      e. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
      f. Anticipated difficulties and proposed resolutions.

B. The design, planning, installation, and removal, of all sheeting, shoring, sheet piling, lagging, and bracing shall be accomplished in such a manner as to maintain the required excavation or trench section and to maintain the undisturbed state of the soils below and adjacent to the excavation.

C. The Contractor shall design sheeting, shoring, and bracing in accordance with WAC Chapter 296-155 Part N.

D. Horizontal strutting below the barrel of a pipe and the use of pipe as support are not acceptable.

E. Design to include dewatering requirements for support of the excavation and its support system. Comply with Section 31 23 19.

F. The Contractor's proposed procedure and corrective measures to be used should horizontal movement or settlements occur adjacent to the shored excavation or trench.

G. Where applicable, the design shall be in accordance with the IBC, with special inspection and testing as required.

1.07 SUPPORT SYSTEM REQUIREMENTS

A. Comply with applicable requirements of the WAC and rules of the WISHA Department of Labor and Industries with respect to excavation and construction.

B. No excavation support systems shall be installed using impact techniques such as hammer driven sheet piles.

C. Submittal to the Engineer will be to assure the District of the Contractor's general compliance with the references and shall not be construed as a detailed review and analysis for adequacy of the support system, nor shall any provisions of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

B. The construction of sheeting, shoring, and bracing shall not disturb the state of soil adjacent to the trench and below the excavation bottom.

C. Trench excavation shall not be started until the design for trench support has been accepted by the Owner.

D. Abandoned elements of excavation support systems shall be indicated on the Record Drawings.

3.02 MOVEABLE SHIELDS

A. Shield width:
   1. If moveable trench shields or boxes are used, provide the following dimensions:

Nominal Pipe Diameter (Inches)	Box Inside Width (Inches)
12 and under	48

   2. Shield widths less than those specified in (1) herein may be used provided that the inside shield width is not less than the OD of the pipe plus 28 inches that bedding material is installed to the top of the pipe or higher if so indicated on the Drawings.

B. Place bedding material to the depth shown on the Drawings over the full inside width of the moveable trench shield or box used.

C. Moveable trench shields or boxes may extend below the top of the pipe, if a suitable means of reconsolidating the bedding or side support material disturbed by moving the box can be demonstrated.

3.03 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.04 TRENCHES

A. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders including those from federal (OSHA) requirements.

B. The construction of sheeting, shoring, and bracing shall not disturb the state of soil adjacent to the trench and below the excavation bottom.

C. Trench sheeting below the top of a pipe shall be left in place.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies paving consisting of aggregate base, asphaltic concrete, and associated materials.

B. Testing:
   1. The Owner will conduct testing to determine compliance with the specified degree of compaction and moisture content.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base:
   1. Aggregate base shall be Aggregate for Gravel Base conforming to Section 9-03.10 of the Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction (SS), 2025 Edition.

B. Asphalt Concrete:
   1. Asphalt binder shall be paving asphalt, Grade PG64-22, and shall comply with Washington State Department of Transportation Standard Specifications.
   2. Asphalt concrete shall be Class ½-inch and shall meet Section 5.05 of the WSDOT SS, 2025 Edition.

PART 3 EXECUTION

3.01 GENERAL

A. Construction shall conform to the details, dimensions and grades specified. Maximum variations in finished grade of paving shall be plus or minus 0.05 feet.

3.02 AGGREGATE BASE PLACEMENT

A. Subgrade:
   1. Paved areas shall be graded and compacted in accordance with Section 31 23 00.

B. Aggregate Base:
   1. Where indicated on the plans. placement of aggregate base shall comply with WSDOT SS, 2025 Edition.

3.03 ASPHALT CONCRETE PAVEMENT

A. Asphalt Concrete:
   1. Placement of asphalt concrete pavement shall comply with WSDOT SS, 2025 Edition.

B. Tack Coat:
   1. Tack coat shall be applied to all vertical surfaces of existing pavement; to curbs, gutters, concrete slabs, and saw cut pavement edges for construction joints against which asphalt concrete will be placed; to pavements to be surfaced; and where specified at the approximate rate of 0.05 gallons per square yard. Immediately prior to placing asphalt concrete, additional tack coat shall be applied to areas where the tack coat has been damaged.
   2. Immediately prior to construction of asphalt concrete berms, a continuous tack coat shall be applied to the pavement surface. Application of the tack coat shall not cause a slip or weakened plane between the two joined surfaces.

C. Prime Coat:
   1. Prime coat shall be applied to the aggregate base prior to placement of asphalt concrete pavement at the approximate rate of 0.25 gallons per square yard. Prior to placement of subsequent material, any excess primer which has failed to penetrate the surface shall be blotted with clean sand.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 DESCRIPTION

This section specifies galvanized chain link fence comprising fences, gates, and appurtenances.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AIS	American Iron and Steel Requirements for SRF Funded Projects
ASTM A90	Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A53	Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
ASTM A121	Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A239	Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip)
ASTM A392	Zinc-Coated Steel Chain-Link Fence Fabric
ASTM F668	Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and Other Polymer-Coated Steel Chain Link Fence Fabric
ASTM F900	Standard Specification for Industrial and Commercial Steel Swing Gates
ASTM F934	Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials

1.03 SUBMITTTALS

A. The following information shall be provided:
   1. Manufacturer's product information designating specific materials provided.
      a. Include AIS Certification Letter from manufacturers and/or suppliers of all iron or steel components as required by the United States Environmental Protection Agency for projects using State Revolving Funds for construction.
   2. Results of the factory testing specified in paragraph 1.02.
   3. The layout of the chain link fence as it is to be provided illustrating fence height, post sizes, bracing configurations, and accessories and installation and detail shop drawings for the fabricated fences and gates including baseplate mounting templates.
   4. Design calculations. Railing and base support connections to be designed by the Contractor incorporating specified criteria and provisions in the current building code with local governing amendments.

B. Factory Testing:
   1. Zinc-coated components shall be tested for zinc coating weight by the method specified in ASTM A90. Ferrous metal, except the fabric, shall be tested for zinc coating uniformity by the method specified in ASTM A239; zinc coating shall withstand six 1-minute dips.

PART 2 PRODUCTS

2.01 MATERIALS

A. Chain Link Fabric:
   1. Chain link fabric shall be 1-1/4 to 1-3/4-inch mesh, 9-gage wire, manufacturer polymer coated per ASTM F668. Width of fabric shall be 6 feet 0 inch (plus or minus 3/4 inch). Fabric shall conform with the requirements of ASTM A392. Color shall be black and in accordance with ASTM F934.

B. Bottom Tension Wire:
   1. Bottom tension wires shall be at least 7-gage wire, per ASTM F1664. Color and class to match chain link fabric.

C. Barbed Wire:
   1. Barbed wire shall be double strand 12 1/2 gage galvanized steel with 14 gage barbs in 4-point pattern on 5-inch centers and shall have a Class 1 galvanized coating per ASTM A121.

D. Posts, Top Rail, Braces and Gate Frames:
   1. Pipe used shall be ASTM A53, Schedule 40 steel pipe. Posts, rails, braces and frames shall have a PVC coating fused and adhered to the exterior zinc coating of the framework. Coating shall have minimum thickness 10-mils, per ASTM F1043. Color to match chain link fabric.

2. Line posts shall be either "H" columns weighing not less than 2.7 pounds per foot or 2-3/8-inch outside diameter pipe weighing 3.65 pounds per foot. Corner and end posts shall be minimum 2-7/8-inch outside diameter pipe weighing a minimum of 5.79 pounds per foot. Braces and top rails where specified, shall be 1 5/8-inch outside diameter pipe weighing 2.27 pounds per foot. Gate frames shall be made of minimum 2-inch outside diameter pipe. Gate posts shall be 4-inch outside diameter weighing 19.0 pounds per foot.

E. Truss Rods and Miscellaneous Fittings:
   1. Truss rods shall be fabricated of 3/8-inch diameter steel rods and shall have turnbuckles or similar means of adjustment. Extension arms for barbed wire shall be steel or malleable iron. Gate hinges, drop bar locking devices, caps, gate stops and miscellaneous bolts, bands, and other appurtenances shall be consistent in quality and strength to the rest of the fence. Fittings used shall be hot-dip galvanized iron or steel with a minimum coating of at least 2.0 ounces of zinc per square foot of surface in accordance with ASTM A123 or A153, whichever is applicable.

F. Swing Gate:
   1. Double leaf swing gate, 20-foot opening for vehicular traffic, and 12-foot gate leaf with operator and 8-foot gate leaf opening manually operated, 6 ft high, per ASTM F900.
   2. Single leaf swing gate for personnel entry, 4-foot opening, manually operated, 6 ft high, per ASTM F900.
   3. Polymer coated gate frames and gateposts to match the coating for the fence framework. Moveable parts such as hinges, latches and drop rods may be field coated using a liquid polymer touch up.
   4. Coordinate gate operator system and gates to be installed at the site. See Section 32 31 15 for gate operator systems.

G. Concrete:
   1. Concrete for post foundations shall be Class C as specified in Section 03 30 00.

PART 3 EXECUTION

3.01 FENCE

A. Line posts shall be equally spaced between corners, end posts, and gate posts at a spacing not exceeding 10 feet. The base top shall be at least 1 inch above grade and sloped for drainage. Posts shall be set vertical, shall be accurately aligned, and shall have their tops level or at a constant slope between changes in grade. Tubular posts shall be fitted with extension arms for barbed wire, post top to permit passage of top rail or rainproof malleable iron caps as applicable.

B. Corner, end, and gate posts shall be braced to the nearest line post. Corner and end posts shall be diagonally braced. Bracing for gate posts shall be horizontal braces with truss rods. Top rails shall be in lengths not less than 18 feet and shall be fitted with couplings for connecting lengths into continuous runs. Couplings shall be not less than 6 inches long and allow for expansion and contraction of the rail.

C. Chain link fabric shall be taut and shall be attached to posts, rails, and wires with galvanized fabric bands or tie wires at a maximum spacing of 12 inches on posts and 18 inches on the rails and tension wires. Stretcher bars shall be provided at ends of fabric. The bottom tension wire shall be stretched tight and shall be located 2 inches maximum above finished grade and on a straight grade between posts by excavating the high points of ground, and in no case shall depressions be filled.

D. Three strands of barbed wire attached to extension arms shall be provided along the fence top. Extension arms shall overhang the outside of the fence at a 45-degree angle. The topmost strand of barbed wire shall be 12 inches above the top of the fabric.

3.02 GATES

A. Gate frames shall be fabricated with welded joints or rigid connectors. The fabric shall be the same as that used for the fence and shall be rigidly attached to the frames. Frames shall be suitably braced and trussed. Gates shall be equipped with suitable hardware and a drop bar locking device with provision for padlocking. A stop to hold the gate open and a center rest with catch shall be provided. Three strands of barbed wire shall be provided on top of chain link gates.

B. See Section 32 31 15 Gate Operator Systems for information on automated gate operation requirements.

END OF SECTION

SECTION 32 31 15

GATE OPERATOR SYSTEMS

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C387	Standard Specifications for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
NEMA 250	Enclosures for Electrical Equipment (1,000 volts max.)
NFPA 70	National Electrical Code

B. Qualifications:

1. Automatic Gate Operator System Supplier: 5 years' experience in gate operator systems.
2. Automatic Gate Operator System Installer:
   a. Completed chain link fences and gates similar in material, design, and extent to those indicated for Project.
   b. Record of successful in-service performance.
   c. Minimum 3 years' experience.

C. Equipment and components designed, supplied, installed and on-call service provided by an individual company meeting the requirements specified.

D. Preinstallation Conference: Conduct conference at Project Site with gate installer to verify layout and operations of automatic gate operating system.

1.02 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes, identifying any deviation from the specified requirements:
         1) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
         2) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
   2. Test Reports: Field test result for compliance of installation of gate operators compared to specified requirements.

B. Informational Submittals:
   1. Manufacturer's recommended installation instructions.
   2. Factory test reports, certified.
   3. Evidence of Supplier and installer qualifications.
   4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
   5. Manufacturer's Certificate of Proper Installation.

1.03 CODES AND REGULATORY REQUIREMENTS

A. Gate Operators:
   1. Built to UL 325 standards.
   2. Listed by a testing laboratory.
   3. Electrical work completed according to local codes and National Electrical Code.
   4. Fieldwork performed in a neat and professional manner, completed to journeyman standards.

B. Safety standards require the use of multiple external sensors to be capable of reversing the gate in either direction upon sensing an obstruction.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground in unopened packaging to provide protection against oxidation caused by ground contact.

1.05 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation, grading, and installation of fence and gates before installing the operators.

B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.
   1. Faulty operations of gate operators and controls.
   2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

B. See the General Conditions and Division 01, General Requirements, which contain information and requirements that apply to the work specified herein and are mandatory for this Project.

2.02 GATE OPERATOR SYSTEM

A. General:
   1. Operator shall meet UL 325 requirements for Class III, Type A operators.
   2. Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, safety devices, and weatherproof enclosures; coordinate electrical requirements with Division 26, Electrical.
   3. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
   4. Provide operator with UL approved components.
   5. Provide electronic components with built-in troubleshooting diagnostic feature.
   6. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
   7. Unless otherwise indicated, provide all conduits and conductors specifically shown for gate operators and controls, including but not limited to, vehicle detector loops, and controller supports.
   8. Coordinate gate operator system and gates to be installed at the site. See Section 32 31 13 for gate specifications.

B. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor.

C. Gate Operator:
   1. Heavy-duty, high frequency, hydraulic models designed to open and close gates provided.
   2. For each gate, supply manufacturer of gate operator with complete details of gate, hardware, adjacent fence posts, and fence construction for development and detailing of gate operator.
   3. Furnish with following features:
      a. Metal enclosure, including attachments, constructed with finish and design suitable for exterior installation in all-weather environment.
      b. Minimum 1-hp motor.
      c. Electric motor driven hydraulic power pack.
      d. Positive limit switch, to sense position of gate and provide control to prevent damage to gate operator.
      e. Disconnecting Means: Provide with external, NEMA 4X rated, disconnect switch capable of being padlocked in the OFF position.
      f. 24V dc control circuit to power remote control gate activation devices.
      g. Manual operation feature or disconnect, without use of tools, for easy operation during power failure, malfunction, or emergency.
      h. Aluminum drive rail designed for attachment to sliding gate in manner that reinforces gate assembly.
      i. Gate Travel Speed:
         1) 15-second to 20-second OPEN/CLOSE.
         2) Speed adjusting feature that provides range of appropriate speeds for swing gate operation is acceptable but not required.
         3) Maximum Gate Weight: 1,000 pounds.
         4) Frequency of Use: Continuous duty.
         5) Operating Type: Suitable for swing gates, with manual release.
      j. Compatible with gate operator control devices provided. Coordinate requirements with manufacturers.
      k. Gate edge sensors that provide a reverse signal to operator when gate hits any obstruction.
      l. Provide relay outputs for gate OPEN status and TROUBLE status back to the SCADA system, dry contacts rated for 2A at 24 V dc.
      m. Fire department override key switch at entry pedestal, and Owner override key switch at entry pedestal.
   4. Manufacturers:
      a. Hy-Security Swing Gate Operator, Seattle, WA.
      b. Or Equal.

D. Access Control:
   1. For safety, provide loop detectors each side of gate to prevent gate closure during vehicle passage.

2. Gate Operation:
    a. Entry: Gate opens when activated by valid long-range vehicle reader. Gate closes after adjustable time period up to 90 seconds.
    b. Entry: Gate opens when activated by key switches. Gate remains open as long as key is active. Gate closes after adjustable time period up to 90 seconds.
    c. Entry: Gate opens when activated through Owner's SCADA system, from dry contact. Gate remains open as long as contact is closed. Gate closes after adjustable time period up to 90 seconds. Discrete sensing voltage shall be 24 V dc.
    d. Exit: Gate opens when activated by detector loop in pavement. Gate closes as for entry.

2.03 LONG RANGE VEHICLE READER

A. Identification up to 33 feet.
    1. Mounted inside the fence, out of reach of vandals.
    2. 24 V dc powered via Gate Operator.
    3. Industry standard Wiegand output.
    4. Compatible with Owner's existing vehicle long range identification tags.
    5. Manufacturer: Nedap Transit standard.

2.04 LONG RANGE IDENTIFICATION TAG

A. Identification up to 33 feet.
    1. Mounts to windshield, can be easily moved from vehicle to vehicle.
    2. Manufacturer: Nedap window button. Include five window buttons, compatible with Owner's existing system.

2.05 KNOX BOX KEY SWITCH

A. Gate Operation: Single Gate Switch Knox Box Model 3501, "Or-equal."
    1. Recessed Mount: Include recess mount box.
    2. Provide key switch for Fire Department.
    3. Built-in multi-purpose switch for gate activation.
    4. Coordinate key cylinder with Fire Department.
    5. UL Listed.

2.06 OWNER-ENTRY KEY SWITCH

A. Gate Operation: SFIC Interchangeable Core Key Switch compatible with Arrow brand 7-pin SFIC key core, Cargo Protectors, Inc., "Or-equal."
    1. Recessed Mount: Include recess mount box. Mount box shall have weather cover. Special Order Key Switch Part No. ICES67B1-WSSG-2-CSGD-1, Cargo Protectors, Inc., "Or-equal."
    2. Provide key switch for Owner. Core cylinder to remain blank after installation.
    3. Built-in multi-purpose switch for gate activation.

4. Coordinate key cylinder with Owner and Harry's Locksmith. Refer to Specification Section 01 14 16, Coordination with Operation of Existing Facilities.
5. UL Listed.
6. See details on Drawings.

2.07 CONCRETE

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 GENERAL

A. Provide necessary hardware for a complete and operational gate meeting specified requirements.

B. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

3.02 PREPARATION

A. In accordance with manufacturer's recommendations.

B. Eliminate ground surface irregularities where the gate operator and access system are located.

C. Clean surfaces thoroughly prior to installation.

3.03 GATE OPERATOR SYSTEMS

A. Install gate operator systems in accordance with manufacturer's recommendations, aligned and true to fence line and grade.

B. Furnish with equipment and accessories necessary for complete installation.

C. Wire the system in accordance with NEC and local codes. Enclose all splices in easily accessible junction boxes or on terminal boards. Tag and identify all cable runs in all junction boxes.

D. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.

3.04 KNOX BOX AND OWNER KEY SWITCHES

A. Install Knox Box and Owner Key Switches to recessed boxes, mounted in column at gate to manufacturer's recommendation.

3.05 LONG RANGE VEHICLE READER

A. Provide and install a long-range vehicle reader at the gate. The reader shall be pole mounted inside the perimeter and mounted high enough to look over the gate.

3.06 FIELD QUALITY CONTROL

A. Automatic Gate Operator:
   1. Energize circuits to electrical equipment and devices.
   2. Adjust operators, controls, safety devises, and limit switches.
   3. Start units to confirm proper motor rotation and unit operation free of binding. Test and adjust all gate controls for proper operation.
   4. Demonstrate coordination with the access controls.
   5. Replace damaged and malfunctioning controls and equipment.
   6. Lubricate hardware, gate operator and other moving parts.

3.07 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 79 00, Demonstration and Training, for installation assistance, inspection and certification of the installation, testing, startup assistance, and training of plant personnel.

B. Coordinate startup services and training of plant personnel with Owner, Engineer, and affected personnel.

C. Minimum time requirements are as follows; travel time excluded:
   1. 2 person-days for installation assistance, field testing, and certification of the installation.
   2. 1 person-day for startup.
   3. 1 person-day for training.

3.08 CLEANUP

A. Remove excess materials and other debris from Site.

END OF SECTION

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SECTION 32 84 00

PLANTING IRRIGATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Work of this section includes all labor and materials necessary to construct or modify the irrigation system as shown on the drawings and specified herein.

B. The work includes, but is not limited to, the following:
   1. Piping
   2. Valves
   3. Controller(s) and other control elements
   4. Electrical Control Wiring and connectors
   5. Sprinkler Heads

C. Related Documents and Sections include but are not limited to:
   1. Section 32 91 13; Soil Preparation
   2. Section 32 92 00; Turf and Grasses
   3. Section 32 93 00; Plants

1.03 DEFINITIONS

A. American Public Works Association (APWA).

B. American Standards for Testing and Materials (ASTM).
   1. D 1785-99 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   2. D 2241-00 - Standard Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
   3. D 2466-91 (1996) - Standard Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   4. D 2564-96a - Standard Specifications for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
   5. B3-01 - Specification for Soft or Annealed Copper Wire
   6. D2564-96a - Specification for Solvent Cements for PVC Plastic Pipe and Fittings

C. American Water Works Association (AWWA)
   1. C500 - Gate Valves for Water and Sewerage Systems.

1.04 SUBMITTALS

A. Submit three copies of the proposed irrigation plan to the Owner's Representative for review and approval a minimum of 10 working days prior to commencement of work. The plan must follow the specifications and design criteria as outlined herein.
   1. Each submittal shall include manufacturer's product information ('cut') sheets for all components and materials proposed for use in fabricating and installing the irrigation system.

B. Record Copy Drawings: During the course of installation, carefully show all field changes in red line on a print of the irrigation system as installed. This drawing shall be labeled "Record Copy", and shall be made available for inspection. The status of the 'Record Drawing' must correlate directly with the percentage of work complete described in the Contractor's Pay Request and may be used as a guide when approving payments.

C. Upon completion of the work of this section and as a condition of its acceptance, the Contractor shall deliver to the Owner's Representative the following:
   1. As-Built Drawings: Submit three prints and one reproducible and/or electronic file of as-built drawings. As-built drawings shall clearly show all original components of the Record Copy and all changes documented in the Record Copy. Main lines, drain valves, valve boxes, and valve markers and other buried equipment shall be positively located by a minimum of two dimensions each from fixed reference points. Emitter schedule (number of emitters per plant type)
      a. Emitter layout charts
   2. Maintenance Manual: Submit three copies of containing the following:
      a. Catalog cuts of all irrigation materials installed.
      b. Contractor's name, address and telephone number.
      a. The duration of the guarantee period.
      b. The name and address of the local manufacturer's representative.
      c. List and description of routine maintenance procedures, including winterization, start-up, and recommended watering times for each zone.

   2. Controller Reference Chart: Submit one chart for each controller installed on site showing the area covered by each sprinkler zone. The chart shall be a reduced copy of the as-built drawings, color coded to differentiate zone areas, sized to fit the controller door, and hermetically sealed between 20 mil. plastic sheets.
   3. Supplemental Equipment: Submit two each of keys to the following: quick coupling valves, quick coupling valve lids, valve markers, manual drain valves, valve boxes, and controller cabinets.

1.05 QUALITY ASSURANCE

A. Proprietary items shown on the drawings and specified herein are shown to establish standards of quality, utility, design and function. Equivalent units by other manufacturers (substitutions) will be considered provided they are similar in characteristics. They shall be substituted only if approved by the Owner's Representative.

B. The Contractor shall store all PVC pipe and fittings out of direct sunlight and protect from physical damage.

C. The Contractor shall store and protect all specified components from adverse weather conditions until installation is complete.

D. The Contractor shall handle all components as directed by the manufacturer's handling and installation instructions. Damage from transportation or other handling of materials shall be the responsibility of the Contractor.

E. All local, municipal and state laws and rules and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications and the Contractor shall carry out their provisions. Any specification herein contained, shall not be construed to conflict with the above rules, regulations or requirements.

1.06 PROJECT CONDITIONS

A. Inspection of the site: The contractor shall inspect the site prior to construction and verify the extent of the work required. The Owner does not warranty field conditions the Contractor may encounter during installation of the Planting Irrigation. Contractor shall include in his bid the cost for trenching and removal of concrete and other debris that may be encountered. Commencement of construction by the Contractor designates acceptance of the site conditions apparent at outset and no additional compensation will be allowed.

B. The Contractor shall verify the locations of all existing utilities, structures, and services before commencing work. The location of utilities, structures and services shown on these plans are approximate only. Any discrepancies between these plans and the actual field conditions shall be reported to the Owner‘s Representative immediately.

C. Weather Limitations: Soil work shall be performed only when weather conditions do not detrimentally affect the quality of work.

D. Project Limits: Areas, as specified within which work is to be performed.

E. The Contractor shall protect all areas of work defined on the drawings and any existing on-site vegetation, structures, utilities, etc. All damage as a result of work under this contract shall be repaired at no cost to the Owner. The Contractor shall be responsible for the provision of traffic control, barricades, safety guards, and any other structures or improvements necessary for the complete protection of the public. The Contractor shall verify non-potable water sources and install labeled components as required by state and federal laws.

F. The Contractor shall verify, locate and protect all existing utilities and features on and adjacent to the project site during construction and shall repair, at their own expense; all damage as a result of construction activities.

G. The Contractor shall, at all times, take adequate precautions to keep rock, dirt, gravel, debris, and all other foreign materials from entering piping, valves and other irrigation equipment.

1.07 COORDINATION

A. Coordinate with other trades affecting or affected by work of this section.

B. Verify that sleeving and other conduits, of sizes and types specified, are installed as required.

C. Prior to the start of work the Contractor shall verify that the performance and components of the existing system are in accord with current jurisdictional requirements and that all necessary components are located as shown on the drawings.

D. The Contractor shall protect the existing system and maintain its performance at all times during the work of this section unless otherwise approved by the Owner's Representative. The Contractor shall cap all lines that are cut by new construction and/or re-route to maintain system performance. Unless otherwise noted in the contract documents the Contractor shall return to the Owner all salvaged heads, electrical components and valve boxes not used in this construction.

E. When necessary during construction the Contractor shall make arrangements for irrigation shutoff through the Owner's Representative. The Contractor shall provide complete temporary irrigation to all landscape areas affected by the shut-off, during normal watering seasons.

F. The Contractor shall maintain, repair or replace controller wiring affected by construction and integrate new system requirements into the existing controller unless otherwise directed in the contract documents. Verify whether or not the existing controller (if one exists) will accommodate the addition of new irrigation zones or any other new watering requirements.

1.08 GUARANTEE

A. The Contractor guarantees that all new irrigation components installed, as part of this work shall be free from defects in materials, design and workmanship for a period of one year from the Date of Substantial Completion.

B. Upon notice from the Owner's Representative of failure on any part of this equipment during the guarantee period, due to faulty installation procedures, new replacement parts shall be promptly furnished and installed by the Contractor at no additional cost to the Owner. Damages to property or site improvements resulting from the failure of specified components shall be repaired promptly, at no additional cost to the Owner.

C. The contractor shall be responsible for grade settlement, and/or erosion of soil surfaces resulting from defects in irrigation installation throughout the specified warranty period.

PART 2 PRODUCTS

2.01 GENERAL PRODUCT REQUIREMENTS

A. Materials and equipment shall be new, delivered to site in original factory condition, and as specified in this section.

2.02 PLASTIC PIPE

A. All plastic pipe shall be polyvinyl chloride (PVC) continuously bearing the seal of the National Sanitation Foundation, with the exception of polyethylene pipe specified as follows.

B. Polyvinyl Chloride (PVC) pipe

1. Lateral Lines: PVC Class 200, Type 1, white, NSF approved, solvent weld pipe meeting the requirements of ASTM D2241-00UVR-PVC Sch. 40 solvent weld pipe, meeting the requirements of ASTM 2855-96 Size as required to meet manufacturer's velocity specifications.
2. Main Lines: PVC Schedule 40**,** Type 1, white, NSF approved, solvent weld pipe meeting the requirements of ASTM D2241-00 UVR-PVC Sch. 40 solvent weld pipe, meeting the requirements of ASTM D2855-96 Size as required to meet manufacturer's velocity specifications.
3. Sleeves:
    a. Sleeves installed beneath asphalt paving: Schedule 40 pipe meeting the requirements of ASTM D2241-00.
    b. Sleeves installed beneath walls and walkways: Schedule 40 pipe meeting the requirements of ASTM D2241-00.
    c. Sized per the requirements of the irrigation system.

C. Risers and Nipples: PVC, Type 1, Schedule 80 one-piece gray, standard weight with molded threads, both ends, ASTM D1784-99a, D2464-99.

D. Electrical Conduit: PVC Schedule 40 electrical conduit, standard weight; minimum 1 - inch nominal diameter unless otherwise required.

E. Polyethylene Pipe and fittings: flexible, thick walled designed to withstand 400 psi burst pressure test: Quality and wall thickness equivalent to RainBird SP Series, or approved equal. Sized per manufacturer's specified velocity tolerances.

2.03 GALVANIZED PIPE

A. Galvanized pipe shall be threaded and hot dip galvanized standard steel pipe Schedule 40 standard weight.

2.04 PLASTIC FITTINGS

A. For Polyethylene Pipe: As specified by manufacturer of polyethylene pipe.

B. For PVC Class 200 Pipe: PVC Schedule 40 meeting the requirements of ASTM D2466-01.

C. For PVC Schedule 40 Pipe: PVC Schedule 80 meeting the requirements of ASTM D2464-99 PVC.

D. Manufactured Swing Joints: 3/4” or greater in size shall be RainBird TSJ series or approved equal.

2.05 GALVANIZED FITTINGS

A. Galvanized fittings shall be threaded and hot dip galvanized standard steel Schedule 40 standard weight.

2.06 PIPE JOINING COMPOUNDS

A. Cement and Primer for Solvent Weld Joints: As recommended by manufacturer of PVC pipe.

B. PTFE-free thread sealant for Threaded Joints (PVC or galvanized): Swagelok or approved equal.

2.07 ELECTRIC CONTROL WIRE AND CONNECTORS

A. Wire: Single strand copper, UL approved for direct burial. Sized in accordance with manufacturer's specifications. Control (hot) wires shall be red and common (ground) wire shall be white. Spare wire shall be black.

B. Wire Connectors and Sealant: UL approved for direct burial.

2.08 AUTOMATIC CONTROLLER

A. Automatic controllers: as shown on drawing, or approved equal. Contractor to modify existing controller to accept all new zones and make fully operational and meeting both normal and specified low volume system requirements as shown on drawings, and as required by site conditions
   1. Controller shall be 'solid state', commercial grade and have a single station for each control valve plus a minimum of one unused station for future expansion and shall be installed per manufacturer's recommended installation procedures.
   2. Controller shall be capable of a minimum of 2 start times per station per day and be equipped with a minimum 7-day watering cycle. Controller shall be equipped with master valve/pump start capability.
   3. Controller must be suitable for either indoor or outdoor mounting. The Contractor shall coordinate with the Owner to identify location for Controller mount and provide appropriate, lockable cabinet for location.

2.09 VALVES, FILTERS, PRESSURE REGULATORS

A. Bronze Gate Valves: MSS SP-80, Class 125, Type 1, nonrising-stem, bronze body with solid wedge, threaded ends, and malleable-iron handwheel.
   1. Available Manufacturers:
      a. NIBCO INC.
      b. Red-White Valve Corp.
      c. Stockham.

B. Manual Isolation Valves: Bronze Globe Valves: MSS SP-80, Class 125, Type 2, with bronze body and nonmetallic disc.
   1. Available Manufacturers:
      a. NIBCO INC.
      b. Red-White Valve Corp.
      a. Stockham.
      c. Walworth Company (The).

d. Watts Industries, Inc.; Water Products Div.

C. Remote Control Valve(s): PEB Valves by Rainbird or approved equal.
   1. Remote Control Valve: Glass-filled nylon body with pressure compensation module, forward flow design and of a size and type to sufficiently operate system. Water volumes and velocity through valve shall not exceed manufacturer's recommended optimum performance criteria.

D. Manual Drain Valve: 3/4-inch size bronze angle valve with rising stem and cross-type handle. Hammond, Buckner or approved equal.

E. Quick Coupling Valve and Accessories: RainBird 44RC with key and Swivel hose ell of same manufacture, or approved equal. Pressure Reducing Valve (if required): As indicated on drawings.

2.10 VALVE BOXES

A. Plastic valve box with locking lid, sized to provide a minimum of 3 inches clear on all sides of the valve to facilitate access, maintenance, repair or removal. Ametek, Carson, or approved equal.

2.11 DRAIN VALVE MARKER COVER

A. Cover as shown on drawings or approved equal.

2.12 SPRINKLERS

A. Sprinkler heads shall be as indicated on plans or approved equal.

B. Where necessary to control zone drainage, at the bottom of slope areas, install low head drainage bodies on lowest heads in zone.

C. Pop-up riser heights shall be as shown on drawings.

2.13 OTHER MATERIALS:

A. Gravel: 3/4-inch minus, washed, crushed rock

B. Manual Drain Valve Key: Minimum length 30 inches

C. Tracer Wire: 14, 12 or 10 AWG SOLID HDPE 45 MIL copper conductor with a 45 mil thick, high-density, high molecular weight polyethylene (HDPE) insulation and rated for 600 volts. Insulation and jacket shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities. Size according to manufacturer's recommendations.

D. Pipe backfill: Clean, dry, friable topsoil void of stones larger than 1" in diameter and other material deleterious to specified pipe. Soil shall be suitable for compaction to eliminate settlement conditions of specified finish grades.

E. All other materials, not specifically described, but required for a complete and proper irrigation system installation, shall be new and of first quality and must be approved by the Owner's Representative prior to installation on site.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to all work of this section, the Contractor shall carefully inspect all previously installed work and verify that all such work is complete to the point where specified installation may properly commence.

B. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the accepted design, the referenced standards, and the manufacturer's specifications.

C. The Contractor shall integrate new components into the existing system and maintain existing performance as specified

D. Make arrangements for water shutoff when necessary with Owner's Representative. Notify Owner 24 hours prior to water shutoff.

3.02 PIPE INSTALLATION

A. Trench depths shall provide minimum covers as shown on drawings

B. The site currently consists of a variety of non-native materials. Other non-native debris resulting from the use of the site as an industrial facility may be encountered during trenching. Contractor shall include in his bid compensations to trench and backfill through the non-native materials encountered on the site. No additional compensation will be allowed.

C. Depth of trenching shall avoid interference with waterlines and other utilities (verify), and shall allow for a four-inch vertical clearance between pipes.

D. Trench bottoms shall have uniform slopes with one percent minimum slope towards drain valves. Trench bottom shall be free of rocks or sharp-edged objects. Stones larger than one-inch in diameter are not allowed in the backfill material. Compact to adjacent soil density. Keep trenches free of debris, during construction.

E. Pipe connections: Do not use solvent cement on threaded joints. Apply thread sealant to threads in accordance with manufacturer's recommendations. Tighten fittings only to manufacturer's specifications. Follow manufacturer's instructions for solvent welding of PVC pipe and fittings to achieve tight and inseparable joints.

3.03 PIPE PULLING

A. Installation of pipe and wires by means of vibratory plow may be used as an alternate to standard trenching methods if approved by the Owner's Representative.

B. Vibratory pipe pulling shall only be allowed on 3/4 inch and 1 inch diameter piping only.

C. Solvent weld joints shall be thoroughly cured prior to pipe pulling.

D. The Contractor shall ensure, by means of an open pit or trench at the beginning, middle, and the end of pull, that pipe and wire is installed at the specified burial depths throughout the entire length of the pull. Burial depths shall be the same as specified for trenching.

E. Allow a minimum of five chain links between plow blade and pulling grip/bullet.

F. Pulling grip/bullet shall be a minimum of two-inch in diameter greater than the combined diameters of pipe joints and wire to be pulled.

G. Wire pulling shall only occur with proper wire blade feed attachment.

3.04 PIPE CONNECTIONS

A. Solvent weld PVC pipes only during non-freezing weather. Solvent weld PVC pipes only under cover in rainy weather. Do not allow flooding of welded piping until specified cure time has elapsed.

B. Air temperature of PVC mating surfaces for plastic pipe and fittings shall be between 40 degrees F and 100 degrees.

C. Do not use solvent cement on threaded joints. Apply thread sealant to threads in accordance with manufacturer's specifications.

D. Follow manufacturer’s instructions for solvent welding of PVC pipe and fittings to achieve tight and inseparable joints.

E. Cementing plastic pipe:
   1. Cut all ends squarely with approved pipe cutting tool. Bevel ends with a deburring tool.
   2. Clean all pipe ends prior to assembly.
   3. Clear all pipe lengths of dirt and debris. Protect from contamination.
   4. Do not use excess primer and solvent when joining pipe ends.
   5. Insert pipe ends to full depth of fitting, hold tightly as necessary to insure full depth bonding.
   6. Allow 15 minutes curing time following joint assembly prior to moving or handling jointed pipe.
   7. Install slip and/or barbed fittings for drip system components per manufacturer's specifications.

3.05 BACKFILLING

A. The Contractor shall completely fill trench with native material free of stones and other debris greater than 1 inch in diameter. In all turf areas, shrub beds and other planting areas backfill material shall conform to the specified soil mix to the depths indicated in Division 2 requirements for soil preparation. The Contractor must fill all voids and tamp thoroughly in compacted layers of 6 inches at a time. The Contractor shall place and compact soil to eliminate settling of final trench grades. The Contractor shall backfill trenches only after main and lateral line inspection and testing and after receiving written approval from Owner's Representative. The Contractor shall notify the Owner's Representative a minimum of 24 hours in advance when requesting inspection.

3.06 DRAIN VALVE INSTALLATION

A. Install one manual drain valve at discharge side of each remote control valve and at all low points in main line pipe to allow for complete drainage of all main lines.

B. Install drain valves as shown on drawings.

3.07 VALVE INSTALLATION

A. Install as shown on drawings.

B. Install specified quick coupling valve, in specified box, at point of connection, and as shown and noted on plans.

C. Valve and valve box locations shall be located in a manner so as not to interrupt plant massing or groups, hedge lines, or otherwise alter the character of the proposed plantings.
   1. Place valves and valve boxes in low growing ground cover areas offset from adjacent paving by a minimum of 2 times the specified ground cover spacing.
   2. In public areas where valves or valve boxes may be readily visible to the public, verify their location with Owner's Representative prior to installation.

3.08 CONTROLLER INSTALLATION

A. Install controller in accordance with manufacturer's specifications, and respective State and Local codes. Install at location as shown on drawings. Notify Owner's Representative prior to installation, of conflicts or complications with specified controller locations.

B. Provide grounding and lightning protection for all controllers per manufacturer's specifications.

3.09 ELECTRICAL WIRING INSTALLATION

A. Run all 24-volt direct burial service wires for remote valves in electrical conduit from the bottom of the controller to the outside of the structure, per State and Local codes.

B. Run all service wire through sleeves under all paving and at 15 foot intervals, bundle together all 24-VAC wiring using standard electrical wire ties, i.e., TYTON No. T-50-R Nylon, one-piece molded, self-locking tie, 1/4 inch (nominal width). It is not required to secure wiring to the main line. Lay "bundled" wiring close to and alongside the PVC main line (or lateral) to remove the damage hazards from backfill and maintenance operations.

C. A spare (black) wire shall be run from the controller past farthest remote control valve(s) in the field, but not connected at inside of valve box. At controller and at each remote control valve, provide as a minimum an 18 inches loop in the spare wire, and label "Spare Wire".

D. Tracer wire or tape shall be installed along the top of all main lines and specified pipes of nonmetallic composition. Tape to piping at 20 foot intervals with standard black 3/4 inch electrical tape.

E. Install all wire in accordance with manufacturer's specifications with a minimum of 18-inches of wire looped inside the valve box at each remote control valve and at the controller.

F. All wire splicing shall occur only within valve or junction boxes. Splices shall be made waterproof by following manufacturer's instructions for wire connectors and sealant.

3.10 GROUNDING

A. All controllers and other devices requiring grounding shall be grounded in accordance with manufacturer’s specification.

3.11 SPRINKLER INSTALLATION

A. Install in accordance with manufacturer's specifications.

B. Install all sprinklers on flexible risers, using flexible polyethylene pipe or PVC swing joints.

C. Sprinklers located on slopes which are less than three percent shall be installed plumb. Those that are located on slopes greater than three percent shall be installed at an angle midway between plumb and perpendicular to the slope.

3.12 SYSTEM FLUSHING

A. After piping, risers, and valves are installed, but prior to installing sprinkler heads, thoroughly flush piping system under full water head.

B. Maintain flushing for five minutes or until water flows clearly.

C. Cap risers immediately after flushing.

3.13 PRESSURE TESTING

A. Conduct test in presence of Owner’s Representative.

B. Test shall be conducted with backflow prevention, quick couplers, control valves and manual drains in place and prior to backfilling. Laterals will be visually inspected for proper solvent welds and leaks prior to backfilling but no pressure test will be required.

C. Piping must not lose more than 4 psi after 60 minutes at 125 psi.

D. Correct defects and retest until Owner's Representative approves entire system.

E. Notify Owner's Representative a minimum of 48 hours in advance when requesting inspection of pressure test.

3.14 SYSTEM PROGRAMMING

A. Calculate three irrigation programs: Spring / Early Summer, Summer, Late Summer/ Fall. System operation requirements shall be based on annual precipitation rates, plant material maturation requirements, solar exposure, and topography and soil conditions.

B. Submit seasonal controller operation program with as-built record drawings and include laminated copy of program at controller location in controller cabinet. Include total application quantities in inches per week for all zones, for establishment period and normal system operation.

3.15 FINAL INSPECTION

A. Thoroughly clean, adjust and balance the installed irrigation system. Adjust spray pattern of nozzles to reduce throw of water onto buildings, structures, vehicles, and paved surfaces. Monitor and re-adjust system operation until components operate continually as specified.

B. The Contractor shall operate the system in the presence of the Owner's Representative to demonstrate satisfactory performance and coverage. The Contractor shall give the Owner's Representative a minimum of 48 hours advance notice when requesting final inspection.

C. The Contractor shall demonstrate complete operation of the system, including controller-operating program, start-up and winterizing procedures, and deliver all supplemental equipment to the Owner's designated operating personnel.

3.16 MAINTENANCE

A. The Contractor shall provide a minimum one-year maintenance period unless otherwise specified in the contract documents. The maintenance period shall start on the day following the date of written acceptance of system installation by the Owner's Representative.

B. After two weeks of operation, flush lines and remove particulates from system. Adjust and clean all filters and/or screens bi-monthly.

C. Review site conditions and plant vitality on a monthly basis and adjust watering schedule and components as necessary to maintain plant health.

D. Run through controller and verify time settings, upon each inspection.

E. Perform seasonal winterization and system start-up. Demonstrate start-up and winterizing procedures to operating personnel.

F. Repair and adjust system throughout warranty period, and prior to turning maintenance schedule over to Owner's operating personnel.

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SECTION 32 91 13

SOIL PREPARATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following:
   1. The work covered in this section consists of furnishing all labor, materials and equipment for testing, preparation, and placement of topsoil and compost as indicated by the drawings and as specified.
   2. Coordinate placement of topsoil and required soil amendments with the establishment of rough grades.
   3. Coordinate depths of soil amendments and topsoil with grading specifications for rough and finish grades.
   4. All rough grading operations shall be completed as required by these specifications. Topsoil placement or backfilling in areas to be landscaped shall not occur until the Owner's Representative has issued written approval of the rough grade and topsoil.

B. Related Sections include but are not limited to the following:
   1. Section 01 56 39; Temporary Tree and Plant Protection
   2. Section 32 84 00; Planting Irrigation
   3. Section 32 92 00; Turf and Grasses
   4. Section 32 93 00; Plants

1.03 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

H. Finish Grade: Elevation of finished surface of planting soil.

I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

K. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

L. Planting Area: Areas to be planted.

M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

R. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

S. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

T. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

1.04 SUBMITTALS

A. At least 20 working days prior to use on site the Contractor shall submit the following information to the Owner's Representative.
   1. Certified analysis of compost mixture components required by these specifications.
      a. Compost Analysis: Furnish analysis by a qualified testing laboratory stating pH range, moisture content, particle size (sieve analysis), soluble salt content, and percentage of inert materials.
   2. Certified analysis of Planting soil (blended soil/compost mix)
   3. Certified analysis of on-site or imported topsoil required by these specifications.
      a. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
      b. Report suitability of tested soil for plant growth.
      c. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      d. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action
      e. Available Testing Laboratories:
         1) Soil and Plant Laboratory, Inc. – www.soilandplantlaboratory.com
         2) Western Agricultural Laboratories – www.al-labs-west.com
   4. Where any tests show results failing to conform to the required standards the Contractor shall include with the testing report a recommended treatment plan to bring the material into conformance.

1.05 QUALITY ASSURANCE

A. Soil Preparation - All soil preparation work shall be done under the supervision of a Contractor having experience in landscape construction. All work shall be done in accordance with proper horticultural practices.

B. Herbicide Application - Applications of herbicide for weed control, as required, shall be made only by an applicator currently licensed under State and Federal law.

C. The Contractor shall store fertilizer and other required materials in a dry place and free from the intrusion of moisture.

D. Soil/Compost Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

1.06 PROJECT CONDITIONS

A. Prior to the work of this section all rough graded surfaces shall be free of:
   1. Concrete, asphalt, and other construction debris;
   2. Limbs, twigs, cones, seed-pods and other woody material; and
   3. Rock, gravel or other material not suitable for plant growth.

B. In all plant bed areas, the sub-grade shall be free of unsuitable material such as stumps, roots, rocks, concrete, asphalt, or metals, for a minimum depth of 24 inches and in all lawn or seeded areas the sub-grade shall be free of unsuitable material for a minimum depth of 12 inches.

C. The Contractor shall provide protective covers and barriers as necessary to prevent damage and staining to all site improvements.

D. The Contractor shall prepare topsoil only when weather and soil conditions allow. Do not attempt soil preparation work when weather or soil conditions would contribute to poor or improper mixing, voids, or other adverse conditions.

E. The Contractor shall take all reasonable precautions to prevent runoff of topsoil and fertilizers from leaving site or entering storm systems, or any waterway.

1.07 SEQUENCING AND SCHEDULE

A. Coordinate soil preparation work with installation of other site improvements and planting of trees, shrubs, ground covers, lawns and other seeded areas.

PART 2 PRODUCTS

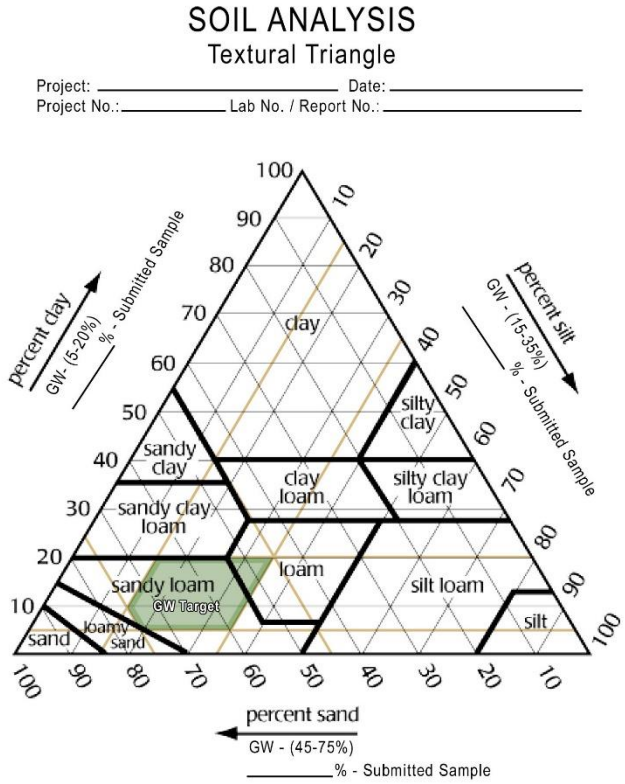
2.01 PLANTING SOILS GENERAL

A. Planting Soil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
   1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
   2. Weight of Lime per 1000 Sq. Ft.: As indicated by soils report
   3. Weight of Agricultural Gypsum per 1000 Sq. Ft.: As indicated by soils report
   4. Weight of Bonemeal per 1000 Sq. Ft.: As indicated by soils report
   5. 5. Weight of Superphosphate per 1000 Sq. Ft.: As indicated by soils report
   6. 6. Weight of Commercial Fertilizer per 1000 Sq. Ft.: As indicated by soils report
   7. 7. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.: As indicated by soils report

8. Topsoil Soil Textural Class Requirements: Topsoil textural analysis shall fall within the following gradations:

Textural Class	% of Total Weight	Average %
Sand (0.05-2.0 mm dia.)	45-75	60
Silt (0.002-0.0 mm dia.)	15-35	25
Clay (less than 0.002 mm dia.)	05-20	15

B. Imported Planting Soil: Imported topsoil or manufactured topsoil from off-site sources combined with soil amendments to produce acceptable planting soil.



1. Obtain topsoil from acceptable clean sources. The contractor shall determine the volume of soil. When that has been used up, provide balance necessary to complete the project from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

C. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of weeds and invasive plants including but not limited to:

1. Cirsium arvense (Canadian Thistle)
2. Convolvulus spp. (Morning Glory)
3. Cytisus scoparus (Scotch Broom)

4. Dipsacus sylvestris (Common Teasel)
5. Festuca arundinaceae (Tall Fescue)
6. Hedera helix (English Ivy)
7. Holcus canatus (Velvet Grass)
8. Lolium spp. (Rye Grasses)
9. Lotus corniculatus (Bird's Foot Trefoil)
10. Lythrium salicaria (Purple Loose Strife)
11. Melilotus spp. (Sweet Clover)
12. Myriophyllum spicatum (Eurasian Milfoil)
13. Phalaris arundinaceae (Reed Canary Grass)
14. Rubus discolor (Himalayan Blackberry)
15. Solanum spp. (Nightshade)
16. Trifolium spp. (Clovers), and
17. Not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.02 INORGANIC SOIL AMENDMENTS

A. General: Provide the following appropriate amendments as indicated by the soil testing lab after their analysis.

B. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   1. Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

C. Perlite: Horticultural perlite, soil amendment grade.

D. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

E. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.03 COMPOST

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inchsieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.04 FERTILIZERS

A. General: Provide the following appropriate amendments as indicated by the soil testing lab after their analysis.

B. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.

C. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

D. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in composition to remedy deficiencies identified in soil tests.

E. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the composition to remedy deficiencies identified in soil tests.

F. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
   1. Size: 10-gram tablets.
   2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.05 PRE-EMERGENT HERBICIDE

A. Pre-emergent herbicide shall be as directed for condition by currently licensed herbicide applicator.

2.06 POST-EMERGENT HERBICIDE

A. Post-emergent herbicide shall be as directed for condition by currently licensed herbicide applicator.

2.07 WATER

A. Water shall be suitable for irrigation, free from oil, acid, alkali, salt or other substances harmful to plant life.

PART 3 EXECUTION

3.01 EXAMINATION

A. The Contractor shall examine the entire site for conditions that will adversely affect execution, permanence and quality of work, and survival of plant materials. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Rough Grading Inspection - Contractor shall notify Owner's Representative a minimum of 72 hours in advance for inspection of rough grades.

C. The Contractor shall verify that rough grades and slopes of areas to be planted areas are set at sufficient depth to allow for placement of specified materials. If the site is not suitable for landscaping operations, the Contractor shall perform necessary corrective work.

3.02 GENERAL PREPARATION OF GROUND SURFACES – ALL PLANTING OR SEEDING AREAS

A. The Contractor shall eliminate uneven areas and low spots, remove lumber, stones, sticks, mortar, concrete, rubbish, debris, contaminated soil and any other material harmful to plant life, in shrub and ground cover beds.

B. The Contractor shall verify that invasive species and weeds have been eliminated prior to the placement of planting soil. The Contractor must not place planting soil until all living weed matter has been eliminated.

C. Weed eradication shall include herbicide and non-herbicide methods. Eradication shall include and is not limited to elimination of the following invasive species and weeds;

Cirsium arvense (Canadian Thistle)

Convolvulus spp. (Morning Glory)

Cytisus scoparus (Scotch Broom)

Dipsacus sylvestris (Common Teasel)

Festuca arundinaceae (Tall Fescue)

Hedera helix (English Ivy)

Holcus canatus (Velvet Grass)

Lolium spp. (Rye Grasses)

Lotus corniculatus (Bird's Foot Trefoil)

Lythrium salicaria (Purple Loose Strife)

Melilotus spp. (Sweet Clover)

Myriophyllum spicatum (Eurasian Milfoil)

Phalaris arundinaceae (Reed Canary Grass)

Rubus discolor (Himalayan Blackberry)

Solanum spp. (Nightshade)

Trifolium spp. (Clovers)

1. Herbicide application shall be by manual 'spot spraying', wicking, or backpack methods per manufacturer's specifications.
2. Herbicide application shall be as directed by a currently licensed applicator and shall be strictly applied by manufacturer's specifications, and applicable codes and regulations.
3. Remove invasive plant material after herbicide application has effectively stopped plant growth. Dispose legally off-site.
4. After initial spraying and removal of weeds, and prior to placing topsoil, the contractor shall water the subgrade sufficiently to germinate dormant weed seeds.
    a. Prior to this weed crop producing seeds, the contractor shall spray these weeds with herbicide and remove them from the site.

b. Before continuing with topsoil placement the contractor shall verify with the Owner's Representative whether or not to repeat this treatment.

5. Selective hand removal by non-herbicide methods shall be utilized if herbicide application threatens existing plantings.
6. Existing or new plantings damaged or killed by herbicide application shall be replaced immediately at no additional cost to the Owner.

3.03 PLACING PLANTING SOILS - GENERAL

A. Planting soils shall be placed in minimum depths of 12 inches in planting beds, and 6 inches in seeded lawn, restoration (including wetland and willow scrub) and meadow grass areas.

B. Planting soil shall be placed at specified grades between any existing or constructed points on the site, such as curbs, walls, walks and paving.

3.04 SOIL PREPARATION IN PLANTING BEDS

A. Scarify subgrade to a depth of 12" prior to placement of Planting soil. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer.
   2. Spread planting soil mix to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread approximately one-half the thickness of planting soil mix over the scarified subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil mix.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades after natural settlement.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.05 SOIL PREPARATION IN LAWN, RESTORATION AND SEEDED AREAS

A. Limit subgrade preparation to areas to be planted within a few days.

B. Newly Graded Subgrades: Till and loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
      a. Delay mixing fertilizer with planting soil if seeding and restoration will not proceed in a few days.
      b. Mix lime with dry soil before mixing fertilizer.
   2. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 3 inches of subgrade. Spread remainder of planting soil mix
      b. Reduce elevation of planting soil to allow for soil thickness of sod.
   3. Regrade and float to finish grade, adding planting soil as needed to match proposed grades. Eliminate washing and puddling. Slope to drain water away from all structures.
   4. Perform soil work no more than two weeks prior to sowing seed.
   5. Install 2 inches of certified compost uniformly over entire Restoration areas and seed directly onto surface of compost.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within +- 1/2 inch of finish elevation. Roll, rake, remove ridges, and fill depressions to meet finish grades. Limit grading to areas to be planted in the immediate future.

D. Moisten prepared seeded areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.06 CLEANUP

A. Keep project site free from accumulation of debris, topsoil, and other material.

B. At completion of each area, completely remove debris, equipment and surplus materials.

C. Any paved area or surfaces stained or soiled from landscaping materials shall be cleaned with a power sweeper using water under pressure. Building surfaces shall be washed with proper equipment and materials as approved by the Owner’s Representative.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Work consists of providing all labor, material and equipment for installing and establishing Lawn Turf Sod, Lawn Seed, and other special Seed mixes as indicated.
   1. Plant and establish seed mixture(s) in areas shown on drawings.

B. Related Requirements:
   1. Section 32 84 00 "Planting Irrigation" for irrigation components.
   2. Section 32 91 13 "Soil Preparation" for planting soil mixes including amendments.
   3. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.
   4. Section 32 93 10 "Landscape Maintenance" for maintenance of turf and grasses.

1.03 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" and drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Herbicides: Product label and manufacturer's application instructions specific to Project.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment..
   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's personnel assigned to the Work shall have certification in one of the following categories from the National Association of Landscape Professionals:
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Lawn Care Manager.
      c. Landscape Industry Certified Lawn Care Technician.
   5. Pesticide Applicator: State licensed, commercial.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk materials with appropriate certificates.

1.09 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 PRODUCTS

2.01 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition:
      a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
      b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition:.
      a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
      b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.02 MULCHES

A. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

2.03 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.04 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 4-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner's Representative and replace with new planting soil.

3.02 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
   2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate

3.06 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
   1. Soil Amendment(s): according to requirements of Section 329113 "Soil Preparation."
   2. Initial Fertilizer: Slow-release fertilizer applied according to manufacturer's recommendations.

J. Apply seed and protect with straw mulch as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.07 SEEDED AREAS ESTABLISHMENT

A. General: Maintain and establish seeded areas by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf or seeded areas. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and seeded areas damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep seeded areas and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
4. Depending on installation timing, provide a single fall mowing to a height of 4 to 6 inches if Landscape Installer's maintenance last to the fall season.

B. Watering: Install and maintain permanent and temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

C. Water seeded areas with fine spray at a rate appropriate to develop and maintain a healthy stand of seeded areas

3.08 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Owner's Representative:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.09 HERBICIDE APPLICATION

A. Apply herbicides according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 MAINTENANCE SERVICE

A. Turf Maintenance Service: According to Section 329310 "Landscape Maintenance."

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Plants.
   2. Fertilizers.
   3. Herbicides.
   4. Mulch.
   5. Tree stabilization.
   6. Landscape edgings.

B. Related Requirements:
   1. Section 01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
   2. Section 31 10 00 "Site Clearing" for clearing and preparation of plant beds prior to planting.
   3. Section 31 10 70 "Erosion Control" for temporary erosion control measures related to plant installation.
   4. Section 32 84 00 "Planting Irrigation" for installation of irrigation equipment around trees and shrubs.
   5. Section 32 91 13 "Soil Preparation" for preparation of plant bed soil prior to or during planting.
   6. Section 32 92 00 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
   7. Section 32 93 10 "Landscape Maintenance" for plant maintenance after installation.

1.03 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants established in the ground and dug with firm, natural balls of earth in which they were grown and wrapped with burlap and twine.

C. Balled and Potted Stock: Plants established in the ground dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container.

D. Bare-Root Stock: Plants established in the ground that are dug and delivered with soil or growing medium removed from its roots.

E. Branch: An outgrowing shoot, stem or twig that grows from the main stem or trunk.

F. Caliper: The measurement of a nursery stock tree as determined in the latest edition of the ANSI Z60.1.

G. Container-Grown Stock: Plants established above ground grown in a removable tub or pot container filled with growing medium.

H. Crown: The portion of a tree consisting of leaves and branches.

I. Defective Plant: Any plant that fails to meet the plant quality requirements of this Section.

J. Fabric Bag-Grown Stock: Plant grown within a fabric bag in-ground to manipulate root growth to develop a fibrous root system within the bag. Fabric bags may be used above ground as a container.

K. Finish Grade: Elevation of finished surface of planting soil.

L. Healthy: Description of quality related to living plants that are growing in a condition that expresses their leaf size, crown density, color and annual growth rates typical of their horticultural description in the region.

M. Included Bark: Ingrown bark tissues that develop where two or more stems grow closely together creating weak stem connections prone to breaking.

N. Kinked Root: A root within the root package that bends more than 90 degrees.

O. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

P. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

Q. Plug: Seeding or rooted cuttings grown in a cylinder of planting medium at a nursery. Sometimes referred to as a "tubeling."

R. Planting Area: Areas to be planted with any combination of groundcovers, shrubs, trees and installed with mulch.

S. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation" for drawing designations for planting soils.

T. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, plugs, tubelings, groundcovers, ornamental grasses, bulbs, corms, tubers, or any herbaceous vegetation.

U. Root Crown; Root Flare; Root Collar; Trunk Flare: The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots and "flares" away from the tree's trunk; the area of transition between the root system and the stem or trunk.

V. Root Ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.

W. Shrub: Wood plants with mature height approximately less than 15 feet.

X. Stem: Structure and support of a plant connecting the roots and leaves; may be woody or herbaceous.

Y. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

Z. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

AA. Tree: Single and multi-stemmed plants with mature height approximately greater than 15 feet.

BB. Trunk: Portion of woody stem or stems of a tree between the roots and the canopy.

CC. Vine: Woody or herbaceous climbing plant material.

DD. Whip: A young tree without branches

1.04 COORDINATION

A. Coordination with Turf (Lawns) and Seeded Areas: Plant trees, shrubs, and other plants after finish grades are established and before planting turf and seeded areas unless otherwise indicated.
   1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.
   2. Coordinate planting installation with planting soil installation according to Section 32 91 13 "Soil Preparation."

1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials. Invoices to be provided a maximum of one month after authorization to proceed. Copies must indicate source of supply by name, address, and phone number.

2. Product Data: For each type of product indicated.

B. Samples for Verification: For each of the following:
   1. Bark and Compost Mulch: 1-quart Insert value volume of each mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
   2. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Inspection Certificates: For plant materials furnished. Provide to Owner's Representative inspection certificates required by law for each shipment of plant materials.

C. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   1. Manufacturer's certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

D. Herbicides: Product label and manufacturer's application instructions specific to Project.

E. Sample Warranty: For special warranty.

1.08 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   2. Experience: Five years' experience in landscape installation.
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Pesticide (Herbicide) Applicator: State licensed, commercial.
   5. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
      a. Landscape Industry Certified Technician - Exterior.

b. Landscape Industry Certified Horticultural Technician.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
   1. Selection of plants purchased under allowances is made by Owner's Representative, who tags plants at their place of growth before they are prepared for transplanting.

C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
   1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
   2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

D. Plant Material Observation: Owner's Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Owner's Representative may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
   1. Notify Owner's Representative of sources of planting materials fourteen days in advance of delivery to site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Store fertilizers in a dry place and protect from moisture.
   3. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   4. Accompany each delivery of bulk materials with appropriate certificates.

B. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

H. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist. Plant materials showing damage from shipping, storage or handling will be rejected and shall be replaced at the Contractor's expense.
   1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
   2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   3. Do not remove container-grown stock from containers before time of planting.
   4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. West of Cascade Mountains: September 1 through May 15.
   2. Plants with Automatic Irrigation: Installed outside the above planting periods only with prior written approval from Owner's Representative.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.

b. Visual presence of plant diseases or insect infestations.
c. Structural failures including plantings falling or blowing over.
d. Faulty performance of tree stabilization or edgings.
e. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.
   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
   b. Groundcovers, Biennials, Perennials, and Other Plants: 12 months.
   c. Annuals: Three months.
3. General: The warranty period for plantings will include the healthy survival of 100 percent of the trees; the healthy survival of 100 percent of shrubs, ornamental grasses, and vines; and the healthy survival of 100 percent of groundcovers, plugs, perennials and biennials.
4. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that do not meet the minimum healthy survival percentage requirements at end of warranty period.
   c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.
5. Warranty Guarantee: A financial instrument as a warranty guarantee in the amount of 100 percent of the contract amount (including all labor, equipment and materials). Acceptable instruments for the warranty guarantee are as follows:
   a. A warranty guarantee incorporated with the performance guarantee.
   b. A maintenance bond.
   c. Cash deposit with Owner.
6. Warranty Exemptions: After Substantial Completion acceptance and during the warranty period, incidents that exempt replacement include: plants removed by others, plants that are lost or damaged, plants impacted due to occupancy of project, plants lost or damaged by a third party, plants lost due to vandalism, or any natural disaster impacting plants.
7. Warranty Period Closure: During and by the end of the warranty period, remove all tree wraps, ties and guying. All trees that lack sufficient caliper to remain upright or those requiring further anchoring are to remain staked as approved by the Owner’s Representative.
8. End of Warranty and Final Acceptance: Upon written request prior to the end of the warranty period date, the Owner’s Representative will observe all warranted Work for final acceptance.

1.13 SUBSTITUTION REQUESTS

A. Size and species of plants that cannot be obtained due to lack of availability can be requested to be substituted. Submit all requests to Owner's Representative with a list of plant sizes, species, and nursery contact information for approval prior to issuing a formal submittal.

PART 2 PRODUCTS

2.01 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated on Drawings.
   1. All plant materials furnished, including root ball dimensions or container size to trunk caliper ratio, shall comply with ANSI Z60.1 where applicable.
   2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
   3. Provide plants of sizes, grades, and ball or container sizes for types and form of plants. Plants of a larger size may be used if acceptable to Owner's Representative, with a proportionate increase in size of roots or balls.
   4. Compliance: All plant materials shall comply with state and Federal laws and regulations for plant diseases, pests, and weeds.
   5. Cold storage plants are not permitted.

B. Plant Quality: Furnish plants with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, conks, pests, eggs, larvae, and defects such as knots, gals, lesions, sun scald, injuries, abrasions, wood cracks, sap leakage, flush pruning cuts, and disfigurement.
   1. Trees: Relatively straight, vertical trunk typical of species, capable of standing upright without supplemental staking, and with a single central leader. Crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable conditions.
   2. Graft Unions: Unions, where applicable, are completely closed, without signs of rejection, healed, and visible above the root ball soil line.
   3. Root-Ball Quality: Measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting. Root balls with roots favoring one side of the ball or with kinked roots are subject to be rejected.
   4. Crown: Form and density typical of species, its stage of growth, and time of year.
   5. Leaves: Size, color and appearance typical of species, its stage of growth, and time of year and be absent of wilted, shriveled, or dead leaves.
   6. Branches: Even distribution of shoot growth throughout the crown typical of species, time of year, and absent of dead, diseased, broken, distorted or injured stems.
   7. Trunk: crooked trunks with wounds, conks, cracks, lesions, or inadequate pruning scars; Relatively straight, vertical typical of species and free of wounds that penetrate to the wood, sunburned areas, conks, wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties or lesions.

C. Balled and Burlapped Plants: Furnish field grown plants dug with firm, natural ball of earth in which they were grown in complying with ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine and optionally accompanied with a wire basket. Root flare to be visible at the surface of the ball as recommended by ANSI Z60.1. Burlap and twine materials to be natural and fully biodegradable.

D. Container Plants: Furnish healthy, vigorous, well-rooted plants grown in a removable and recyclable container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container but not root bound. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

E. Bare-Root Plants: Furnish plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required. Plants to be harvested while fully dormant and a minimum of 4 weeks before leaf out.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Labeling: Label each individual tree and at least one plant of each variety and size for all other plant types with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

H. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

2.02 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots. Fertilizers to meet 0-F-241D, “Federal Specification, Fertilizer, Mixed, Commercial.”
   1. Size: 10-gram tablets.
   2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.03 MULCHES

A. Bark Mulch: Commercially produced, free from deleterious materials, sawdust, wood shavings, and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   1. Type: Ground or shredded bark hemlock.
   2. Size Range: 5/8 inch minus, fine texture Insert dimensions.
   3. Color: Natural.

B. Ornamental Rock Mulch:
   1. Washed river rock
   2. Size: 1/2” to 3/4” diameter, smooth, rounded.
   3. Color: gray when dry, dark gray/black when wet.

2.04 HERBICIDES

A. General: Herbicide registered and approved by the EPA and state of Oregon, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted herbicides unless authorized in writing by authorities having jurisdiction. Use of neonicotinoids class of pesticides are prohibited.

B. Pre-Emergent Herbicide (Selective and Nonselective): Registered and approved by the EPA and state of Oregon. Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Registered and approved by the EPA and state of Oregon. Effective for controlling weed growth that has already germinated.

2.05 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:
   1. Tree Stakes: Straight, square or round, rough-sawn, sound, new softwood with specified wood pressure-preservative treatment, free of knots, holes, cross grain, and other defects, nominal wood sizes and length indicated on Drawings, pointed on below grade end.
   2. Tree Ties: UV resistant, flat, broad, flexible and nonabrasive material.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Wide, flexible, adjustable, nonabrasive, with appropriate slack for trunk movement and lengths required to reach tree stakes.
            a) V.I.T. Products, Inc.; "Cinch-Tie."
            b) Villa Root Barrier, Villa Rubber Tree Tie.
            c) Webbing tie; 3/4-inch wide, soft woven polypropylene fabric with a 900-pound break strength; green or beige in color; new or reclaimed material.
            d) Approved equal.

2.06 MISCELLANEOUS PRODUCTS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

C. Biochar: Commercially available soil amendment, high carbon fine-grained residue charcoal byproduct of sustainably sourced biomass material via pyrolysis, suitable for plant growth and soil health.
   1. Cationic Exchange Capacity: 25 to 45 millieq/l.
   2. Carbon: 85 wt percent C.
   3. Moisture: 15 wt percent H20.

4. pH: 7.

D. Water: Suitable for planting irrigation and free from oil, acid, alkali, salt or other substances harmful to plant, animal or aquatic life.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
   3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
   5. Verify the subgrade and planting soils are at appropriate elevations and meet all quality requirements for areas receiving plants.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner's Representative and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner's Representative acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations indicated on Drawings. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

3.03 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 91 13 "Soil Preparation."

B. Placing Planting Soil: Blend planting soil in place.

C. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Application of Mycorrhizal Fungi: Broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.04 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.
   1. Excavate planting pits as shown on drawings with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
   2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
   3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
   4. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
   5. Maintain supervision of excavations during working hours.
   6. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
   7. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

C. Backfill Soil: Subsoil and topsoil removed from excavations may only be used if amended according to 32 91 13 "Soil Preparation".

D. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
   1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

E. Drainage: Notify Owner's Representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.05 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare above adjacent finish grades as indicated on Drawings.
   1. Backfill Method: Backfill around root ball with planting soil.
   2. After plant is set in hole, carefully cut and remove burlap, rope, and metal wire baskets as indicated on Drawings. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked, broken, or compromised where the plant cannot stand upright. Root balls that are cracked but not compromised shall have the burlap cut down to depth indicated on Drawings and loosely retied with twine to stabilize root ball before backfilling.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets.. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Two per plant.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare above adjacent finish grades as indicated on Drawings.
   1. Backfill Method: Backfill around root ball with planting soil.
   2. Carefully remove root ball from container without damaging root ball or plant. Loosen root mass as indicated on Drawings.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets.. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
      a. Quantity: Two per plant.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare above adjacent finish grades as indicated on Drawings.
   1. Backfill Method: Backfill around root ball with planting soil.

2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets.. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    a. Quantity: Two per plant.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare above adjacent finish grade as indicated on Drawings.
1. Backfill Method: Backfill around root ball with planting soil.
2. Spread roots without tangling or turning toward surface. Plumb before backfilling and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside soil-covered roots about 1 inch from root tips; do not place tablets in bottom of the hole or touching the roots.
    a. Quantity: Two per plant.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.06 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Owner's Representative.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Owner's Representative, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.07 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
    a. Stake trees 2-inch caliper or less with one stake; 2- through 4-inch caliper with two stakes; and 4- through 6-inch caliper with three stakes of length, penetrating below bottom of backfilled excavation and extending above grade to accept ties as indicated on Drawings. Set vertical stakes and space to avoid penetrating root balls or root masses with dimension indicated on Drawings.
    2. Support trees with bands of flexible tree ties at contact points with tree trunk. Set ties around trunk to provide a minimum two inch clearance, providing enough slack to avoid rigid restraint of tree and allowing tree to reasonably flex in wind without failing.

3.08 GROUNDCOVER AND PLANT PLANTING

A. Set out and space groundcover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
    1. Trees in Turf Areas: Apply bark mulch ring of 2-inch average thickness with 36-inch radius around trunks or stems. Do not place mulch directly onto trunks or stems of tree and maintain clear distance as indicated on Drawings.
    2. Bark Mulch in Planting Areas: Apply 2-inch average thickness of mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch directly onto trunks or stems of plants and maintain clear distance as indicated on Drawings.

3.10 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes at manufacturer’s standard spacing, driven below top elevation of edging.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices, when possible, to minimize use of herbicides and reduce hazards.

3.12 HERBICIDE APPLICATION

A. Apply herbicides according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and groundcover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 REPAIR AND REPLACEMENT

A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Owner's Representative.
   1. Submit details of proposed pruning and repairs.
   2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
   3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Owner's Representative.

B. Remove and replace dead or unhealthy plant materials as required in the "Warranty" Article before the end of the corrections period. Replace plants that are damaged during construction operations that the Owner's Representative determines are incapable of restoring to normal growth pattern.
   1. Provide new trees of same size as those being replaced for each tree of 6 inches or smaller in caliper size.
   2. Provide one new tree(s) of 6-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.
   3. Species of Replacement Trees: Same species being replaced.

3.14 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.15 MAINTENANCE SERVICE

A. Maintenance Service for Trees and Shrubs: According to Section 32 93 10 "Landscape Maintenance."

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SECTION 32 93 10

LANDSCAPE MAINTENANCE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes maintenance of installed landscape areas including but not limited to plants, turf, seeded areas, and planting irrigation systems.

B. Related Requirements:
   1. Section 32 84 00 "Planting Irrigation" for irrigation components.
   2. Section 32 91 13 "Soil Preparation" for planting soil mixes including amendments.
   3. Section 32 92 00 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.
   4. Section 32 93 00 "Plants" for trees, shrubs, groundcovers, and other plant materials.

1.03 DEFINITIONS

A. ISA: International Society of Arboriculture.

B. Herbicide: A type of pesticide that kill weeds and other unwanted plants.

C. Pesticide: Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest which includes herbicides.

D. Planting Area: Areas planted with any combination of groundcovers, shrubs, trees, and mulch, including turf and seeded areas.

1.04 LANDSCAPE MAINTENANCE SERVICE

A. Plant Maintenance Period: Services provided during the year, spread out from late winter through fall. The maintenance period shall start on the date of written acceptance of installation.
   1. Plant Beds (Ornamental): Provide a one-year maintenance period a minimum of three times a year.

B. Turf and Seeding Maintenance Period: Provide a one-year maintenance period a minimum of three times a year. The maintenance period shall start on the date of written acceptance of installation.

C. Irrigation Maintenance Period: Provide a one-year maintenance period a minimum of three times a year. The maintenance period shall start on the date of written acceptance of installation.

1.05 ACTION SUBMITTALS

A. Maintenance Work Plan: Written work plans, scaled plans, and related documents necessary to indicate understanding of areas to be maintained and services to be provided.
   1. Schedule: At the beginning of each year, by January 15, submit a complete yearly schedule of maintenance operations indicating timing of scheduled visits and services outlined.
   2. Weed Eradication Program: Identify methods of weed eradication. If herbicides are approved for use in weed eradication, identify areas on site anticipated for application in writing with diagrams or pictures as necessary to identify limits of application. Submit herbicide manufacturer product sheets, application rates, and schedule of application. Provide copies of manufacturer's federal registered label and material safety data sheet.
   3. Pruning Services: Indicate methods of pruning to be employed, including understanding of acceptable pruning practices in accordance with this Section.
   4. Water Source: Identify potential source(s) or water for supplemental irrigation.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and personnel.

B. Pesticide Applicator License: Commercial Pesticide Applicator's License held in the individual's name and license number. Submit a certification each time a new applicator works on project.

C. Log of maintenance date with activities performed after each visit.

D. Annual Summary: At the end of each year, by December 1, submit a written summary of the maintenance activities conducted during year including:
   1. Record of irrigation winterization and startup.
   2. Irrigation schedule, repairs, and adjustments.
   3. Herbicides applied, if any, including types and applications.
   4. Water level conditions of planting areas.
   5. Repair, replacement, or restoration activities.
   6. Any conditions addressed outside of the scheduled maintenance tasks outlined this Section.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer, including personnel assigned to the Work.
   1. Experience: Five years' experience in landscape maintenance in commercial or public settings of similar scope, size, and duration.
   2. Personnel Certifications: According to Section 32 93 00 "Plants."
   3. Licensed Landscape Contractor in the State of Oregon.

B. All Work performed shall be done in manner that maintains the original integrity of the landscape design.

1.08 DELIVERY, STORAGE, AND HANDLING

A. According to 32 93 00 "Plants", 32 84 00 "Planting Irrigation" and 32 92 00 "Turf and Grasses".

1.09 FIELD CONDITIONS

A. Weather Limitations: Proceed with maintenance only when existing and forecasted weather conditions permit maintenance to be performed and when beneficial and optimum results may be obtained. Do not conduct any portion of the Work in planting areas if existing soil is saturated or has the potential to become compacted.

B. Plant and Seed Restrictions: Plants and seed may be replaced and installed outside of the planting restriction window and may require supplemental care for establishment.
   1. Adhere to additional requirements according to 32 93 00 "Plants", 32 84 00 "Planting Irrigation" and 32 92 00 "Turf and Grasses".

1.10 WARRANTY

A. Plants: Warranty for replaced plants shall begin at date of installation and match duration according to Section 32 93 00 "Plants."

B. Planting Irrigation: Warranty for replaced irrigation parts shall begin at date of installation and match duration according to Section 32 84 00 "Irrigation."

PART 2 PRODUCTS

2.01 GENERAL

A. All products provided as part of this Section, including replacement products, shall conform to the requirements of Section 32 93 00 "Plants", 32 91 13 "Soil Preparation", 32 84 00 "Planting Irrigation" and, 32 84 00 "Turf and Grasses".

2.02 FERTILIZERS

A. Fertilizer: Slow-release dry granular cottonseed meal or approved equal.
   1. Nutrient Composition: 6 percent nitrogen, 2 percent phosphorous, and 2 percent potassium, by weight plus micronutrients, or approved alternative composition.

PART 3 EXECUTION

3.01 DEBRIS

A. Trash Removal: Prior to commencing any other maintenance task, collect trash, litter, and other debris from planting areas.

B. Leaf Litter Removal: Rake and remove all leaf litter from site. Do not disturb plant beds or damage plants during leaf litter removal.

C. Sweep pedestrian walkways to maintain clean and safe walking surfaces. Remove accumulated clippings and plant debris from walkways and entrances. Clean all paved surfaces soiled by landscape maintenance operations.

D. Dispose of all trash, debris, and plant waste legally offsite.

3.02 PLANTING AREAS

A. General: Provide temporary fencing, flags, signage, or other measures as necessary to protect planting areas during establishment.

3.03 PLANT MAINTENANCE

A. General: Maintain plants by pruning, watering, weeding, fertilizing, mulching, restoring plant saucers, and performing other operations as required to establish healthy, viable plantings. Replace all damaged, dead, dying plants covered during warranty period within 30 days of initial identification of condition.

B. Pruning: Design and installation of planting beds including individual plant spacing within beds assumes future plant growth and is planted to achieve a specific design intent. Provide standard professional horticultural and arboricultural practices for pruning techniques, as documented by ISA. Do not excessively prune, top, shear, or otherwise shape plants, and only prune to enhance natural plant form. Conduct major corrective or rejuvenation pruning only during the dormant season, unless otherwise specified. Improper pruning of plants, including harm to plant natural form, will require replacement and installation at cost to Contractor.
   1. Tree Pruning: Performed by qualified personnel and conducted in accordance with the American National Standard (ANSI) A300 "Part 1 - Pruning Standard" and ANSI Z133 "Arboricultural Operations - Safety Requirements."
      a. Remove only dead, dying, crossed limbs, or broken branches.
      b. Do not apply pruning paint to wounds.
      c. Identify hazardous tree limbs of existing trees, if present, to Owner's Representative.
   2. Shrub and Groundcover Pruning:
      a. Prune only dead, dying stems, including those causing visual obstructions, and conflicts with structures and walkways.
      b. Rejuvenation Pruning: Select species of shrubs and groundcovers may be pruned close to ground to produce vigorous growth. Once a year before first sign of new growth, prune shrubs to 24 inches above grade or to first bud. Species that qualify for rejuvenation pruning are those that tolerate topping and include nootka rose, red osier dogwood, and spirea plant species.
         1) Identify shrubs and groundcovers that would benefit from rejuvenation pruning. Obtain approval from Owner's Representative prior to any proposed rejuvenation pruning.
   3. Ornamental Grass Pruning: Once a year in later winter, before sign of new growth, prune according to plant type:
      a. Warm Season Grasses: Cut back to a few inches above grade in later winter or early spring before new growth appears.

b. Cool Season Grasses: Cut back to one-third of overall plant height in late winter or early spring, before new growth appears.
c. Evergreen Grasses: Do not shear or cut back evergreen grasses. Comb plant with rake to tease out old plant material. Cut out dead or dying strands not removed from combing.

4. Perennial Pruning: Once a year in later winter or early spring, before first sign of new growth, prune perennials to three inches above grade.
5. Vine Pruning: Pruned to provide six inches clearance around any structure or walkway.

C. Tree Stabilization Materials: Inspect all tree trunks and root balls for any damage caused by tree stabilization materials. Adjust stabilization devices impacting any part of tree including trunk, branches, or roots. Adjust ties around trunk to provide a minimum two-inch clearance, providing enough slack to avoid rigid restraint of tree and allowing tree to reasonably flex in wind without failing. Adjust and repair tree-stabilization devices where encountered, resetting to proper grades or vertical position.

D. Fertilizing at Planting Beds: Apply specified organic base commercial fertilizer at manufacturer's recommended rate, two times per growing season. First application on March 15 and the final application on June 15. All fertilizer shall be washed off foliage and watered in thoroughly, if not watered by normal rainfall.

E. Weeding: Maintain clean planting beds by pulling and removing all weeds.

F. Herbicides: Spraying shall occur only by a licensed pesticide applicator with prior written approval from Owner's Representative. Apply treatments as required to keep planting areas and soils weed free. Use integrated pest management practices, when possible, to minimize use of herbicides.

G. Mulching: Replenish bark mulch as needed to maintain original installation depth. Rake mulch in early spring before applying new mulch material to break "crust" of old mulch.

H. Watering: Water all plants using the installed permanent or temporary irrigation systems, or such means as has been established prior to maintenance service regime. Additional, supplemental watering may be required for plant establishment regardless of presence of irrigation system. Verify balance of watering and adjust schedule if evidence of excess puddling or runoff is encountered, or plants indicate stress. Watering frequencies shall at a minimum match local ET rates of plant or grass species, in addition to requirements specified in "Watering Requirements" Article.

I. Protect site from erosion and siltation. Utilize approved erosion control methods as required to contain and mitigate erosion. Fill in, as necessary, soil subsidence that may occur because of settling, erosion, or rutting. Monitor runoff conditions and notify Owner's Representative of drainage, erosion, plant diseases, animal browsing, vandalism, or other related issues affecting natural area health.

3.04 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
   4. Watering: Start water application as soon as season requires. Maintain turf uniformly moist to a depth of 4 inches or to sufficient quantity and frequency to maintain good color and health. Adjust watering as required to limit surface runoff. Cease watering operations when seasonal rains provide ample water to sustain lawn health.
   5. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   6. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing at least once a week to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Utilize clean, sharp equipment that is free from bacteria, fungi, chemicals, or contaminant detrimental to turfgrass growth prior to bringing onto the site. Clean and remove turfgrass clippings from mowing operations and dispose of legally offsite.

C. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow new turf to a height of 2 to 3 inches.

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

E. Edge planting beds and turfgrass perimeters every two weeks, after establishment.

F. Apply herbicide weed control by licensed applicator sufficient to control invasive broadleaf weeds and grasses.

3.05 WATERING REQUIREMENTS

A. General: Watering requirements indicated are guidelines for planting area establishment, including areas receiving automatic irrigation or areas with no irrigation systems. Apply supplemental water as needed during extended dry or warm periods, or where irrigation system is not sufficiently irrigating plants, to maintain planting health and vigor.
   1. Trees: Water all coniferous trees and deciduous trees caliper at a frequency of once a week from the beginning of May through June and twice a week from July through October. Slowly apply water to plant roots at each watering occurrence, allowing water to infiltrate into soil. Apply sufficient water to maintain trees in good condition.
   2. Shrubs and Groundcovers: Water all container plants at frequency of once a week from the beginning of May through June and twice a week from July through October. Apply two gallons of water to plant roots per installed nursery container size number (gallon) size.
   3. Turf Areas: Apply water according to minimum ET rate of turfgrass species. Apply water according to good horticultural practice under the prevailing conditions, as required to promote a healthy stand.
   4. Seeded Areas: Apply water according to good horticultural practice under the prevailing conditions, as required to promote a healthy stand.

3.06 WEED ERADICATION

A. Weed Eradication: Shall include eradication by manual and herbicide removal methods through a weed eradication program as approved. Identify all weeds prior to removal. Planting areas shall be free of noxious weeds and invasive plants as classified by the Oregon Department of Agriculture as type "A" or "B" weeds and not limited to the following: Canada thistle, morning glory, scotch broom, common teasel, English ivy, Himalayan blackberry, velvet grass, purple loosestrife, reed canary grass, kudzu, butterfly bush, bentgrass, Italian arum, spurge laurel, yellow archangel, false brome, garlic mustard, lesser celandine, pokeweed, giant hogweed, Japanese knotweed, jointed goatgrass, tree of heaven, and tansy ragwort.

B. Herbicides: Apply herbicides according to city, county, state, and federal requirements including manufacturer's written instructions. Obtain approval and notify Owner's Representative prior to each application, including coordinating with Project operations and adjacent site uses in proximity to the Work. Herbicides in watersheds, waterway and drainage areas, or sensitive lands shall only be conducted after non-herbicide measures prove impractical and strictly applied according to all requirements.
   1. Selective manual removal of weeds shall be utilized if herbicide application threatens planting areas. All planting areas indicating damage by herbicide application shall be replaced immediately at no additional cost to the Owner.

3.07 IRRIGATION SYSTEM INSPECTION AND MAINTENANCE

A. General: Irrigate all planting areas to maintain healthy and thriving conditions.

B. After two weeks of system operation, flush lines and remove particulates from system. Adjust and clean all filters or screens twice a month.

C. Once a month, review site conditions and assess for signs of over or under watering. Inspect plant growth and vigor; adjust watering schedule, as necessary.
   1. Inspect controller for proper functioning. Verify zone timing settings at each inspection visit.
   2. Repair and adjust system throughout warranty period.

D. Perform seasonal winterization and system start-up services. Demonstrate start-up and winterization, including manual system shut off valve locations, in the presence of the Owner's Representative.
   1. Late Fall Deactivation (Winterization): Turn off irrigation system at the point of connection, flush and open all manual drain valves, backup irrigation programs and set controller to "rain" mode or unplug from power source. Unplug battery from battery controllers.
   2. Spring Activation (Startup): Flush and close drain valves opened from previous winterization, turn point of connection on, activate or power on controller with restored irrigation program, test all zones from controller, and adjust nozzles and heads. All battery-operated controllers shall have their batteries replaced once a year.
   3. Summer Monitoring: Adjust nozzles and heads. Adjust the controller program as needed.
   4. Provide a list to Owner's Representative for necessary repairs after each activation or deactivation service.

3.08 INSPECTIONS

A. During the maintenance service period, the Owner's Representative will make three inspections jointly with the Contractor at the following times:
   1. Spring, early May.
   2. Summer, mid-July.
   3. Fall, later September.

B. Depending upon the beginning of the maintenance service and duration, one of these visits will be the final inspection.

C. After each inspection, the Owner may determine based upon the specified success criteria according to "xxx" Article, that corrective Work is required. If so, the Owner will provide the Contractor with a written notice of required corrective Work.

3.09 CORRECTIVE WORK

A. Provide plant replacements of the same variety, size, and quality as originally installed, unless otherwise approved.
   1. Planting outside of planting season window allowed for corrective Work, after each periodic inspection.

B. Correct deficient items within 30 days after written notification.

3.10 CLEANING AND PROTECTION

A. According to Section 32 93 00 "Plants."

END OF SECTION

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SECTION 33 05 01

PROTECTION OF EXISTING UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes materials and procedures for protecting existing underground utilities.

1.02 RELATED WORK

A. Section 31 23 00 - Excavation and Fill

B. Section 31 23 33 - Trenching, Bedding and Backfill

PART 2 MATERIALS

2.01 REPLACEMENT IN KIND

A. Except as indicated or as specifically authorized by the Engineer, reconstruct utilities with new material of the same size, type, and quality as that removed.

2.02 CONTRACTOR SUPPLIED TEMPORARY MATERIALS

A. Supply all materials, including but not limited to, steel beams and bracing, support straps, sheeting and shoring, timbers, and all other items necessary to protect existing underground utilities.

PART 3 EXECUTION

3.01 GENERAL

A. Replace in kind street improvements, such as curbs and gutters; fences; signs; paved surfaces; etcetera, that are cut, removed, damaged, or otherwise disturbed by the construction.

B. Where utilities are parallel to or cross the pipeline trench but do not conflict with the permanent work to be constructed, follow the procedures given below and as indicated on the drawings. Notify the utility owner 48 hours in advance of the crossing construction and coordinate the construction schedule with the utility owner's requirements. For utility crossings not shown on the Drawings, refer to the instructions of the Engineer for guidance.

C. Determine the true location and depth of utilities and service connections which may be affected by or affect the work. Determine the type, material, and condition of these utilities. In order to provide sufficient lead time to resolve unforeseen conflicts, order materials and take appropriate measures to ensure that there is no delay in work. Expose utilities in advance of construction by potholing potential conflicts prior to starting excavation activities on the site.

3.02 PROCEDURES

A. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise specified. Owner will be the point of contact for work that impacts utilities owned by others on the site. Contractor shall coordinate with the Owner prior to commencing with placing protection measures or removal of any utility line or feature.

B. Cut and Plug Ends: Cut abandoned utility lines and fill with concrete slurry prior to installing cap. Dispose of the cut pipe as unsuitable material.

C. Remove and Reconstruct: Where necessary or as required by the Engineer, remove the utility and, after passage, reconstruct it with new materials. Provide temporary service for the disconnected utility.

3.03 COMPACTION

A. Utilities Protected in Place: Backfill and compact under and around the utility so that no voids are left. Where utilities are concrete encased, use the alternative construction method (sand slurry) for backfill around the utility. Coordinate with Owner to ensure that this procedure is acceptable for utilities owned by others prior to implementing.

B. Alternative Construction - Sand Slurry: Sand slurry consisting of one sack (94 pounds) of Portland cement per cubic yard of sand and sufficient moisture for workability may be required for backfill to aid in reducing compaction difficulties. Submit specific methods and procedures for the Engineer to review prior to construction.

3.04 ADJACENT PARALLEL UTILITIES

A. Protect existing parallel utilities from any disturbances and repair the lines and associated appurtenances if they are damaged in any way.

3.05 COST FOR UTILITY PROTECTION

A. All costs incurred for protection of utilities, or any costs incurred due to the presence of the lines, whether or not they lie within the new construction, shall be borne in full by the Contractor.

END OF SECTION

SECTION 33 05 19

DUCTILE IRON PIPE FOR YARD PIPING

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies ductile iron pipe, ductile fittings and gaskets.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe
ASTM C150	Portland Cement
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances

Reference	Title
AWWA C606	Grooved and Shouldered Type Joints
ISO 8179	Ductile Iron Pipes, Fittings, Accessories and their Joints — External zinc-based coating

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
• Water or other liquid	AWWA C151
• Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
• Rubber gasket	AWWA C111
• Threaded flange	AWWA C115
Fittings	
• Water or other liquid	AWWA C110/AWWA C153
• Gas	ANSI A21.14
Cement mortar lining	AWWA C104

2.02 PIPE

A. Unless otherwise specified, ductile iron pipe shall be Class 50 and have nominal laying lengths of 18 or 20 feet. For grooved-end pipe, wall thickness shall be minimum Class 53 except where the specified pressure requires heavier pipe.

2.03 GASKETS

A. Unless otherwise specified, gasket stock shall be a synthetic rubber compound in which the elastomer is nitrile or neoprene. The compound shall contain not less than 50 percent by volume nitrile or neoprene and shall be free from factice, reclaimed rubber and other deleterious substances. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints.

2.04 FITTINGS

A. Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified.

2.05 JOINTS

A. Restrained Joints:
   1. General: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.
   2. Push-On Joints: Restrained push-on joints shall be as specified in paragraph 2.05 Push-On Joints, modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Engineer.
   3. Flange Assemblies: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.
      a. Unless otherwise specified, bolts and nuts for flange assemblies shall conform with Section 40 05 06. Gaskets shall be as specified in Section 40 05 06.
   4. Mechanical Joints: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.
      a. Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

B. Ball And Socket Flexible Joint Pipe: Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

C. Bolts and Nuts: Corrosion-resistant bolts and nuts for use with ductile iron joints shall be high-strength, low-alloy steel as specified in ANSI/AWWA C111/A21.11.

2.06 PIPE COATING

A. All ductile iron pipe provided shall be factory applied zinc coated with a minimum application rate of 130 grams per square meter. The zinc layer shall have a finishing layer of asphaltic material compatible with the zinc coating. The mean dry film thickness of the finishing layer shall not be less than 2.8 mils with a local thickness not less than 2.0 mils as specified in ISO 8179.

B. All fittings shall be zinc coated as noted for ductile iron pipe above, with a finishing layer of asphaltic material as specified in ISO 8179.

C. V-Bio Enhanced Polyethylene Encasement
   1. Field installed
   2. Encase pipe and fittings in polyethylene tubing as specified in AWWA C105.
   3. Three layer, co-extruded, linear low density polyethylene wrap.

4. 8 mils minimum wrap thickness
5. Inner surface of polyethylene wrap infused with anti-microbial biocide and corrosion inhibitor
6. Candidate Manufacturers:
    a. Daubert Cromwell
    b. Approved Equal

2.07 PIPE LINING

A. Unless otherwise specified, pipe and fittings shall be lined with cement mortar material as specified in AWWA C151.

B. Cement Mortar Lining: Where specified, interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.

2.08 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
    1. Shop drawings.
    2. Alignment drawings.
    3. Certifications specified in the following documents:
        a. ANSI A21.14, paragraph 14-4.2
        b. ANSI A21.52, paragraph 52-4.2
        c. ASTM A716, paragraph 4.2
        d. AWWA C110, paragraph 10-5.3
        e. AWWA C111, paragraph 11-7.1
        f. AWWA C115, paragraph 15-4.2
        g. AWWA C151, paragraph 51-5.2
        h. AWWA C153, paragraph 53-6.3
        i. AWWA C606, paragraph 4.1.1.1

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
    1. Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01 33 00.
    2. Pipe shall be installed in accordance with AWWA C600.
    3. Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. Insulating Sections:

1. Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in Section 40 05 06.

C. Anchorage:

1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

3.02 ACCEPTANCE TESTING

A. Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.

B. The Contractor shall conduct the tests in the presence of the Engineer or Owner's Representative.

END OF SECTION

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SECTION 33 10 00

WATER PIPE FOR UTILITIES

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section includes all pressure pipe, fittings, specials, and appurtenances for water piping. This spec only applies to buried potable water utility piping and not process piping.
   2. Adhere to all requirements of the latest revision of the City of Vancouver General Requirements and Details for the Design and Construction of Water, Sanitary Sewer, and Surface Water Systems, and these Specifications. Where a conflict in requirements exists, the stricter requirement shall be used, and the Engineer notified.
   3. All pipe, fittings, appurtenances and ancillary components must be NSF 61 compliant.
   4. All fittings and connections shall be restrained.

B. Pipe Designations:
   1. The following pipe designations are defined:

Designation	Definition
PVC	Polyvinyl Chloride
DI	Ductile Iron

1.02 REFERENCES

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASTM C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ASTM C110	Ductile-Iron and Gray-Iron Fittings, 3 Inches through 48 Inches for Water and Other Liquids
ASTN C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ASTM C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
ASTM C150	Thickness Design of Ductile-Iron Pipe
ASTM C151	Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids
ASTM C153	Ductile-Iron Compact Fittings, 3 In. Through 24 In. and 54 In. Through 64 In., for Water Service
ASTM C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
ASTM C605	Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
NSF 61	Drinking Water System Components – Health Effects

1.03 SUBMITTALS

A. Product Data: The following information shall be provided in accordance with 01 33 00:
   1. Pipe and joint details.
      a. Size

b. Dimensions
c. Conformance with referenced standards
d. Pressure Class
e. Gasket type
f. Pipe Color

2. Special, fitting, and coupling details.
3. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.

B. Certificates and Affidavits: Furnish the following prior to shipment.
1. Manufacturer's certificates of compliance with the specified.
2. Affidavit of compliance with applicable standard.
3. Test certificates.

1.04 QUALITY ASSURANCE:

A. Manufacturers shall be experienced in the design and manufacture of pipe, fittings, specials, or appurtenances for a minimum period of 5 years.

B. Inspection of the pipe shall be made by the Engineer after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Ship all material to the site and store in laydown areas.

B. Handling and storage shall be in accordance with specification requirements in Part 3 of this Section.

PART 2 PRODUCTS

2.01 PVC PIPE

A. Pressure Pipe:
1. PVC pipe and components shall be certified under NSF 61.
2. PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454-B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241. Pressure rating for pipe shall be in excess of test pressure specified below.
3. Neoprene gaskets with push-on joints shall conform to ASTM F477.

B. Materials:
1. Materials shall conform to AWWA C900.
2. Gaskets shall conform to ASTM F477 and be synthetic rubber.

C. Design of Pipe: Design shall conform to AWWA C900 and as specified:
   1. Internal Loading:
      a. Internal pressure specified plus allowance for surge pressure conforming to AWWA C900.
      b. Hydrostatic test pressure as specified.
   2. External Loading:
      a. Earth dead load cover at 120 pcf plus AASHTO H-20 live loads.
      b. 5% deflection limit.
      c. Bedding condition as indicated.
   3. Soil Modulus E' =500 and pipe bedding angle of 90°.
   4. Pressure Class DR 25 (165 psi).
   5. Diameters: PVC pressure pipe shall have Ductile-Iron-Pipe-Size (DIPS) outside diameters.
   6. Joints: Pipe shall be furnished with integral bell-type pipe ends designed for joint assembly using synthetic rubber gaskets.
   7. Marking: Identification markings on pipe shall conform to AWWA C900.
   8. Color: The color for PVC pressure pipe shall be blue in color.

2.02 DUCTILE-IRON PIPE:

A. Design and Manufacture of Pipe:
   1. Ductile-iron pipe shall conform to AWWA C115, C150 and C151 except as otherwise specified.
      a. Ductile Iron Pipe must be centrifugally cast, lined, and coated.
   2. With laying condition Type 4 for ductile iron for load requirements tabulated herein.
      a. Use Soil Modulus E' of 700 and pipe bedding angle of 90°.
      b. 3% deflection limit.
      c. Add service allowance and standard casting tolerances of AWWA C150 and AWWA C151.
      d. Select next standard pressure class thickness above total calculated thickness required.
   3. Unless otherwise specified, ductile iron pipe shall be Class 50.

B. Dimensions: The minimum thickness for mechanical or push-on type joint ductile-iron pipe shall be thickness Class 50 with restrained joints:
   1. Minimum thickness for ductile-iron pipe threaded for screw-on flanges shall be in accordance with AWWA C115.

C. Joints:
   1. Mechanical and Push-On Type:
      a. Provide mechanical or push-on-type joints for all buried pipe unless otherwise specified or indicated.
      b. Joints shall conform to AWWA C111.

2. Flanged:
    a. Provide flanged joints for all interior and exposed exterior pipe except where otherwise specified or indicated.
    b. Flanges for pipe shall be ductile iron and conform to the applicable provisions of AWWA C110 and C115 and shall be rated for a minimum of 150 psi.
    c. Contractor is responsible for matching all flange drilling patterns.
3. Sleeved or Coupled:
    a. Provide for sleeves or couplings where indicated.
    b. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
    c. Provide anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated.
4. Restrained:
    a. Provide restrained joints of following approved types:
        1) Restrained mechanical joint.
        2) Restrained push-on joint.
        3) Anchored couplings.

D. Lining:
1. All pipes shall be cement mortar lined in accordance with AWWA C104.

E. Coating:
1. The exterior of ductile iron pipe shall have an asphaltic coating per AWWA C151.

2.03 FITTINGS (FOR DI AND PVC PIPE):

A. Fittings shall conform to AWWA C110 or C153 and be ductile iron. Fittings shall be mechanical joint.

B. Fittings for pipe with push-on joints shall be mechanical joint or push-on-type joint.

C. Include all specials, taps, plugs, flanges, and wall fittings as required.

D. Provide openings for air valve, drain, testing, and other connections via saddle connection located where indicated.

E. Lining:
1. Fittings shall, at a minimum, be cement-mortar lined in accordance with AWWA C104. Fusion-bonded epoxy lining per AWWA C116 is acceptable.

F. Coating:
1. All ductile iron fittings shall have fusion bonded epoxy lining conforming to AWWA C116.

G. Pressure Pipe:
1. Pressure pipe shall be formulated of polypropylene conforming to ASTM D4101. Pipe shall be 150 psi rated in all sizes.

2.04 RESTRAINING SYSTEMS:

A. Harness Rods:
   1. Harness rods and nuts shall be high-strength, low alloy corrosion resistant steel per AWWA M11.

B. Joint Restraint Devices:
   1. Shall be manufactured of ductile iron conforming to ASTM A 536
   2. Shall have twist-off nuts, sized the same as the tee head bolts used to ensure proper torque.
   3. EBBA Mega Lug or equal.

2.05 SLEEVES AND COUPLINGS:

A. Sleeves:
   1. AWWA C110 mechanical joint ductile-iron solid sleeve type:
      a. Pipe end space shall not exceed one-third of the sleeve laying length.
      b. Buried service as indicated.

B. Couplings:
   1. Center sleeve and compression gland-type end ring conforming to AWWA C219 and NSF 61 certified.
   2. Center sleeve shall be without pipe stop.
   3. Bolted sleeve-type couplings may be installed on CI, DI, and PVC pipe. Components shall be suitable for exposure to chloraminated water.
   4. Bolts and heavy hex nuts shall be fabricated from high strength low alloy steel known in the industry as Cor-ten, Usalloy, or Durabolt. The Manufacturer shall supply information as to the recommended torque to which the bolts shall be tightened.
   5. Lining and Exterior Coating:
      a. Use for all steel couplings intended for direct bury, exposed exterior, vault, or pit installations.
      b. Completely coat center sleeve and end rings.
      c. End rings and the center sleeve shall be coated in accordance with AWWA C210 or C213 with a minimum DFT of 12-mils.

2.06 GASKETS AND BOLTING MATERIALS:

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings, and specials complete and ready for service.

B. Mechanical Joints:
   1. SBR gaskets conforming to ASTM F477 and AWWA C111
   2. AWWA C111 with tee-head bolts and hexagon nuts fabricated from a high-strength, low alloy steel known in the industry as Cor-Ten, Usalloy, or Durabolt.

C. Flanged:
   1. Gaskets for flanged joints shall conform to ANSI B16.21 and ANSI/AWWA C111/A21.11, nitrile or neoprene, NSF 61 certified, thick full-face gasket, thickness per manufacturer based on pipe diameter.
   2. Gaskets for ductile iron flanged pipe and fittings 12-inch and smaller shall have "nominal" inside diameters, not the larger inside diameters per ANSI B16.21.
   3. Bolts for flanged joints shall conform to ASTM A307, Grade B. Nut and bolt heads shall be hexagonal.
   4. Gaskets and bolts for other than flanged joints shall be as otherwise specified for pipe and pipe joints.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Piping specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with 01 33 00.
   2. Pipe shall be installed in accordance with AWWA C600.

B. Insulating Sections:
   1. Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating connection shall be provided.

C. PVC pipe shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings shall be lined and coated as specified herein. Unless otherwise specified, PVC piping exposed to sunlight shall be painted with a minimum of two coats of a latex coating on a properly prepared substrate.

D. Use equipment, methods, and materials ensuring installation to lines and grades indicated.
   1. Maintain within tolerances specified or acceptable laying schedule.
      a. Alignment: +/- 1 inch per 100 feet in open cut or tunnel.
      b. Grade: +/- 1 inch per 100 feet.
   2. Do not lay on blocks unless pipe is to receive total concrete encasement.
   3. Accomplish horizontal and vertical curve alignments with bends, bevels, and joint deflections.
      a. Limit joint deflection with ductile-iron pipe to conform to AWWA C600 and with PVC pipe to conform to AWWA C605 and HDPE pipe to conform to ASTM D2774. Deflection may, with approval, exceed standard deflections by using machined bells.
      b. Limit joint deflection in PVC pipe to:
         1) 3% with mechanical joint or 75% of the manufacturer’s allowable, whichever is more stringent.
         2) 1% with bell and spigot-rubber gasket joint or 75% of the manufacturer’s allowable, whichever is more stringent.

E. Clean interior of all pipes, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.
   1. Close open ends of pipe with snug-fitting closures.
   2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
   3. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.

F. Brace or anchor as required to prevent displacement after establishing final position.

G. Perform only when weather and trench conditions are suitable. Do not lay in water.

H. Observe extra precaution when hazardous atmospheres might be encountered.

3.02 DELIVERY AND OFF-LOADING

A. All pipes shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.

B. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify the Engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.

C. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's guidelines shall be followed.

D. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.

E. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to ensure that pipe is not dropped or damaged.

3.03 HANDLING AND STORAGE

A. Any length of pipe showing a crack, or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the Engineer.

B. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Engineer.

C. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

D. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.

E. If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.

F. Pipe shall be stored and stacked per the pipe supplier's guidelines.

3.04 JOINTING:

A. General Requirements:
   1. Locate joint to provide for differential movement at changes in type of pipe embedment, impervious trench checks, and structures not more than 24 inches from structure wall, or
   2. Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing, as indicated.

B. Perform conforming to manufacturer's recommendations.
   1. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
   2. Use methods and equipment capable of fully seating or making up joints without damage.
   3. Check joint opening and deflection for specification limits.

C. Special Provisions for Jointing PVC Pipe:
   1. Pressure pipe installation shall conform to AWWA C605 and AWWA M23.
   2. Excavate bell holes at each joint or coupling to provide full length barrel support of the pipe and to prevent point loading at the bells or couplings.
   3. Connect pipe to new or existing rigid structures with bolted sleeve or solid sleeve couplings.

3.05 PIPE CUTTING

A. Cut in neat manner without damage to pipe.
   1. Observe Specifications regarding joint locations.
   2. Cut cast-iron, ductile-iron, and steel pipe with carborundum saw or other acceptable method per manufacturer's instructions.
      a. Smooth cut by power grinding to remove burrs and sharp edges.
      b. Repair lining as required and approved.

3.06 THRUST RESTRAINT:

A. Piping and fittings with push-on or mechanical joints, or similar joints subject to internal pressure shall be blocked, anchored, or harnessed to preclude separation of joints. All push-on and mechanical joint bends deflecting 11-1/4 degrees or more shall be provided with suitable blocking, anchors, joint harness, or other acceptable means for preventing movement of the pipe caused by internal pressure.

B. Concrete thrust blocks shall be used only where shown on the Drawings. Retrained pipe joints and fitting connections are required as shown on the Drawings.

C. Concrete blocking shall extend from the fitting to solid undisturbed earth and shall be installed so that all joints and bolts are accessible for repair.

D. The dimensions of concrete blocking shall be as indicated on Construction Detail Drawings may be used only if specified by the design professional on the Approved for Construction drawings. If support against undisturbed earth cannot be obtained, restrain joints. Restrained length shall be approved by the Engineer.

E. A maximum of eight (8) inches of backfill material may be placed over concrete arch encasement or concrete blocking after the initial set, to aid in curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least one (1) day.

F. All clamps, rods, bolts, and other metal accessories used in reaction anchorages, or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be protected from corrosion with a method acceptable to the Engineer.

G. Cold-Weather Placing: Conform to the practice recommended in ACI 306R when the temperature is below 40˚ F or is likely to fall below 40˚ F during 24-hour period after placing.

H. Hot-Weather Placing: Conform to practices recommended in ACI 305R when temperature is 90˚ F or above or is likely to rise above 90˚ F within 24-hour period after placing, or when there is a combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.

3.07 POLYETHYLENE ENCASEMENT:

A. Encase metallic pipe, fittings, valves, restraining harnesses, and other metallic appurtenances with polyethylene film as indicated or specified.

B. Installation:
   1. Perform to conform to AWWA C105.
   2. Use adhesive tape to fasten polyethylene film in place.
   3. Minimize exposure of polyethylene film to sunlight.
   4. Wrap pipe, valves, fittings, and couplings per AWWA C105 installation standards.

3.08 FIELD TESTING:

A. Acceptance Tests for Pressure Pipelines:
   1. Perform hydrostatic pressure and leakage testing.
   2. Perform flushing.
   3. Perform after backfilling.

B. Contractor shall furnish and install test plugs.
   1. Including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs.
   2. Be responsible for any damage to public or private property caused by failure of plugs.

B. Limit fill rate of line to available venting capacity. Fill rate shall be regulated to limit velocity in lines when flowing full to not more than 0.05 to 1 fps.

C. Owner shall make water for testing available to Contractor at nearest source.

3.09 DISINFECTION AND HIGH CHLORINE TESTING:

A. Disinfection of Pipelines for Conveying Potable Water:
   1. Contractor shall provide all equipment and materials and perform conforming to AWWA C651.
      a. As modified herein.
      b. At no additional cost to Owner
      c. Include preliminary flushing, chlorination, and high chlorine slug flushing.
   2. Submit disinfection and testing materials and methods to the Engineer for approval.
   3. May be conducted in conjunction with acceptance tests.
   4. Owner will provide sampling and laboratory testing.
   5. At minimum initial dosage of 50 mg/L (ppm) in all portions of the line.
      a. Allow to stand for a minimum of 24 hours.
      b. Minimum residual after required contact time shall be at least 50 mg/L (ppm) at all tested locations.
      c. Flush pipeline before use for potable water supply purposes. Dispose of final flushing water without damage to public or private property.
      d. Obtain safe bacteriological samples on two (2) consecutive days before placing waterline into service.
   6. Repeat disinfection procedure should initial treatment fail to yield satisfactory results.
      a. At no additional cost to Owner.
      b. Owner will provide water under terms stipulated for acceptance tests.

3.10 HYDROSTATIC PRESSURE AND LEAKAGE TEST:

A. Contractor shall provide all equipment and materials and perform conforming to AWWA C600/C605 procedures.
   1. As modified herein.
   2. At no additional cost to Owner.
   3. Test pressure shall not be less than 150% of working line pressure.

4. Test pressure shall be at least 2-hour duration. Maintain pressure throughout test. Leakage test shall be conducted concurrently with the pressure test.
    a. Acceptable when leakage does not exceed that determined by the following formula:

$$L = \frac{S*D*\sqrt{P}}{148{,}000}$$

L = Allowable Leakage in gallons per hour
S = Length of pipe tested, in feet
D = Nominal diameter of pipe, in inches
P = Average test pressure during the hydrostatic test, in PSI:

    b. When testing against existing closed valves, an additional leakage per closed valve of 0.0078 gal/hr./in of nominal valve size shall be allowed.
5. When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
6. Repeat test as necessary.
    a. After location of leaks and repair or replacement of defective joints, pipe, fittings, valves, or hydrants. All visible leaks are to be repaired regardless of the amount of leakage.
    b. Until satisfactory performance of test.
7. Engineer will witness pressure and leakage test.

B. The Contractor shall have the Engineer verify results.

3.11 FLUSHING:

A. The entire line shall be flushed after installation.

B. Such flushing shall continue until the water is clear.

C. Minimum flushing rates to produce 2.5 fps velocity in pipe.

D. Dispose of flushing water without damage to public or private property.
1. The discharge of flushed water shall be accomplished such that no erosion will occur and with no harm to fish, animals, or plants. Procedures for discharge will be subject to the review by the Engineer.

END OF SECTION

SECTION 33 14 26

UTILITY VALVES AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes all valves and accessories for public water distribution systems.

B. Contractor shall adhere to all requirements of the latest revision of the City of Vancouver General Requirements and Details for the Design and Construction of Water, Sanitary Sewer, and Surface Water Systems and these Specifications. Where a conflict in requirements exists, the Engineer shall be notified.

C. Related Work Specified Elsewhere:
   1. Section 31 23 33 - Trenching, Bedding and Backfill

1.02 REFERENCES:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings.
      b. A536 - Ductile Iron Castings.
   2. American Water Works Association (AWWA):
      a. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      b. C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 Inch through 144 Inch.
      c. C509 - Resilient-Seated Gate Valves for Water Supply Service.
      d. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. Other
      a. City of Vancouver General Requirements and Details for the Design and Construction of Water, Sanitary Sewer, and Surface Water Systems – latest edition

1.03 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Include, but not limited to, the following:
   1. Catalog data or illustrations showing principal dimensions, parts, and materials.
   2. Spare parts list referenced to illustration of parts.
   3. Assembly and disassembly or repair instructions.
   4. Valve coating information including performance tests of adhesion, hardness, and abrasion resistance.

C. Certificates and Affidavits: Furnish prior to shipment. Include the following:
   1. Test certificates.

2. Affidavit of compliance with applicable AWWA Standard.

1.04 QUALITY ASSURANCE

A. Manufacturers shall be experienced in the design and manufacture of specific valves and accessories for a minimum period of 5 years.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Ship all valves with suitable end covers to prevent entrance of foreign material into valve body.

B. Protect valve threads, flanges, stems, and operators from damage.

C. Ship valves 4-inch and larger to the project site tagged with the station number shown on the Drawings. Tag smaller valves to show the piping system in which it is to be used.

1.06 RESPONSIBILITY:

A. Actuators, their controls, and accessories shall be the responsibility of the valve manufacturer for sizing, assembly, certification, field testing, and any adjustments necessary to operate the valve as specified.

PART 2 PRODUCTS

2.01 RESILIENT-SEATED GATE VALVES:

A. Acceptable Manufacturers:
   1. American AVK (AWWA C509 only)
   2. American Flow Control (AWWA C509 only)
   3. Clow (AWWA C509 only)
   4. East Jordan Iron Works
   5. Kennedy Valve (AWWA C509 only)
   6. Mueller Company (AWWA C509 only)
   7. US Pipe and Foundry Company

B. Design:
   1. Mechanical joint ends.
   2. Conform to AWWA C509 or C515 and as specified.
   3. Non-rising brass stem.
      a. All stem seals shall be double O-ring type.

C. Actuators:
   1. All valves shall open counterclockwise (left).
   2. All buried valves shall have a 2-inch-square operating nut. All operating nuts shall be red.
   3. All valves installed indoors shall be non-rising stem, right hand open, with hand wheel operators.

D. Interior and Exterior Coating:
   1. Conform to AWWA C550.
   2. Apply to all interior and exterior ferrous metal surfaces.
   3. The coating shall be a two-part thermosetting epoxy suitable for field over coating and touch-up.
      a. Minimum thickness of four mils.

E. Bolting Material:
   1. High-strength, low alloy steel known as Cor-Ten®, Usalloy, or shall be DI Durabolt.

F. Testing:
   1. Testing shall be performed conforming to AWWA C509.
   2. Furnish affidavit of compliance.

G. Valve Schedule:
   1. See drawings for sizes and locations.

2.02 TAPPING SLEEVES:

A. Acceptable Manufacturers:
   1. Fabricated Steel – For use on ductile iron pipe only
      a. JCM 412
      b. Romac FTS 420
      c. Smith-Blair 622
   2. Stainless Steel – For use on PVC or ductile iron pipe
      a. Cascade Style CST
      b. Ford FTSS
      c. JCM 432
      d. Power Seal 3490
      e. Romac Style SST
   3. Design:
      a. Conform to AWWA C223.
      b. Meet all requirements specified in Denver Water Material Specification – 9.
      c. Triangular sidebar style sleeve
      d. 250 psi minimum working pressure up to and including 12-inch.
   4. Flange insulator kit is required between the valve and tapping sleeve.
   5. Provide stainless steel nuts and bolts.

2.03 TAPPING VALVES:

A. Acceptable Manufacturers
   1. American AVK
   2. American Flow Control, Series 2500 RW
   3. Clow
   4. Kennedy

5. Mueller
6. US Pipe and Foundry Company.

B. Design:
   1. Conform to AWWA C509 or C515 and as specified.
   2. Non-rising brass stem.
      a. All stem seals shall be double O-ring type.

C. Actuators:
   1. All valves shall open counterclockwise (left).
   2. All buried valves shall have a 2-inch-square operating nut.

2.04 POLYETHYLENE ENCASEMENT:

A. Where required. polyethylene encasement material shall be as follows:
   1. Linear Low Density Polyethylene Encasement.
      a. Provide minimum 8-mil polyethylene material per AWWA C105.
      b. Conform to AWWA C105.
      c. To be clear in color.
   2. Size shall be as follows:

Flat Width Tubing (in)	Pipe Diameter (in)
24	4 - 8
30	12
36	16
52	20 - 24

   3. Buried harness rods shall be covered with 4-inch flat width polyethylene tubing.
   4. Adhesive tape shall be as follows:
      a. Approximately 2 inches wide and plastic backed.
      b. Capable of bonding securely to metal surfaces and/or polyethylene material.
      c. Scotchrap No. 50 (polyvinyl), or Engineer-approved equal.

2.05 VALVE BOXES:

A. Acceptable Manufacturers:
   1. Castings, Inc – 6860 Series, CI 160B Oval Base
   2. East Jordan Iron Works – 8560 Series and 6800 Series Drop Lid
   3. Star Pipe – VB-0006 Series
   4. Tyler Union – 6860 Series

B. Provide for all buried valves.

C. Design:
      a. Conforming to ASTM A48 Class 20A
      b. Gray cast-iron, buffalo-type

c. Boxes shall be three-piece cast-iron screw type with 5-1/4-inch shaft.
d. Use wide oval base #160.
e. Provide extension stem to bring operating nut within 5 feet of valve box top.

D. Covers (Lids)
1. Drop cover shall be marked "WATER."
2. Lids shall have a lip or flange extending into the valve box shaft.
a. No slip-type boxes will be allowed.
3. Zone valve lids shall be of the locking lid type (lock lid type).
a. Tyler 145462 or equal.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Comply with provisions of AWWA C600 and as specified.

B. Thoroughly clean and remove all shipping materials prior to setting. Operate all valves from fully opened to totally closed.

C. Equip with anchorage where indicated.

D. Set fire hydrants with bottom of traffic break-away flange 2 inches above finished grade. Check and fill stem bonnet lubricant reservoir.

END OF SECTION

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SECTION 33 14 42

CATHODIC PROTECTION FOR BURIED PIPING

PART 1 GENERAL

1.01 SCOPE

A. Install a corrosion control system for ductile iron and other metallic buried yard piping. The cathodic protection (CP) system shall protect all associated pipes, joints, valves, fittings, etc., and includes electrical continuity (joint bonding), electrical isolation of flanges between buried and exposed segments of pipe (insulating flanges), sacrificial (magnesium) prepackaged anodes, and cathodic protection testing facilities, as specified herein.

B. Review the installation procedures under this and other Sections and for coordinating the installation of the corrosion control system, as required by the Contract Documents, and this specification.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Specification for Soft or Annealed Copper Wire
ASTM B80	Specification for Magnesium-Alloy Sand Castings
ASTM D149	Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D257	Test Methods for DC Resistance or Conductance of Insulating Materials
ASTM F436	Standard Specification for Hardened Steel Washers
ASTM G97	Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications
AWWA C17	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipeline
NACE SP0169	Control of External Corrosion on Underground or Submerged Metallic Piping Systems

Reference	Title
NACE SP0286	Electrical Isolation of Cathodically Protected Pipelines
NACE TM0497	Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems
NSF 61	Drinking Water System Components – Health Effects

1.03 SUBMITTALS

A. Catalog cuts of all materials to be installed shall be submitted for approval in accordance with Section 01 33 00.

B. Qualifications of the Contractor's Corrosion Engineer and Corrosion Technician, as outlined in the Quality Control Inspection Section 1.04, shall be submitted for approval.

C. Manufacturer's information for each item listed below shall be submitted for approval. (Include sufficient information to show that the materials meet the requirements provided herein, including references to specific sections and details shown on the Drawings.)
   1. Prepackaged Magnesium Anodes
   2. Above-Grade Cathodic Protection Test Stations
   3. Flush-Mounted Cathodic Protection Test Stations
   4. Pipe Lead and Joint Bond Wire
   5. Thermite Weld Equipment and Materials
   6. Thermite Weld Coating
   7. Insulating Flange Components
   8. Compression Connectors
   9. Electrical Tape
   10. Cable Warning Tape

D. The following reports shall be submitted for approval:
   1. ASTM G97 current capacity test results
   2. Insulating Flange/Joint Inspection Report.
   3. Electrical Isolation Testing Between Pipe and Steel Reinforcement Report.
   4. Baseline (Native) Potential Survey Report.
   5. A letter report documenting all testing performed during system installation and activation. The letter report shall include a description of the test methods, all data, analysis of the data, and conclusions about the cathodic protection system's effectiveness.

1.04 QUALITY CONTROL INSPECTION

A. The criteria used to indicate adequate corrosion protection of the metallic water pipeline shall be as listed in NACE Standard SP0169.

B. The installation of the cathodic protection system's electrical components shall conform to the National Electrical Code, applicable federal, state, and local codes, and the recommendations of NACE Standard SP0169.

C. Provide all materials, equipment, labor, and supervision necessary for the completion of all installations and testing.

D. Services of Corrosion Engineer: Obtain the services of a Corrosion Engineer to inspect, activate, adjust, and evaluate the effectiveness of the cathodic protection system. The Corrosion Engineer is herein defined as a registered Professional Engineer with certification or licensing that includes education and experience in cathodic protection of buried or submerged metal structures, or a person accredited or certified by NACE at the level of Corrosion Specialist or Cathodic Protection Specialist (i.e., NACE CP Level 4). Such a person shall have not less than five years' experience inspecting pipeline cathodic protection systems.

E. Services of Cathodic Protection Technician: Obtain the services of a Cathodic Protection Technician to inspect, activate, adjust, and evaluate the effectiveness of the cathodic protection system. The Cathodic Protection Technician is herein defined as a person accredited or certified by NACE as a Cathodic Protection Technician (NACE CP Level 2). Such a person shall have not less than five years' experience inspecting pipeline cathodic protection systems.

F. Maintain record drawings for the cathodic protection system throughout the installation of the equipment. Properly identify all items of equipment and material. Show the exact locations of all anodes, buried wires, and cathodic protection test boxes using dimensional ties to existing structures or survey monuments. Record all changes by using a red pen or red pencil on full-size drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide cathodic protection system materials and equipment that are new, undamaged, and in the original packaging marked with the manufacturer's name or trademark. The materials and equipment shall be of the manufacturer's latest standard design and shall be fully compatible to provide a complete and functional cathodic protection system.

2.02 PREPACKAGED MAGNESIUM ANODES

A. Each high-potential magnesium anode shall have a nominal weight of 17 pounds, excluding backfill. The anode shall be 25.25 inches long by 3.50 inches wide by 3.75 inches high.

B. Composition of the anode shall be as follows:

Component	Composition by Weight
Aluminum	0.01 percent
Manganese	0.50 to 1.30 percent
Copper	0.02 percent
Nickel	0.001 percent
Iron	0.03 percent
Others (total)	0.30 percent
Magnesium	Remainder

C. The 17-pound anodes shall be packaged in permeable fabric that is 29 inches in length by 6.5 inches in diameter.

D. The fabric for each 17-pound anode shall contain a minimum of 28 pounds of backfill. The backfill material shall have the following composition:

Hydrated Gypsum	75%
Bentonite	20%
Sodium Sulfate	5%

E. The anode and backfill shall be prepackaged into a single unit, as described in Paragraphs 2.02 A thru D. A minimum of 25 feet of AWG No. 8 stranded copper wire with HMWPE insulation (black) shall be attached to the anode. The wire shall be sufficient length to reach the termination point without splices. Wire-to-anode attachment shall be by silver solder and sealed to prevent any moisture penetration. The anode system shall be as manufactured by BK Corrosion or approved equal.

F. The anode's current capacity, as measured using the ASTM G97 standard test procedure, shall be minimum 480 amp-hours per pound. If anodes are of the cast type, the anode foundry or the anode retail supplier shall have a quality control program that includes random ASTM G97 testing. ASTM G97 current capacity tests shall be performed on randomly selected anodes at a minimum rate of 1 for every 2,500 anodes cast. Submit the ASTM G97 current capacity test results for the testing date that is closest to the production date of the anodes supplied for this project. All cast high-potential magnesium anodes shall bear a stamp with its foundry heat number for traceability.

2.03 CATHODIC PROTECTION TEST STATIONS

A. Flush-Mounted Test Stations

1. The flush-mounted test station shall consist of a nonconductive terminal board mounted in a locking cast iron lid and collar (suitable for placement in heavy traffic areas) and a plastic shaft.
2. The test box shall pass U.S. DOT H-20 roadway load test. The cast iron of the lid and collar shall meet or exceed ASTM A48 Class 25 specification. The test box lid shall be made of cast iron and painted yellow. The lid shall feature a cast-in pentagonal bolt to lock into the cast iron cover.
3. The cast iron collar shall be at least 2.75 inches high with lugs cast inside to accept the locking lid and to accept a 1-inch cast iron repaving adapter with original lid.
4. The plastic shaft shall be made of ABS (acrylonitrile butadiene styrene), 18 inches long, with a flared bottom—to resist sinking in soil and provide protection against wire damage. The plastic shaft shall have a 5-inch inner diameter. The plastic shaft shall be riveted to the cast iron collar.
5. The test block shall be made of nonconductive PVC (polyvinyl chloride) plastic.
6. The test station shall be permanently labeled with the purpose, type, stationing, and pipeline.
7. The terminal board shall contain a minimum of seven terminals—using 0.25-inch by 20-thread nickel-plated machine screws and nuts. The terminal board shall fit into the lid using hangers cast inside the lid.
8. The flush-mounted test station shall be manufactured by CP Test Services, Cott Manufacturing, Inc., or approved equal.

B. Test Station Concrete (Flush-Mounted Test Station)

1. In unpaved areas, provide a square reinforced concrete pad that is 24 inches by 24 inches, and 6 inches thick. Reinforcement shall be #4 bars, at 12 inches on center each way, in the center of the pad. Edges shall be provided with a 3/4-inch chamfer. To channel water away from the test station slope the concrete 2 percent from center.
2. In paved areas, provide a square reinforced concrete pad that is 24 inches by 24 inches, and 12 inches thick. Reinforcement shall be #4 bars, at 12 inches on center each way, in the center of the pad. To channel water away from the test station slope the concrete 2 percent from center.

C. Junction Box

1. The junction box enclosure shall be galvanized steel with dimensions of 10 inches high by 8 inches wide by 6 inches deep.
2. The enclosure shall be locking type with a minimum NEMA 3X rating. Enclosure shall be capable of operating at continuous ambient temperature of 120 degrees Fahrenheit in full sunlight with an expected life of 10 years minimum. Enclosure shall conform to NEMA 250 Type 3, 3R or 3X and be suitable for post or wall mounting. Enclosure shall be 16-gauge galvanized steel with top drip shield and seam-free sides, front and back. Hinged doors shall be provided with quick-release clamps and a padlock hasp to secure them in a closed position.
3. The insulating panel shall be 1/4-inch thick micarta. Panel board shall be non-conductive and a minimum 1/4-inch-thick material. Electrical components shall be mounted on bolts or studs with backing nuts. Arrange nuts, washers, and lock washers to avoid compression of the panel board. Copper bus bar shall be a minimum of 1/8 inch thick by 1 inch wide. Resistance shunts shall be sized according to the design-rated current output of the anodes and anode groundbed. The shunts shall be Holloway Type CP, Type RS or Type JB, or approved equal.
4. Shunts shall be 0.01 ohm, one per individual anode circuit.
5. All bolts, nuts and washers shall be either stainless steel or brass.

D. Current-Measuring Shunt

1. Test station shunts shall be constructed to fit the terminal posts for the specified test station or junction box. The resistance shall be 0.01 ohm with a current capacity of 8 amperes. The shunt shall be Model "Yellow", as manufactured by Cott Manufacturing Company or approved equal for test stations, or type RS for junction boxes.

2.04 PIPE LEAD AND JOINT BOND WIRE

A. All wiring shall be stranded copper wire of the AWG wire size and insulation color shown on the Drawings, excluding wire provided with the magnesium anodes and reference electrodes.

B. Wire for bonded joints shall be single conductor, stranded copper with high molecular weight polyethylene (HMWPE) insulation (black). Wire size shall be AWG No. 2 for piping larger than 36-inch diameter, AWG No. 4 for 16-inch through 36-inch diameter piping, and AWG No. 6 for smaller than 16-inch diameter piping and all associated pipe fittings. A minimum of two bonding wires per joint shall be installed.

C. Pipeline test wires shall be single conductor, AWG No. 8 stranded copper wire with 600-volt HMWPE insulation, with colors as shown on the Drawings.

D. No wire splices shall be allowed unless prior written approval is given by the Corrosion Engineer.

2.05 THERMITE WELD EQUIPMENT AND MATERIALS

A. Thermite weld molds and charges shall be suitable for the sizes and types of materials and shapes encountered. Adapter sleeves shall be utilized for all thermite welds.

B. Typical size of the exothermic weld charge is 15 grams. The manufacturer shall be consulted for the proper charge size and material to be welded.

C. All welding materials and equipment shall be the product of a single manufacturer.

2.06 THERMITE WELD COATING

A. Thermite welds to piping shall be coated with a prefabricated assembly, specifically designed for covering cathodic protection wire connections to piping and fittings. There shall be one weld per prefabricated assembly. The prefabricated assembly shall consist of the following components:
   1. Top plastic sheet formed with an igloo-shaped dome and entry tunnel for the lead wire.
   2. A special elastomeric compound in the plastic dome, firm enough to resist flow at normally encountered application and operating temperatures, but soft enough to mold itself around and completely cover the irregular welded profile.
   3. A double row of parallel, flexible, serrations on each side of the dome to assist with conforming around small-diameter pipe; and
   4. A base of black, unbacked, elastomeric tape with exceptional adhesive properties for bonding firmly to a surface, when used with the appropriate primer.

B. Caps shall be Model Handy Cap, as manufactured by Royston Laboratories Division or approved equal. The appropriate primer, as required by the elastomeric cap manufacturer, shall be used. Primer for the Royston Handy-Cap shall be Model Roybond 747 Primer, as manufactured by Royston.

2.07 INSULATING FLANGE COMPONENTS

A. For purposes of this specification, the terms “Pipe Flange Insulating Kit,” “Insulated Flange,” “Insulated Joint,” and “Dielectric Flange” are used synonymously.

B. Pipe flange insulating kit materials shall be designated by the manufacturer as suitable for service at the operating temperatures and pressures for the pipeline.

C. All insulating flanges for this project will be at the first flanged joint above grade, where metallic piping extends from buried to exposed service.

D. Flange insulating kits shall consist of a one-piece, full-face, insulating gasket; an insulating sleeve for each bolt; insulating washers; and steel washers. For nominal pipe diameters up to, and including, 36 inches, provide one insulating washer and one steel washer on each side of the flange for each flange bolt. For nominal pipe diameters greater than 36 inches, the insulating washers shall be installed sandwiched between a pair of matching steel washers on each side of the flange for each flange bolt.

E. Insulating Gasket: Insulating gasket retainers shall be full-face, Type E, NEMA G-10 glass, reinforced epoxy retainers with an ethylene propylene diene monomer (EPDM) rubber rectangular cross section O-ring seal. Minimum total gasket thickness shall be at least 1/8 inch. The gasket shall have the same outside diameter as the pipe flange. At valve-to-pipe connections where the inside diameters are not equal, the gasket inside diameter shall be equal to the smaller of the two inside diameters. Dielectric strength shall be at least 550 volts per mil in accordance with ASTM D149, and compressive strength shall be not less than 50,000 psi. The manufacturer's name and date of manufacture shall be marked on both sides of the gasket with a minimum of 2-inch-tall block letters using a durable marking ink or paint. The gasket shall be installed within six months of its manufacture date. Do not store insulated flange gaskets under direct sunlight nor at temperatures exceeding 110 degrees Fahrenheit. Use PSI Linebacker insulating gasket or approved equal.

F. Insulating Sleeves: Provide full-length, one-piece, NEMA G-10 glass-reinforced epoxy insulating flange bolt sleeves. Dielectric strength shall be at least 400 volts per mil, in accordance with ASTM D257. The length of the insulating sleeves shall provide an air gap between the end of the insulating sleeve and the inside surface of the stud bolt nut with a tolerance of 1/32 inch minimum and 1/8 inch maximum. Insulating sleeve length must be adjusted for the actual thickness of the steel washers and insulating washers, in accordance with ASTM F436. The bolt holes on the opposing flanges shall be aligned so as not to pinch the insulating sleeve, which would result in electrical shorting of the two flanges.

G. Insulating Washers: Insulating washers shall be NEMA G-10 glass-reinforced epoxy with a minimum thickness of 1/8 inch. Dielectric strength shall not be less than 550 volts per mil, and compressive strength shall not be less than 50,000 psi. The insulating washer inside diameter shall be sized to fit over the insulating sleeve outside diameter.

H. Steel Washers: Provide hardened steel washers that conform to ASTM F436 for insulated flanges greater than 36 inches in nominal diameter. Double steel washers— four steel washers per flange bolt—are required for insulated flanges greater than 36 inches in nominal diameter. The inside and outside diameters of the steel washers shall match those of the insulating washers. The steel washers must be able to freely rotate around the insulating sleeve. Attention must be paid to the fit between the steel washers and the insulating sleeve in order to avoid the washers twisting and cracking the sleeves when the flange bolts are torqued.

I. Provide four extra insulating sleeves and eight extra insulating washers for each insulating flange upon successful inspection of the insulating flange by the Engineer.

2.08 COMPRESSION WIRE TERMINALS

A. Test station terminal lugs shall be non-insulating, one-hole ring type, compression terminal lugs for a 0.25-inch bolt size. Compression terminals shall be specially manufactured for terminating copper cables at test stations. The terminals shall be copper or tin-coated copper, as manufactured by Burndy Corporation or approved equal.

B. Compression connectors shall be specially manufactured for terminating the copper cables at the test stations or junction box. The connectors shall be copper and shall be manufactured by Burndy Corporation or approved equal.

2.09 ELECTRICAL TAPE

A. Electrical tape shall be a conformable, water-tight sealant having a dielectric strength of at least 15 kV for a 1/8-inch-thick layer.

B. Tape shall be Scotch 88 Vinyl Tape and Scotch C130 Rubber Tape or approved equal.

2.10 CABLE WARNING TAPE

A. Cable warning tape shall be polyethylene material, minimum 6 inches wide, red, or yellow in color, and labeled "CAUTION - CATHODIC PROTECTION".

B. Tape shall be Terra Tape, as manufactured by Reef Industries or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. The Drawings are diagrammatic. The exact locations and routing of anodes, test stations, cables and conduits shall be governed by structural conditions and any physical interference. The final placement of the anodes and test stations shall be at the locations approved by the Owner’s Engineer and shall be marked on the record drawings.

B. All materials, workmanship and installation shall conform with all requirements of the legally constituted authority having jurisdiction. These authorities include, but are not limited to, the Federal, State, County, or City codes and regulations.

C. Unless otherwise indicated, install all materials in accordance with the manufacturers’ recommendations and safety procedures, and as shown on the Drawings.

D. Where requirements of this section conflict with the manufacturer's recommendations, the manufacturer's recommendations shall take precedence.

E. All materials and equipment to be used in construction shall be stored in such a manner as to be protected from detrimental effects from the elements. If appropriate storage is not available, stack materials and equipment well above ground level and protect from the elements as needed.

3.02 THERMITE WELDING

A. All thermite welds shall be made as shown on the Drawings and in accordance with the manufacturer's recommendations using the proper combination of equipment for the material and wire size being welded.

B. Ensure that the area where the attachment is to be made is absolutely dry. Remove mill coating, dirt, grime and grease from the pipe or fitting surface at the weld location by wire brushing or by the use of suitable safety solvents. At the weld location, use a mechanical grinder to clean a 2.5-inch square area of the pipe or fitting surface to a bright shiny surface, free of all serious pits and flaws.

C. Prepare the wire for welding by ensuring the cable is absolutely dry. The cable shall be free of dirt, grease, and other foreign products. Cut the cable in such a way as to avoid flattening or forcing out of round. To prevent deformation of the cable, cut the cable with cable cutters. Remove the insulation in a manner that will avoid damage to strands. Install adapter sleeves for all bonds and test wires prior to welding; either prefabricated factory sleeved joint bonds or bond wire with formed sleeves made in the field are acceptable. Hold the cable at an approximate 30-degree angle to the pipe surface when welding.

D. When the weld has cooled, remove the weld slag and test the weldment for strength by striking with a sharp, shearing blow using a 2-pound hammer, while pulling firmly on the wire. Remove unsound welds and make new welds at least 2 inches away. Thoroughly clean mold and mold covers after completion of each weld to assure that no slag will penetrate into the next weld.

E. After soundness of the weld has been verified, thoroughly clean with a stiff wire brush and apply primer over the entire weld area where the elastomeric cap will be placed. The elastomeric cap shall extend on all four sides beyond the cleaned area. Push the dome of the prefabricated cap, containing elastomeric material, firmly into weld area. Lift the wire away from the pipe and apply the elastomeric material completely around and underneath the wire. Push the wire back down on the pipe. Follow all manufacturer's instructions for installing prefabricated caps.

F. Repair the pipe coating in accordance with the pipe coating manufacturer's recommendations.

3.03 BONDED JOINTS

A. All new, pipeline joints—including those on pipe, fittings, valves, and branch connections intended to be cathodically protected, and except those specified to be insulated—shall be bonded as shown on the Drawings. All bond cables shall be thermite-welded to the pipe or fitting, as described in 3.02 above.

B. All joints shall be bonded with two HMWPE-insulated copper cables. Wire size shall be AWG No. 2 for larger than 36-inch diameter piping; AWG No. 4 for 16-inch to 36-inch diameter piping; and AWG No. 6 for smaller than 16-inch diameter piping and associated pipe fittings.

3.04 PREPACKAGED MAGNESIUM ANODES

A. Prepackaged high-potential magnesium anodes shall be installed where indicated on the civil Drawings or in accordance with the CP schedule. Each anode shall be placed a minimum of 5 feet from the pipeline. Provide a minimum of 10 feet of separation between anodes that are grouped and electrically connected in a single termination point. Provide a minimum anode spacing of 2 feet from other pipelines. Prior to installation, remove all shipping covers from the anode. (Note: The prepackaging fabric for magnesium anodes shall not be removed.) Install the anodes in existing soils—free from rocks, roots, organic material, trash, or other debris—and backfill with a minimum of 6 inches of native soil. Do not install the anodes in sand, rock or gravel backfill. After placement, but prior to backfilling, pre-soak the anodes with 5 gallons of water.

B. Each anode shall be lowered, using a sling or rope, into the hole/excavation site and placed vertically at the bottom of the hole. The anodes shall not be transported, lifted, or lowered into the excavation using the anode lead wires. Care shall be taken to ensure that the anode lead wire insulation is not damaged. Anodes with damaged lead wires or insulation shall be removed from the project and replaced.

C. Anode lead wire shall be long enough to reach the junction box or test station without splicing. Care shall be taken not to damage the lead wire throughout the installation and testing process.

D. Prior to connecting the anodes to the structure wires, the open circuit potential of each anode shall be measured. A voltage of –1.70 volts, or more negative, shall be obtained. If –1.70 volts are not obtained, further investigation shall be conducted to determine why the –1.70 volts have not been obtained. If required, replace the anode.

E. At anode test stations, anode lead wires shall be buried a minimum of 2 feet below grade. Handle wire with care. Route the anode wires to the junction box or test station, without splices, in a manner to prevent damage to the wires.

F. The metal portion of the anodes shall not contact the protected pipeline, except through the anode leads at termination points.

G. Where multiple anodes are installed, the anodes shall be installed with half on the left side and half on the right side of the pipeline. As looking upstream, the right-side anode leads shall be orange color-coded, and the left-side anode leads shall be black color coded.

H. All anode wires shall terminate at a or junction box or test station for testing and monitoring.

3.05 DIRECTLY CONNECTED ANODES

A. All galvanic anodes shall be connected to the pipeline through a junction box or test station. Direct connection of anodes to the pipeline will not be permitted.

3.06 TEST STATIONS

A. The Contractor shall have responsibility for determining the correct test station type to install, based on the location, structural obstructions, roads, anodes, insulating flanges, etc. Test stations shall be installed so as to avoid being damaged or obstructing the normal operation of any equipment.

B. Install test stations at the locations indicated on the civil Drawings or in accordance with the CP schedule. Test stations shall be located directly over the pipeline, except in areas that would place the test station in a roadway. If the Drawings or CP schedule indicate a placement location that lands in a roadway, then locate the test station at the closest point, just off the edge of the road. If installing an offset from the pipeline, refer to the offset test station detail on the Drawings. Flush-mounted test stations can be installed in the roadway as an alternate method. All test stations shall be properly labeled to indicate that they are for cathodic protection.

C. Attach test wires to the pipeline as indicated, using the proper thermite welding equipment and charges specified for the wire size and respective pipe material. Follow all procedures as outlined in Section 3.02 above.

D. All test station wires shall be routed a minimum of 2 feet below finished grade. Maintain sufficient slack in the test wires so that the wires can extend a minimum of 18 inches beyond the test station. Connect the test wires to the test station terminal block with one-hole compression terminal lugs for a 0.25-inch bolt size. Install a shunt and a copper shorting strap to connect the anode leads to the pipe lead, where indicated on the Drawings.

E. The test station wires shall be protected from damage where they enter the conduit below the concrete pad.

F. The test stations shall be set in poured concrete (2 feet on each side and 6 inches thick) and reinforced with #4 rebar.

G. Where offset test stations are utilized in roadways, the test wires shall be routed under the roadway to the test station through PVC electrical conduit.

3.07 TRENCHING AND BACKFILL FOR CATHODIC PROTECTION SYSTEMS

A. Complete excavations and trenching, regardless of the type, nature, or condition of materials encountered, as required to accomplish specified construction to lines and grades shown.

B. Take care to avoid damage to existing structures and utilities during excavating and trenching process. Contractor may modify location, as approved by the Engineer, to minimize possible damage to existing structures. Trenches shall be of uniform depth and width, level, smooth, and free of sharp objects.

C. Slope, shore, or brace excavations and trenches, in accordance with OSHA regulations, as necessary, to prevent caving during excavation in unstable material, and to protect adjacent structures, property, workers, and the public.

D. Install horizontal runs of PVC electrical conduit in trenches at a depth of 36 inches. Install plastic warning tape in a continuous manner at 12 inches above all horizontal runs.

E. Securely attach identification tags to all wires with nylon fasteners prior to backfilling operations.

F. Backfill trench with excavated backfill materials, if suitable. Suitable backfill shall be free of angular rock, debris, roots, turf, or other deleterious materials.

G. Do not use backfill material of frozen or consolidated debris. Leave the trench with the excess backfill material neatly mounded at not more than 4 inches above the existing ground level for the entire width of the trench.

3.08 CLEARANCE TO OTHER STRUCTURES

A. Natural clearance of 18 inches between the pipeline and other structures shall be maintained where possible. If 18 inches of clearance cannot be maintained, then an insulating blanket shall be installed between the two structures.

3.09 INSULATING FLANGES

A. Insulating flanges shall be installed where indicated on the Drawings. The Contractor shall carefully align and install the insulating components according to the insulator manufacturer's instructions.

3.10 REINFORCED CONCRETE STRUCTURES

A. Under no circumstances shall metallic pipe be in contact with reinforcing steel.

B. Position reinforcing steel used in the construction of support blocks, anchor blocks, vaults, and any and all other concrete structures so that they are not in contact with the piping. Maintain a minimum clearance of 2 inches between the piping and all reinforcement steel or other metallic components. Under no circumstances shall metallic pipe be in contact with reinforcing steel, in accordance with NACE SP0286. If sufficient clearance cannot be provided, then an insulating blanket may be required between the pipe and reinforcing steel.

C. When penetrating a reinforced concrete slab (wall or floor), install a linked rubber seal between the pipe and the concrete slab sleeve. Install the linked rubber seal, in accordance with the manufacturer’s requirements, to form direct contact to the concrete and to seal the area of the pipe penetration from water intrusion.

3.11 ISOLATION AND CONTINUITY TESTING

A. Insulating Flanges
   1. Test each insulated pipe flange in the presence of the Corrosion Engineer for effective electrical isolation of the two mating pipe flanges. Effectiveness of the insulated pipe flange shall be judged in accordance with NACE SP0286, Section 8.2.7, using an insulation checker (e.g., M.C. Miller Gas Electronics Model 601, Tinker & Rasor RF-IT or approved equal).

B. Casings
   1. Test for electrical isolation between any metallic pipeline and metallic casing in accordance with NACE SP0286.
   2. Prior to and upon completion of backfilling operations, test the electrical isolation between the pipeline and all casings the pipe passes through to ensure the casing is not electrically shorted to the pipeline. If the casing is found to be electrically shorted, or electrolytically coupled to the pipeline, the Contractor shall correct the deficiency at the Contractor's expense.

C. Joint Bonding
   1. After installation, test all joint bonds to ensure the intended structures are electrically continuous.
   2. Where the pipeline is installed utilizing horizontal directional drilling (HDD), or any method other than open trench, the pipe section shall be tested for electrical continuity prior to connecting to the upstream and downstream pipe sections.
   3. The Contractor is responsible for the electrical continuity of pipe where the bonding is performed.
   4. Install bonding jumper in accordance with section 3.03, where mechanical couplings are used.

3.12 CATHODIC PROTECTION SYSTEM ACTIVATION

A. The Contractor’s Corrosion Engineer and Cathodic Protection Technician shall inspect, activate, and adjust the cathodic protection system. The CP Technician shall work under the direct supervision of a Corrosion Engineer, as defined by this specification.

B. The Corrosion Engineer shall evaluate whether there are any stray currents affecting the water pipeline. If stray currents are present and affecting the water pipeline, and if there is the possibility that the current can cause detrimental corrosion, then the cathodic protection system’s performance shall be evaluated.

C. Do not proceed with the cathodic protection system activation until the reports for the following have all been submitted and accepted as complete by the Engineer: Insulated Flange/Joint Inspection Report; Electrical Isolation Testing Between Pipe and Steel Reinforcement Report; and Baseline (Native) Potential Survey Report. Provide a minimum of five days’ advance notice to the Engineer before the cathodic protection activation will be performed to allow for coordination and observance of these tests.

D. Before beginning each day of testing, calibrate portable copper/copper sulfate reference electrodes with respect to a master reference copper/copper sulfate reference electrode.

E. Measure and record native pipe-to-soil potentials (i.e., baseline pipe-to-soil potentials) at all cathodic protection test stations prior to activating the cathodic protection system. Measure native potentials at dielectric unions and at all test station wires. Measure the native potentials of electrically grounded equipment inside all vaults and structures along the pipeline. Where two wires are attached to the same pipeline, measure and record the native potentials for both wires. If the potential measurements for the same pipeline differ by more than 5 millivolts, investigate the cause. All test measurements shall be in accordance with NACE TM497.

F. At test stations constructed with buried copper/copper sulfate reference electrodes (i.e., stationary reference electrodes), measure and record native potentials of the pipeline using both the stationary reference electrode and a portable copper/copper sulfate reference electrode before the cathodic protection system is activated.

G. Measure the potentials of all galvanic anodes before they are connected to the pipe. Verify that the open-circuit potential of each high-potential magnesium anode is more electro-negative than –1,700 millivolts. While making these measurements, place the copper/copper sulfate reference electrode in the soil directly over the anode hole.

H. Activate the cathodic protection system by connecting all of the anode wires to the terminals inside each test station.

I. Measure and record "On" potentials at the same locations where native potentials were previously measured.

J. Measure and record the initial current of each anode groundbed using a portable digital meter. Measure and record the individual anode current outputs. Next, bond the anode lead wires to the pipe lead wires and measure the "On" potentials.

K. Resurvey the cathodic protection system at least two weeks after the initial energization to allow for the development of the cathodic polarization process.

L. Use the most recent current output of each anode groundbed to calculate the anode replacement dates, assuming continued uniform current outputs and the appropriate anode alloy consumption rate. Assume an 85% utilization rate for all anode ingots.

M. Furnish all test results, including all potential readings, anode groundbed current readings, insulating flange test data, dates, and times. Reference all data to the pipeline name and station number from which it was taken/observed. Submit all data, along with a letter report, to the Engineer. The letter report shall include a description of the test methods, analysis of the data, and conclusions about the cathodic protection system's effectiveness. Submit all data in a spreadsheet format compatible with Microsoft Excel. Submit data in both hard copy and electronic format.

N. Prior to substantial completion, the Engineer shall perform post-installation testing of all cathodic protection components. The repair or replacement of any defective or improperly installed components shall be the sole responsibility of the Contractor. Any and all repairs or replacement of defective or improperly installed cathodic protection components shall be performed by the Contractor and at no additional cost to the Owner.

3.13 ACCEPTANCE CRITERION FOR PIPE

A. The operation of the cathodic protection system shall be tested to ensure that all portions of the pipeline are provided a full level of corrosion protection.

B. The criteria used to evaluate the protection levels shall be as listed in NACE SP0169.

C. Workmanship, equipment, and materials furnished by the Contractor shall be guaranteed for two years.

END OF SECTION

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SECTION 33 31 14

THERMOPLASTIC PIPE

1.01 DESCRIPTION

A. Scope:

1. This section specifies polyvinylchloride pipe and fittings.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat-Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

PART 2 PRODUCTS

2.01 PVC PIPE

A. Pressure Pipe:
   1. PVC pressure pipe shall be AWWA C900 DR18 pipe. Pressure rating for pipe shall be in excess of test pressure specified in Section 40 05 01. Neoprene gaskets with push-on joints shall conform to ASTM F477.
   2. Schedule 80 PVC shall conform to ASTM D1784. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron push-on IPS-sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 40 05 24.

B. Nonpressure Pipe:
   1. Gravity Sewer Pipe: PVC material for sewer pipe and fittings shall conform to Class 12454-B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 35. Neoprene gaskets with push-on joints shall conform to ASTM F477.
   2. Overflow, Drain, Waste and Vent Pipe: PVC material for overflow, drain, waste and vent pipe and fittings shall conform to Class 12454-B, ASTM D1784 for Schedule 80. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 COMPONENTS

A. PVC Solvent Weld Cement:
   1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
   5. Universal plastic pipe solvent is not acceptable.

B. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent-cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push-on joints and steel or ductile iron push-on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 40 05 24. Unless otherwise specified, PVC piping exposed to sunlight shall be painted with coating system L-2 as specified in Section 09 90 00.

B. Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

3.02 TESTING

A. Testing of plastic piping shall be as specified in Section 40 05 01.

END OF SECTION

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SECTION 33 32 16

PACKAGED UTILITY WASTEWATER PUMPING STATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This Section includes Packaged Submersible Sewage Grinder Nonclog Pump Stations including alarm requirements, station piping, and O&M data packages.
   2. Adhere to all requirements of the latest revision of the City of Vancouver General Requirements and Details for the Design and Construction of Water, Sanitary Sewer, and Surface Water Systems, and these Specifications. Where a conflict in requirements exists, the stricter requirement shall be used, and the Engineer notified.
   3. All pipe, fittings, appurtenances and ancillary components must be NSF 61 compliant.
   4. All fittings and connections shall be restrained.

B. Equipment List

Item	Equipment Number
Grinder Pump 1	U05-PMP100
Grinder Pump 2	U05-PMP200
Grinder Pumps Local Control Panel	U05-LCP100

C. Pipe Designations:
   1. The following pipe designations are defined:

Designation	Definition
PVC	Polyvinyl Chloride
DI	Ductile Iron

1.02 REFERENCES

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C509	(2023) Resilient-Seated Gate Valves for Water Supply Service
AWWA C515	(2020) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C517	(2009) Resilient-Seated Cast-Iron Eccentric Plug Valves
AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA M23	(2020) Manual: PVC Pipe - Design and Installation - Third Edition
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)

ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2024) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D883	(2020a) Standard Terminology Relating to Plastics
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2017) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3753	(2019) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ISO 1940-1	(2003; R 2008) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
NEMA MG 1	(2021) Motors and Generators
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 820	(2016) Standard for Fire Protection in Wastewater Treatment and Collection Facilities
UL 67	(2018; Reprint Aug 2023) UL Standard for Safety Panelboards
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.03 SUBMITTALS

A. Provide in accordance with Section 01 33 00.

B. Action Submittals:
   1. Product Data:
      a. Pump Performance Curve
      b. Pump Motor
      c. Pump Control System
      d. Wet Well and Valve Vault
      e. Flexible Flanged Coupling
      f. Station Piping and fittings

g. Valves
h. Access Hatch Covers
i. SD-05 Design Data
j. Buoyancy Calculations
k. SD-06 Test Reports

2. Shop Drawings:
   a. Fabrication Drawings
   b. Erection/Installation Drawings
   c. Electrical Wiring Drawings
3. SD-07 Certificates

C. Closeout Submittals:
   1. Certificates and Affidavits: Furnish the following prior to shipment.
      a. Manufacturer's certificates of compliance.
      b. Pump Test
      c. Pressure Sensor Test
      d. Float Test
      e. Affidavit of compliance with applicable standard.
      f. Test certificates.
      g. Operation And Maintenance Manuals

1.04 QUALITY ASSURANCE:

A. Manufacturers shall be experienced in the design and manufacture of Packaged Utility Wastewater Pumping Stations for a minimum of five years.

B. Inspection of the unit shall be made by the Engineer after delivery. The unit shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though unit may have been accepted as satisfactory at the place of manufacture. Rejected parts and units shall be removed from the jobsite immediately.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Ship all material to the site and store in laydown areas.

B. Handling and storage shall be in accordance with specification requirements in Part 3 of this Section.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide a complete packaged duplex sewage pump station with submersible grinder nonclog pumps including equipment and materials, installed and ready for operation. The pump supplier furnishes the controls, pumps, and rail system to ensure unit integrity.

B. Submit fabrication drawings before installation. Submit drawings covering necessary or recommended changes to accommodate the equipment offered. Show on the drawings the design of the chamber, with dimensions, types, and thicknesses of materials, and elevation levels with reference to those elevations indicated.

C. Submit erection/installation drawings for the manhole chamber with the required equipment and accessories. Show the design of the chamber, with dimensions, types, and thicknesses of materials, and elevation levels with reference to those elevations indicated.

2.02 SUBMERSIBLE SEWAGE GRINDER NONCLOG PUMPS

A. Provide submersible sewage nonclog pumps with grinder units as indicated. Provide UL listed pumps for explosion proof Class I, Division 1, Groups C and D hazardous locations. Provide submersible, centrifugal sewage pumps and grinder units capable of grinding the materials found in normal domestic sewage, including plastics, rubber, sanitary napkins, disposable diapers, animal hair and wooden articles into a finely ground slurry with particle dimensions no greater than 1/4 inch of the nonclogging type with passageways designed to pass 3 inch diameter spheres without clogging. Provide pump capacity, number of pumps and motor characteristics as indicated on the drawings. Select pumps to continuously operate in a submerged or partially submerged condition.

B. Pump Construction
   1. Casing:
      a. Provide hard, close-grained cast iron casing or steel that is free from blow holes, porosity, hard spots, shrinkage defects, cracks, and other injurious defects. Provide casings permitting replacement of wearing parts. Ensure all joints are gasketed to prevent leakage. Ensure passageways permit smooth flow of sewage and are free of sharp turns and projections. Use free standing pump support legs of cast-iron.

C. Impeller
   1. Provide a stainless steel impeller for the grinder pump with stainless steel cutter, grinder, or slicer assembly. Provide nonclogging type cast-iron impeller, conforming to ASTM A48/A48M, Class 30, for a submersible nonclog pump. Ensure the impeller has a smooth surface and allows free flowing with the clearance to permit objects in the sewage to pass. Fit and key, spline, or thread impeller on shaft, and lock in such manner that lateral movement is prevented, and reverse rotation will not cause loosening.

D. Bearings
   1. Provide self-lubricated, permanently sealed bearings sized to withstand imposed loads.

E. Balance
   1. Balance rotating parts of the equipment mechanically and hydraulically to operate throughout the required range without excessive end thrust, vibration, and noise. Conform allowable vibration limits with ISO 1940-1, Table 1. Existence of defects that cannot be eliminated by adjustment will be sufficient cause for rejection of the equipment.

F. Pump Motor
   1. Provide hermetically sealed electric motors with moisture and temperature-sensing probes in the wet well for submersible pumps. Motor horsepower must not be less than pump horsepower at any point on the pump performance curve. Fit motors with lifting "eyes" capable of supporting entire weight of pump and motor. Seal the power cable inside the motor end bell. Provide a waterproof power cable for its full length. Provide motors UL listed for explosion proof Class I, Division 1, Groups C and D. Air filled motors are not acceptable. Ensure oil used may be disposed as non-hazardous waste.

G. Pump Control System
   1. General
      a. Provide an automatic type pump operating control including all necessary components including motor starters to function reliably. Mount controls in a NEMA 4X rated control panel. Ensure equipment subject to contact with sewage or sewage gases is corrosion-resistant metal.
      b. Provide mode of operation for pumps to start, stop and auto start/stop based on level. Provide indication for running, ready, trouble, alarms, and pump performance statistics.
      c. Operate on 120 Vac, 60 Hz, single phase power supply.
      d. Provide a remote alarm dry contact rated 24 Vdc at 0.5 amps for SCADA to interface for each pump.
      e. Protect pumping stations from lightning and transient voltage surges and equip with phase protection.
      f. Design the control system to operate pumps at the power characteristics as shown on the plans. Ensure all controls and wiring meet or exceed the requirements of NFPA 70. For pumps specified as explosion proof, have pump power and control installation meets NEC requirements for Class I, Division 1, Group D Hazardous Location, including intrinsically safe controls. Provide components that are UL listed or FM approved.

H. Enclosure
   1. Provide a NEMA 3R rated enclosure manufactured from stainless steel. The enclosure is a buried type, suitable for subsurface installation with a minimum depth required to collect the wastewater from the drain lines connected to the pump. Provide a rubber composition door gasket and assures a positive weatherproof seal. Provide a door that opens a minimum of 180 degrees and is equipped with a 3-point latch.

I. Level Control System
   1. Provide a sealed, mercury-free level instruments interconnected to the control system to sense variations of sewage level in the wet well.
   2. Provide stainless steel brackets in accordance with manufacturer's recommendations.
   3. Mount level instruments at fixed elevations as recommended by manufacturer.

J. Coating:
   1. The exterior of ductile iron pipe shall have an asphaltic coating per AWWA C151.

2.03 WET WELL AND VALVE VAULT

A. Provide a fiberglass reinforced polyester resin basin include a separate valve vault. Provide a wet well and valve vault with inside diameters 36 inches and to the depths indicated on the drawings.

B. Fiberglass Basins
   1. Buoyancy Calculations: Submit buoyancy calculations sealed by a licensed professional engineer assuming seasonal high groundwater elevation at proposed finished grade. Prevent flotation in accordance with manufacturer's written instructions. Include manufacturer's written instructions with submitted calculations.
   2. Select Fiberglass Reinforced Polyester (FRP) wet well in accordance with ASTM D883 relating to plastics and ASTM D3753.
   3. Use commercial grade polyester resins evaluated as a laminate by test or determined by previous service to be acceptable for use in the wastewater environment.
   4. Use a commercial grade continuous strand fiberglass reinforcement material.
   5. Design FRP based on the following assumed conditions. Provide independent third-party testing.
      a. Hydrostatic pressure of 305 kilogram-force/square meter 62.4 pounds/square foot with water at ground surface.
      b. Saturated soil weight of 1,922 kilogram/cubic meter 120 pounds/cubic foot.
      c. Soil modulus of 3,418 kilogram-force/square meter 700 pounds/square foot.
      d. Pipe stiffness values as specified in ASTM D3753.
      e. Provide FRP laminate with a surface hardness of 90 percent Barcol.

C. Access Hatch Covers
   1. Provide stainless steel access hatch covers as indicated. Include lifting mechanism, automatic hold open arm, slam lock with handle, and flush lift handle with vinyl grip. Use automatic hold open arm that locks in the 90-degree position. Use access hatch cover capable of withstanding a live load of 300 lb./sq. ft.

D. Wet Well Base Material
   1. Provide crushed stone as indicated and specified in Section 31 00 00 EARTHWORK

E. Accessories
   1. Provide flanges, connecting pieces, transition glands, transition sleeves,
   2. and other adapters as required.

F. Flexible Flanged Coupling
   1. Provide flexible flanged couplings applicable for sewage as indicated. Use flexible flanged coupling designed for a working pressure of 2.41 MPa 350 psi.

G. Valves And Other Piping Accessories
   1. For valves within valve vault, use manufacturer provided valves designed for wetwell system.
   2. Check valve compatible with the pump is required on the discharge piping immediately downstream from the pump assembly.
   3. For valves and accessories outside of wetwell vault, see applicable specifications.

H. Identification Tags and Plates
   1. Provide the manufacturer's name or trademark on a corrosion-resistant identification plate or cast integrally, stamped, or otherwise permanently marked in a conspicuous place on each item of equipment. Include on the pump identification plate the pump capacity in liter per minute gpm, pump head in meter feet and speed of rotation. Cast on the body of the pump in the direction of rotation.

2.04 MANUFACTURERS

A. E/One Extreme duplex grinder pump station with E/One Sentry Protect Plus panel or approved equal. The E/One grinder pump station requires installation of the E/One UNI-LATERAL™ stainless steel check valve assembly, Model NA0330P04.

PART 3 EXECUTION

3.01 INSTALLATION

A. INSTALLATION
   1. Provide pump station in accordance with drawings and requirements of the respective equipment manufacturers. Dampen and isolate equipment vibration.

B. Equipment Installation
   1. Install equipment in accordance with these specifications and the manufacturer's installation instructions. Grout equipment mounted on concrete foundations before installing piping. Install piping to avoid imposing stress on equipment. Match flanges before securing bolts.

C. Clean interior of all pipes, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.
   1. Close open ends of pipe with snug-fitting closures.
   2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
   3. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.

D. Brace or anchor as required to prevent displacement after establishing final position.

E. Perform only when weather and trench conditions are suitable. Do not lay in water.

F. Observe extra precaution when hazardous atmospheres might be encountered.

3.02 FIELD TESTING:

A. Provide appliances, materials, water, and equipment for testing. Water and electric power needed for field tests will be provided as set forth in Division 01. Conduct testing after equipment, electrical services, and piping are installed, and the pump station is ready for operation. Correct defects discovered to the satisfaction of the Owner, and tests repeated, at no additional cost to the Owner, until the equipment functions as intended and designed. Limit fill rate of line to available venting capacity. Fill rate shall be regulated to limit velocity in lines when flowing full to not more than 0.05 to 1 fps.

B. Owner shall make water for testing available to Contractor at nearest source.

3.03 TESTING PROCEDURE

A. Perform a pump test, and float test. Submit the test results to the Engineer.

B. Test all panels to the power requirements as shown on the plans to assure proper component operation. Activate each control function to check for proper operation and indication.

C. Field Representative
   1. A representative of the pump manufacturer is to direct the startup of the station and instruct representatives of the Owner in startup and operation procedures.

3.04 CLOSEOUT ACTIVITIES

A. Operation and Maintenance
   1. Submit operation and maintenance manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA for package lift stations, including Equipment Description, Assembly and Installation Procedures, Adjustment and Alignment, Checkout Procedures, Procedures of Operation and Troubleshooting. Include preventative maintenance and inspection procedures for package lift stations. Include in procedures the frequency of preventative maintenance, inspection, adjustment, lubrication, and cleaning necessary to minimize corrective maintenance and repair.

B. Supply special tools that are required for maintenance and testing of the package lift stations.

C. Submit spare parts data, including a complete list of parts and supplies with current unit prices and source of supply. List parts and supplies that are either normally furnished at no extra cost with the purchase of equipment or specified to be furnished as a part of the contract, and list additional items recommended by the manufacturer to ensure an efficient operation for a period of one year.

D. Install on or near the package lift stations, a complete package of posted instructions, consisting of labels, signs, and templates of operating instructions.

E. Provide a list or reference all specific operation and maintenance procedures that are required to keep the warranty valid.

END OF SECTION

SECTION 33 39 13

MANHOLES, FRAMES, AND COVERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment required to install precast concrete manholes, grade rings, frames and covers, and appurtenances as shown on the Drawings and as specified herein.

B. Requirements And Responsibilities:
   1. Construct the manholes complete, as specified and shown on the Plans.
   2. Install required facilities and equipment in the precast concrete manholes in accordance with the intent of these Contract Documents, referring to all the Plans and Specifications, and show drawings for other trades for details of support, attachments, embedments, finishes and other construction which affects the work covered under this Section.
   3. Furnish all labor, materials, supplies, and equipment required to perform the work specified in this section, including but not limited to the construction of the manholes and concrete structures, the installation and testing of all required equipment, and any flow diversions or bypass pumping required to complete the work.

C. The following items are specified in this Section.
   1. Factory design and manufacture of precast concrete manhole sections and accessories.
   2. Quality assurance and control.
   3. Field installation of manholes.
   4. Waterproofing and epoxy coating of manholes.
   5. Installation of frames and fall protection.
   6. Ladders and safety devices.

1.02 RELATED SECTIONS

A. Section 03 20 00 - Concrete Reinforcing

B. Section 03 30 00 - Cast-In-Place Concrete

1.03 REFERENCES

Reference	Title
ASTM A48	Gray Iron Castings
ASTM C150	Portland Cement
ASTM C207	Hydrated Lime for Masonry Purposes
ASTM C478	Precast Reinforced Manhole Sections
ASTM C858	Underground Precast Concrete Utility Structures
ASTM C891	Installation of Underground Precast Concrete Utility Structures
ASTM C913	Precast Concrete, Water, and Wastewater Structures

Reference	Title
ASTM C923	Resilient Connectors Between Concrete Manhole Structures and Pipes
ACI 301	Specifications for Structural Concrete Buildings
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 315R	Manual of Engineering and Placing Drawings for Reinforced Concrete Structures
ACI 318	Building Code Requirements for Structural Concrete
CRSI 63	Recommended Practice for Placing Reinforcing Bars
FEDSPEC SS-S-00210A	Sealing Compound, Preformed Plastic for Pipe Joints

1.04 DESIGN

A. All manholes shall be designed by a licensed professional engineer registered in the State of Washington and engaged by the manufacturer. All dead loads, live loads, flotation, erection, temperature, and anchorage stresses shall be considered.

B. The calculations and drawings shall be prepared in a neat and legible manner, sealed by the licensed Professional Engineer performing the calculations.

C. The sealed calculations shall include a summary page to list all design loads, material specifications, and design criterion used in the calculations.

D. For design, groundwater shall be assumed at grade and the design shall provide for a 50 percent factor of safety against floatation.

E. Manholes shall be designed for HL93 wheel load on top slab, frame and cover, and surcharge loading at grade around all sides of the structure.

1.05 SUBMITTALS

A. Shop drawings, product data, materials of construction, and details of installation shall be submitted in accordance with Section 01 33 00. Submittals shall include the following:
   1. Design calculations, sealed by a Professional Engineer licensed in the State of Colorado, indicating adequate strength to resist the vertical and lateral loadings including HL93 wheel loadings, and buoyancy forces.
   2. Base sections, riser sections, eccentric and concentric conical top sections, flat slab tops, grade rings with notarized certificate indicating compliance with ASTM C478.
   3. Concrete mix design.
   4. Detail of pipe connection(s) to manhole.
   5. Manhole frame and cover style and finish with notarized certificate indicating compliance with ASTM A48, Class 30.
   6. Method of repair for minor damage to precast concrete sections.
   7. Submit evidence that shows current PCI, NPCA, and/or CDOT certification.
   8. Submit shop drawings of wall sections and bases proposed for this project, include joint design and related details for field assembly as applicable.
   9. Submit certification of conformance with Contract Documents and ASTM C478 or C858.

10. Submit catalog cut and installation details for cast iron manhole covers, and ladders with safety devices, as needed.

B. Submit catalog cut for epoxy coating system used at interior surfaces and waterproofing system used on exterior surfaces.

C. Under a separate submittal, provide copies of calculations for each manhole indicating all loads and load combinations. Other than the summary page, calculations will not be reviewed; calculations will not be returned to Contractor.

D. Manufacturers Installation (or Application) Instructions

E. Operation and Maintenance Data

1.06 QUALITY ASSURANCE

A. All material shall be new and unused.

B. Materials' quality, manufacturing process and finished sections are subject to inspection and approval by the Engineer. Inspection may be made at place of manufacture, at work site following delivery, or both.

C. Materials will be examined for compliance with ASTM specifications, these Specifications, and approved manufacturer's drawings. Additional inspection criteria shall include appearance, dimensions(s), blisters, cracks, and soundness.

D. Materials shall be rejected for failure to meet any Specification requirement. Rejection may occur at place of manufacture, at work site, or following installation. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to Owner.

E. Repair minor damage to precast concrete sections by approved method if repair is authorized by the Engineer.

F. Manufacturer shall be a PCI, NPCA, and/or WSDOT-certified plant for production of precast manholes as specified herein.

G. Aggregate used in producing concrete shall be from WSDOT approved sources.

1.07 QUALITY CONTROL INSPECTION

A. The quality of all materials, the process of manufacture and the finished sections shall be subject to inspection by the Engineer. Such inspection may be made at the place of manufacture and/or at the Site after delivery.

B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface shall be dense, close-textured, and free of honeycomb, cracks, roughness, exposure of reinforcement, damaged joints, or other irregularities.

C. All sections which have been damaged after delivery will be rejected, or if already installed, shall be repaired, or removed and replaced entirely at Contractor’s expense.

D. Rejected sections shall be tagged as such, segregated from other sections, and removed from the Site.

PART 2 PRODUCTS

2.01 CONCRETE

A. Minimum 28-Day Compressive Strength - 4500 psi. Ship precast concrete only after concrete has attained a minimum 3,000 psi compressive strength.

2.02 REINFORCEMENT

A. Reference Section 03 20 00.

2.03 GROUT

A. Conform to Section 03 60 00.

2.04 PRECAST OR CAST-IN-PLACE CONCRETE BASES

A. Design and manufacture of precast concrete bases shall conform to the requirements of this section and ASTM C478 and C858. Cast-in-place concrete bases shall conform to Section 03 30 00.

B. Bases shall conform to the dimensions indicated on the Drawings or as required by design. Bottom slab thickness shall equal the riser wall thickness or flat slab top thickness, whichever is greater. The horizontal joint at the top of the base shall be compatible with that of the precast wall section.

C. Sumps shall be field constructed where shown on the Drawings. Walking surfaces shall be sloped to the sump, have a non-slip broom finish, and be sealed with a penetrating concrete sealer. Minimum concrete fill thickness at sumps shall be two inches.

2.05 PRECAST CONCRETE WALLS

A. Design and manufacture of precast concrete walls shall conform to the requirements of this section and ASTM C478 or C858.

B. Wall thickness shall be a minimum of 6 inches.

C. All tongue-and-groove joints in the precast wall, including the joint at the top of the base, shall be made up using gaskets.

D. The precast sections shall be provided with a special groove to receive and hold the gasket in position during joint assembly.

E. Manhole joint seals shall be of preformed type in conformance with FEDSPEC SS-S_00210A. Thickness of the seal shall be as recommended by the manufacturer of the precast manhole sections.

F. After joint assembly, the gap between sections shall be packed on the inside and outside with “Masterflow 713” by Master Builder; “Five Star Grout” by U.S. Grout Corp.; or equal and shall be troweled smooth so that no projections remain on the inside. There shall be concrete to concrete bearing between the various sections. The gasket shall not support the weight of the section.

2.06 PRECAST CONCRETE TOPS

A. Unless otherwise specified, top section for manholes shall be eccentric cone where cover over pipe exceeds 4 feet; top section shall be flat slab where cover over top of pipe is four feet or less, or where shown.

B. Precast reinforced concrete tops shall be manufactured in accordance with ASTM C478 or C858. Openings and frames shall be provided for hatches where shown on the Drawings.

C. Slab tops shall be crowned or sloped to drain, minimum 1/4 inch per foot.

D. Concrete slab tops shall receive a non-slip broom finish and a penetrating concrete sealer per Section 03 30 00.

2.07 MANHOLE FRAME AND COVER

A. Manhole frames and covers shall be of good quality, strong, tough, even grained ductile iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Manhole covers and frame seats shall be machined to a true surface. Castings shall be thoroughly cleaned and subject to hammer inspection. Ductile iron shall conform to ASTM A536.

B. Manhole rings and covers shall be Neenah Foundry R-1798 or Deeter Foundry 1197 (Neenah R-1798-1S or Deeter 1161 for flush frames), or equal.

C. Manhole frames and covers shall be the heavy-duty type designed for HL93 highway loading, shall be removable and non-rocking, and have a 30-inch clear frame opening with a 4-1/2-inch minimum flange height, unless indicated otherwise on the Drawings.

D. Cover pattern shall be checkered pattern design and shall have concealed or closed pick holes with sufficient dimensions to allow for removal without special equipment. Bearing and wedging surfaces shall be machined to ensure a tight fit and to prevent rocking. Frames shall be provided with four 1-inch diameter holes for anchor bolts. The use of salvaged or scrap materials will not be permitted. The type of service piping, of the size and letter type acceptable to the City, shall be cast into each manhole lid.

2.08 PIPE SEALS

A. Where polyethylene, plastic or PVC pipe is utilized, connections between manhole and pipes shall be made with flexible rubber sleeves with stainless steel straps and bolts. Provide an elastomeric waterstop gasket where sleeve sizes are not commercially available.

B. Flexible Sleeve - Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe in sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve; Kor-N-Seal connector; PSX Press-Seal Gasket or equal.

C. Compression Gasket - Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gasket shall be A-Lok, or equal.

D. The annular space around the pipe wall or sleeve shall be packed with “Masterflow 713” by Master Builders, “Five Star Grout” by U.S. Grout Corp.; or equal. Before the grout has set, recheck invert elevations of the pipe.

E. For steel or ductile iron pipe, provide a pipe sleeve sized to accept the pipe plus a modular mechanical seal such as Link Seal or equal.

2.09 LADDER

A. Where shown on Drawings, provide ladder rungs made from polypropylene with steel reinforcement. Rungs shall be either cast in place or drilled and adhesive grouted in the shop. Rungs are equally spaced at a maximum 12-inch spacing from the top of the base slab to the top of the top slab.

B. Install ladder rungs so that the distance from the rungs to the finished wall is seven inches.

2.10 PRECAST CONCRETE GRADE RINGS

A. Concrete used to fabricate grade rings shall contain a proportion of cement in the mixture not less than 564 pounds per cubic yard of concrete except that a maximum of 64 pounds of Portland cement may be replaced with a minimum of 100 pounds of fly ash. The mixture shall contain 6 percent (plus/minus 1.5 percent) entrained air. The minimum compressive strength shall be 5,500 psi at 28 days. the maximum water absorption shall not exceed 6 percent by weight. If the grade ring is steam cured, it shall not be reduced in temperature more than 40 degrees F per hour until it is within 20 degrees F of the outside temperature. The units shall be maintained at a temperature above 32 degrees F during the first 6 days after curing.

2.11 OPENINGS AND INSERTS

A. All openings required in the concrete shall be reinforced with additional diagonal bars tied to each layer of wall or slab reinforcement.

B. Any required pipe sleeves, inserts, and wall openings shall be coordinated with mechanical requirements prior to casting the units.

2.12 MORTAR AND GROUT

A. Use mortar to shape inverts for smooth flow across structure floor, and to bed cover frames. Non-shrink grout used to point irregularities where pipes penetrate manhole walls.

2.13 MOISTURE PROOFING

A. Cold applied asphalt-emulsion per ASTM D1227. Type 2, Class I and ASTM D1187 Type 1, 1/8-inch minimum thickness.

B. Exterior wall surfaces shall be moisture proofed using manufacturer's standard system, designed to dampproof the exterior of concrete surfaces in a below-grade submerged condition.

C. For the top slab and above-grade exposed side walls, the concrete shall be sealed with two coats of a penetrating concrete sealer.

2.14 EPOXY COATING

A. The interior surface of sanitary sewer manholes shall receive a factory applied epoxy coating. Apply at wall surfaces (full height) and ceiling for flat top slabs and vaults.

B. Surfaces shall be abrasive blasted and allowed to cure a minimum of 28 days prior to application of epoxy coating system. Follow manufacturer's instructions for primer, application temperatures, etc. Use Sika Corporation "Sikagard 62", Euclid Chemical Company "Duraltex 1707", or equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade elevations for manhole base is correct, excavation is dewatered, and subgrade is pre-compacted.

B. Verify that rejected units have been removed from Site.

3.02 PREPARATION

A. All excavation, temporary shaft supports, sheeting and shoring, foundation cushion, concrete and grout required to support the walls of shafts and necessary to construct the manholes as shown on the plans shall be provided.

B. Excavated materials shall be disposed of by the contractor as described in Section 31 23 00 of the specifications and the cost of which shall be included in the various lump sum prices stipulated in the bid.

C. Shoring, sheeting, and bracing required for the construction of manholes and cleanouts shall conform to those requirements as specified in Section 31 41 00.

D. Provide foundation mat of run-of-crusher stone to support base. Class E1 aggregate base as defined in Section 31 23 00 may also be used for the foundation mat. Mat shall be 12 inches minimum depth and shall bear on sound undisturbed earth; excavate and remove subgrade material as necessary to reach sound subgrade. Compact as specified in Table A of Section 31 23 00.

E. Stone foundation mat diameter shall be a minimum of one foot greater than the footprint of the manhole base, and shall be compacted to a uniform, level surface.

3.03 INSTALLATION

A. Manhole shall be accurately located and uniformly supported on the foundation mat in a level position.

B. Install manholes in accordance with ASTM C891 and the drawings. Precast concrete manhole riser sections shall be installed plumb and true on the concrete base sections as shown on the plans. Before placing the joint seal, all bearing surfaces shall be wiped clean. Care shall be taken when lowering any precast unit into the trench that no dirt gets on the seal or into the joint. Top sections of precast manholes shall be eccentric cone sections cast to the proper dimensions to receive the manhole casting shown on the plans. Top section shall be flat slab only where cover over top of pipe is four feet or less, or where shown on the drawings.

C. Install wall sections in properly oriented position; follow manufacturer's instructions for joining together each section using the gaskets. Pack joints with grout.

D. The top of the cone or flat lid section will not extend closer than six (6) inches nor more than twelve (12) inches from the top of the manhole cover. Grade rings shall be used to adjust the manhole frame to final grade.

E. Backfill for manholes shall be Class B1 material, placed and compacted in accordance with the requirements of Section 31 23 00.

F. The top of the wall of all manholes shall be properly leveled off to meet or site above grade as indicated on the Drawings but shall not be left in a depression to act as an area drain.

G. When there is not enough room for a full length of precast concrete riser section to be installed under the manhole frame, precast reinforced concrete grade rings and mortar shall be used for sanitary manholes. The use of brick masonry is prohibited.

H. Precast bottom sections with integral bases when used shall be set plumb on a firm foundation in the trench. Height of the bottom section shall be provided to admit the various pipes at the elevations shown on the drawings and still contain sufficient material for structural integrity across the top of these openings. Pipe openings shall be cast into the unit at the time of manufacture. All pipe connections to precast concrete manholes shall be made with resilient connectors conforming to ASTM C923.

I. Cast-in-place reinforced concrete manhole bottom sections shall be built in accordance with the dimensions indicated on the plans.

J. Construct manhole inverts in conformance with manhole details shown on the Plans, and with smooth transitions to insure an unobstructed flow through the manhole. Remove all sharp edges or rough sections which tend to obstruct flow. Where a full section of pipe is laid through a manhole, break out the top section and cover exposed edge of pipe completely with mortar. Trowel all mortar surfaces smooth.

K. The trough of a manhole for sanitary sewers shall be the same diameter as the larger of the adjoining sewers. The pipe may be laid through the manhole, and the upper half of the pipe shall be removed after the manhole is built. The pipe shall be supported on solid concrete blocks for the placement of the concrete base. The concrete shall be extended under the pipe to the face of a pipe joint and where the pipe rests on undisturbed soil. This extended portion of the manhole base shall rest on undisturbed soil.

L. The manhole frames shall be adjusted to make the top of the rim a two to three inches higher than the surrounding ground so it will not act as a surface drain in unpaved areas, or flush with paved surfaces.

M. Contractor is responsible for the integrity of all materials and protection against flotation during the installation and backfilling process.

3.04 PIPE TO MANHOLE CONNECTIONS

A. Provide joints in reinforced concrete, nonreinforced concrete and clay pipe sewers not more than one foot from the outside face of manhole walls. Provide joints in flexible pipe sewers within 1 to 3 feet from manhole walls. Pipes entering and leaving the base of the manhole shall be laid on compacted bedding material.

B. Where pipe enters the manhole above the manhole base, it shall be supported with compacted Type B Structural Backfill as specified in Section 31 23 00. The backfill shall extend from the manhole wall to undisturbed earth.

3.05 MANHOLE FRAMES AND COVERS

A. Install frames and covers on top of manholes grade rings to prevent all infiltration of surface or ground water into manholes. Frames shall be set in a bed of mortar with the mortar carried over the flange of the frame. Set frames so tops of covers are flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

3.06 BACKFILLING

A. Backfill using well compacted structural fill material, being careful to not damage exterior waterproof coating while providing full support under connecting pipes using compacted bedding material.

B. During the one-year warranty period, all visible leaks shall be sealed in an approved manner.

3.07 HYDROSTATIC TESTING FOR MANHOLES AND CONNECTED PIPING

A. When the groundwater table is too low to permit visual detection of leaks, all manholes shall be hydrostatically tested, or vacuum tested.

B. Hydrostatic Testing: The test shall consist of plugging all inlets and outlets and filling the manhole with water to a height determined by the Engineer. Leakage in each manhole shall not exceed 0.2 gallon per hour per foot of head above the invert. A manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into the pipe walls to take place. Repair all manholes that do not meet the leakage test, or are unsatisfactory from visual inspection, to conform to the requirements herein.

C. Vacuum Testing: Vacuum test in accordance with ASTM C1244.
   1. Plug pipe openings; securely brace plugs and pipe.
   2. Inflate compression band to affect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 10 inches of Hg; close valve; start test.
   3. Test duration for manhole sizes is as follows:

      4-foot diameter 60 seconds

      5-foot diameter 75 seconds

      6-foot diameter 90 seconds
   4. Record vacuum drop during test period; when vacuum drop is greater than 1 inch of Hg during test period, repair, and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test, and accept manhole.
   5. When vacuum test fails to meet 1 inch Hg drop in specified time after repair, repair and retest manhole.

D. Piping shall be tested as outlined in Section 40 05 01 Piping Systems.

END OF SECTION

SECTION 40 05 01

PIPING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 40. This section shall be used in conjunction with those sections.

B. Use the general requirements specified in this section with the more specific requirements listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and other referenced sections. Except where referenced specification sections specify alternate provisions, the requirements of this Section apply to all piping systems listed in Section 40 05 02.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   5. Section 03 30 00 – Cast-in-Place Concrete
   6. Section 09 90 00 – General Coating Specification
   7. Section 31 23 00 – Excavation and Fill
   8. Section 40 05 02 – Piping System Schedules
   9. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   10. Section 40 05 07 – Hangers and Supports for Process Piping
   11. Section 40 05 07.13 – Seismic Restraints for Piping
   12. Section 40 05 07.16 – Expansion Control for Piping
   13. Section 40 05 45 – Piping System Identification
   14. Section 40 05 57.13 – Manual Actuators
   15. Section 40 05 57.23 – Powered Actuators
   16. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
AASHTO M36/M36M	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Under-drains
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM B88	Seamless Copper Water Tube
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C296	Asbestos-Cement Pressure Pipe
ASTM C443-REV A	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

Reference	Title
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger--Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C301	Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
AWWA C303	Reinforced Concrete Pressure Pipe--Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe--A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
FEDSPEC L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-STD-810C	Environmental Test Methods
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
UPC	Uniform Plumbing Code

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Maximum pressure: The greatest continual pressure at which the piping system is designed to operate.
   2. Test pressure: The hydrostatic, air, or gas pressure used to determine system compliance.
   3. Take down coupling: Pipe couplings that facilitate disassembly of piping systems without damage or demolition of piping system components.

4. Embedded/Encased piping: Piping enveloped in reinforced concrete, typically under structures and under roadways, where specified on the drawings.
5. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

B. Piping System Identification
1. Process, mechanical, plumbing, utility, vent, and HVAC piping system piping is identified by a two component alpha-numeric code, (Line Label) as follows:
   a. The first component of the code indicates the nominal line size.
   b. The second component of the code identifies the process Service or fluid being conveyed in the Piping System.
2. Process Service identifiers for pipelines are specified on the drawings. The Process Service is defined for each Process Service Identifier in Section 40 05 02.
3. Detailed specifications for each Process Service are scheduled in Section 40 05 02.00 through 40 05 02.99.
4. Mark and label Piping Systems as specified in Section 40 05 45.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Refer to Section 40 05 45 for process piping identification requirements.
2. Pipe Sleeves: Coordinate placement of sleeves and penetrations in cast-in-place concrete with raceway, duct, and pipe penetrations prior to concrete placement. Coordinate placement of sleeves and wall penetration prior to construction of masonry building elements.
3. Coordination required with the design of piping supports (hangers, guides, anchors, structural attachments, etc.), expansion joints, and expansion control and seismic restraints. Refer to sections 40 05 07, 40 05 07.13, and 40 05 07.16.

1.06 SUBMITTALS

A. Action Submittals:
1. Procedures: Section 01 33 00.
2. A copy of this specification section, along with Sections 01 73 24, 40 05 07, 40 05 07.13 and 40 05 07.16, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Submit piping layout drawings for all piping systems, including raceway, duct and other specified systems support. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, flushing connections, drains, sample taps, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall and floor penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.). Include details of connections to new and existing equipment, piping and structures. Submit original layouts by the Contractor; photocopies of Contract Drawings are not acceptable. Identify the invert elevation of buried pipe at changes in slope, pipe crossings, and connections to structures on piping layout drawings in addition to providing coordinates for locating changes in horizontal alignment of buried pipe.
4. For each piping system (refer to Piping System Schedules in Section 40 05 02.00 through 40 05 02.99), submit document listing pipe, fittings, linings, coatings, valves, flexible connectors, expansion joints, couplings, bolts, gaskets, restraints, and other items provided for each applicable pipe size and category.
5. Welding: Prior to commencing any welding of steel or stainless steel pipe, supports, and/or structural attachments, provide a written description of welding techniques, including, but not limited to, materials, methods, and quality control. Identify differences in shop and field techniques. Indicate in the submittal that the welding technique has been reviewed for each piping service and certify that the technique is acceptable for the intended service condition (piping service defined in Section 40 05 02 and area exposure designation specified in Section 01 61 45). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of Washington and qualified for welding design.

B. Informational Submittals:
1. Procedures: Section 01 33 00
2. Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.
3. Safety plans for pneumatic pressure testing.

1.07 QUALITY ASSURANCE

1. Review the drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Construction Manager to determine the adjustments necessary to resolve conflicts.
2. Confirm the routing of each section of pipeline with other services prior to commencement of installation. Advise the Construction Manager of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Construction Manager.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Requirements:
1. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.

2. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.
3. Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.
4. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.
5. Protect non-UV light inhibited plastic from sunlight.
6. Maintain refrigerant piping factory seals until ready for incorporation into the Work.
7. Cover openings in piping, and temporarily seal to protect from contamination.
8. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by elevating above floor or surrounding grade.
9. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.
10. Protect piping and valves from damage pending performance of system tests.
11. Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe, linings, and coatings.
12. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.
13. Prevent entry of foreign matter during handling, assembling, and installation. Use compressed air, wire brush, solvent and other acceptable means to remove all foreign matter from inside of pipe prior to installation. Remove residual scale, dirt and other foreign matter from interior of piping before final connections are made.

PART 2 PRODUCTS

2.01 PIPE MATERIALS - GENERAL

A. All pipe materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and related sections.

B. New and existing piping is designated by process service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Investigate connections to existing piping and provide suitable connections, including electrical isolation, as necessary.

C. Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same manufacturer.

D. Buried Piping: Size temporary and/or permanent thrust restraints. Design restraint systems to allow complete piping system disassembly without destruction of any portion of the piping system.

2.02 MATERIAL FOR PIPING SUPPORT, SEISMIC RESTRAINTS AND PIPE ANCHORS

A. This paragraph specifies materials for pipe supports specified in Section 40 05 07, seismic restraints specified in Section 40 05 07.13, pipe anchors, certain expansion control elements specified in Section 40 05 07.16, and all associated appurtenances. Section 01 61 45 defines environmental exposures by physical location. Pipe Support, Seismic Bracing, and Pipe Anchor materials are specified based on the environmental exposure specified in Section 01 61 45. Provide Pipe Support, Seismic Bracing and Pipe Anchor components fabricated from materials as specified in the following table:

Environmental Exposure or Pipe Material	Materials [1]	Nuts, bolts, washers, and fasteners
Outdoor	Steel, hot dip galvanized after fabrication	Type 304/316 stainless steel
Indoor, Dry	Steel, hot dip galvanized after fabrication	Steel, Zinc plated or hot-dip galvanized after fabrication
Indoor, Wet	Type 316 stainless steel or FRP	Type 316 stainless steel
Chemical Corrosive	Fiberglass (FRP)	Type 316 stainless steel
Head Space	Type 316 stainless steel or FRP	Type 316 stainless steel
Submerged	Type 316 stainless steel or FRP	Type 316 stainless steel
Undefined	Type 316 stainless steel or FRP	Type 316 stainless steel
Stainless steel piping	Type 316 stainless steel	(per area as defined in this table)

Notes:

1. *Where materials as designated in drawing details or indicated in other specification sections, those requirements govern over the provisions of this table.*

2.03 VALVES

A. Coordinate the selection of pipe materials, linings, and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves). Support wafer style valves or spectacle flanges between flanges of equal inside diameter.

B. Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be nonasbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length.

C. Flanges shall meet the requirement of ANSI B16.5. Push-on and mechanical joints shall meet the requirements of AWWA C111.

D. Valve operators are specified in Sections 40 05 57.13 and 40 05 57.23.

2.04 BONDING JUMPERS

A. Provide plated, flexible copper braid jumpers with unplated copper ferrules for attachment to pipe flanges, rated for a 100 amp minimum. Provide Burndy Electrical, Type B series, or Approved Equal, and sufficient conductive, anti-oxidant compound (Burndy Electrical Penetrox series or Approved Equal) to protect ferrules.

2.05 JOINTS – GENERAL

A. Provide joints for disassembly within 3.0 ft of any connection to equipment, on both sides of structural penetrations, and within 2.0 ft of all threaded end valves.

B. Unless otherwise specified on the drawings or in equipment specifications, adapt all equipment connections to a flanged connection compatible with the connected piping system.

C. Flexible Joints at Structural Joint Crossings: Provide a flexible joint (or joints) on all piping crossing structural joints.

2.06 FLANGES AND OTHER COUPLINGS

A. Pipe connections are specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99.

B. General requirements for flanges are as follows:
   1. Where raised-face and flat flanges are provided for connection, reface the raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.
   2. Provide flat-faced flanges on each side of butterfly valves.
   3. For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

C. Slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.) are not acceptable.

2.07 FITTINGS – GENERAL

A. Fittings are specified in the Piping System Schedules.

B. Provide eccentric reducers in horizontal lines with the flat side on top, unless specified otherwise on the drawings (e.g., flow meters in horizontal runs requiring submergence).

C. Provide concentric reducers in vertical lines, unless otherwise specified on the drawings.

D. Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow measurement device dimension. Coordinate with the specific instrument requirements.

E. Provide long radius (greater than or equal to 1.5 x nominal diameter) elbows unless otherwise specified on the drawings.

2.08 GASKET MATERIALS

A. For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ANSI B16.21.

B. Refer to the Piping System Schedule for the specified gasket material. Material designations used in the detailed pipe specification sheets are as follows:
   1. EPDM: ethylene-propylene-diene-terpolymer 70 durometer

2. Neoprene: neoprene (black) 70 durometer
3. Nitrile: nitrile (Buna N)
4. SBR: Styrene-butadiene (red)
5. Natural rubber: natural rubber
6. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)
7. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37)
8. CPE - Chlorinated Polyethylene
9. Spiral-wound: per ASME B16.20, rated to 1200 degree Fahrenheit Flexitallic SS316L or approved equal

2.09 DISSIMILAR METAL CONNECTIONS

A. Where dissimilar metals are to be connected, provide dielectric fittings and/or isolating flanges, including bolt sleeves and washers, according to Section 40 05 06.

2.10 CATHODIC PROTECTION

A. Provide cathodic protection of piping, pipe fittings, and appurtenances where specified on the drawings.

2.11 STRUCTURAL ELEMENT PENETRATIONS

A. Penetrations through structural elements are referenced to a custom detail or Standard Detail. Where a penetration detail is not specified, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

B. Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

2.12 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker, detectable warning tape, and tracer wire materials per Section 40 05 45.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation, inspect, and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

B. Pothole existing pipe at connections to new pipe to confirm material and joints prior to submittal of pipe layout drawings.

C. The Drawings are, in part, diagrammatic, make all minor modifications to suit installed equipment and structural element locations and elevations and coordinate with electrical construction.

D. Provide details of connections to new and existing equipment, piping, and structures in piping layout drawing submittals. Unless otherwise specified on Drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

E. Piping arrangements indicated on the drawings have been estimated from the approximate configuration of the type of equipment listed in the equipment specifications. If the equipment to be provided does not have the same configuration, modify the piping arrangement as necessary. Include any piping modifications in shop drawings submitted prior to fabrication or installation.

3.02 PIPE SUPPORT, ANCHORAGE, AND SEISMIC BRACING

A. Support piping with anchor brackets, guides, saddles, or hangers. Acceptable types of supports, guides, saddles, hangers and structure attachments for general pipe support, expansion/ contraction and for seismic bracing, as well as anchorage details, are shown on the drawings. Minimum spacing shall be as specified for supports and for seismic bracing. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used there. Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced where indicated to resist lateral load. Supports shall be provided on each run at each change of direction.

B. Do not use existing pipes and supports to support new piping.

C. Install expansion loops, anchors, expansion joints, and guides where specified on the drawings.

3.03 PIPING CONNECTIONS TO MACHINES

A. Align piping at machine connections in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines.

B. Do not force bolts into mating flange bolt holes. Align flange bolt holes to permit insertion of bolts by hand (without tools, hammering, or prying).

C. Use of ‘dutchmen’ mitered sections or similar specials to achieve the required alignment with machine connections are strictly prohibited.

D. Provide equipment connection fittings per Section 40 05 06 as specified on the drawings.

3.04 JOINT AND COUPLING OPTIONS

A. Provide pipe connection (joint and coupling) options as specified in the Piping System Schedule.

B. If a Piping System Schedule lists several connection options, then any of the listed options may be used for a particular pipe material, but the selected option shall be used consistently. For example, if flanged or grooved connections are specified and grooved are represented on the Drawings, then flanged may be installed in lieu of the grooved couplings specified on the drawings.

C. Connecting straight runs of pipe by welding is acceptable only where the individual Piping System Schedule allows welding as a connection option.

D. Where connections other than those indicated on the Piping System Schedule are specified on the Drawings, locate the connection specified on the drawing at the specific location indicated on the drawing.

E. Provide rigid, non-rotating connections at all valves and equipment.

3.05 SMALL BORE UTILITY PIPING

A. Field route small bore (generally less than 3-inch) diameter branch piping for utility services.

B. In general, small bore utility branch piping is not specified on the Drawings unless a specific pipe routing or configuration is to be provided or where necessary to show valves or instrumentation requiring electrical connections.

C. Distribution lines for small bore utility piping are specified on the Drawings along with service connection routes to locations that require utility service piping.

D. Install small bore utility piping that must be drained to provide freeze protection with a continuous slope down to the drain.

3.06 PIPING IDENTIFICATION

A. Pipe Coding:

1. After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 2.02 Plastic Coding Markers. Legend markers and directional arrows shall be located at each side of walls, floors and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. Plastic Tracer Tape:

1. A single line of tape as specified in paragraph 2.02 Plastic Tracer Tape shall be provided 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

3.07 SEWER AND DRAIN PIPING

A. Run horizontal drainage piping as straight as practicable and at uniform pitch.

B. Install pipe 3-inch or less in diameter with slope of not less than two percent, unless otherwise specified on the Drawings.

C. Install pipe larger than 3-inch diameter with slope of not less than one percent, unless otherwise specified on the Drawings or required by the Plumbing Code.

3.08 SLEEVES

A. Unless otherwise noted in the specified pipe penetration details or otherwise approved by the Construction Manager, provide sleeves where piping passes through a wall, floor, or ceiling.

B. Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

3.09 PIPE JOINTS AND CONNECTIONS

A. Field cuts for glass-lined pipe are not permitted.

B. Cut pipe with appropriate tool and deburr.

C. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.

D. Do not use sharp toothed wrench in making up brass pipe, or chrome plated items.

E. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.

F. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.

G. Welding procedures, welder certification/qualification, and weld testing per ASME Section IX, Boiler and Pressure Vessel Code. Make welds per the specified standard when ASME B31.1 or ASME B31.3 are specified for a Piping System in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).

H. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

3.10 TAKEDOWN COUPLINGS

A. Takedown Couplings: Provide takedown couplings at the locations specified on the Drawings in accordance with this Section.

B. Provide takedown couplings at changes in piping direction and where specified in the Drawings on straight runs of pipe.

C. Provide screw unions, flanged or grooved end coupling type joints as takedown couplings.

D. Use flanged or grooved end joints on pipelines 1.5-inch diameter and larger.

E. Where piping passes through walls provide takedown couplings within 40 inches of the wall.

F. Provide a union or flanged connection within 24 inches of each threaded end valve.

3.11 INSTALLATION OF BURIED PIPE AND PIPE BELOW STRUCTURES

A. Trenching and backfill for buried pipe: conform to Section 31 23 00.

B. Pipe laying and bedding: conform to Section 31 23 00.

C. Restrain all plugs, caps, tees and bends in buried pressure piping systems by means of restrained joints as specified in the respective Piping System Schedule.

D. In accordance with Section 40 05 06, and where specified on the Drawings, provide flexibility per specified details where buried pipe passes under, through, or is connected to structures. Provide restrained joint connections or provide restraints across each un-restrained joints.

E. Install pipe in straight alignment. Do not exceed 3/8-inch variance over 30 ft from the true alignment in any direction.

F. Slope gravity lines uniformly from point of origin to discharge.

G. Ensure the pipe alignment stays true during and after placement of concrete encasement.

H. Ensure that the method used to prevent pipe uplift during placement of concrete encasement results in an invert and crown true to intended grade.

I. Maintain circular cross section of pipe.

J. Provide lean concrete below the underside of the slab or footing for backfill over pipe laid below structures when pipe is less than 6 inches below the underside of the slab or footing, unless specified otherwise. Place concrete in accordance with Section 03 30 00.

K. Provide Heat-Shrinkable Cross-Linked Polyolefin Coating or Tape Wrap coating on all flanged, grooved, and welded joints that are buried or below structures.

L. Provide Petrolatum Tape wrap on all valves and mechanical pipe couplings that are buried or below structures. Install per manufacturer's recommendations. Candidate Manufacturers:
   1. Denso Densyl Tape
   2. #1 Wax Tape
   3. Approved Equal

M. Use anti-seize compound with all stainless steel nuts and bolts.

N. Provide detectable warning tape for all buried pipe. Provide tracer (locate) wire as specified in Section 40 05 45.

3.12 EXPOSED INSTALLATION

A. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with the Plumbing Code.

B. Provide pipe system layout in accordance with the following criteria:
   1. Drawings show general layout of piping. Exact dimensions determined by Contractor.
   2. Maintain minimum clear areas through tunnels and principal access aisles as specified in this Section.
   3. Expanding or swaging of tubing to fit IPS (Iron Pipe Size) fitting sockets is not permitted.
   4. Use reducing fittings where change in pipe size occurs.
   5. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
   6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
   7. Make changes in direction only with fittings.
   8. Install piping with not less than minimum slope to ensure adequate drainage and venting.
   9. Maintain clear areas around equipment to allow adequate access for maintenance as specified in this Section.
   10. Ensure valve operators are accessible from floor level. Provide chain wheel operators for valves with centerline elevations of 7 feet or above.
   11. Ensure piping ancillaries and in-pipe instrumentation is installed in accessible locations which do not create problems for traffic in the clear areas.

C. Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage.

D. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

E. Install expansion joints where specified on the Drawings to allow for piping expansion and contraction.

F. Install expansion loops or bends where specified to allow for proper pipe expansion. Construct expansion loops with long radius welded bends.

G. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

H. Accurately cut all piping for fabrication to field measurements.

I. Install pipes in straight alignment and parallel to wall. Do not exceed 3/8-in variance over 30 ft from the true alignment, in any direction.

J. Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. Unless approved by theEngineer, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Construction Manager to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

K. Slope instrument air piping to condensate traps.

L. Do not cut or weaken the building structure to facilitate installation of piping.

M. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

N. In vertical pipe runs of pipe diameter greater than 10 inches, provide 8-inch long spool piece on lower side of each valve.

O. Do not install water piping over electric switchboards, transformers, cable tray or electric motor starters.

P. Provide pipe markers for all exposed pipe.

3.13 THREADED JOINTS

A. Conform to the requirement of ANSI B31.1.

B. Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

C. Clean out pipe and repair linings and coatings prior to joining.

D. Apply PTFE-free thread tape to male threads and join pipe. Use both thread tape and PTFE-free sealing compound on stainless steel pipe threads. Do not apply extra tape to make up for slack in the joint.

3.14 GROOVED JOINTS

A. Ensure pipe ends are clean and free of burrs prior to installation. Clean gasket prior to connection.

B. Apply manufacturer-approved lubrication as needed for installation. Ensure the gasket does not become rolled, pinched, or cut during installation.

3.15 FLANGED JOINTS

A. Maintain consistent flange bolt hole positions along the entire length or run of the pipe.

B. For pipe installed with a horizontal axis, position flange bolt holes so that the vertical centerline of the flange face bisects the arc between flange bolt holes (“Two-Holed”).

C. For pipe installed with a vertical axis, position flange bolt holes so that the horizontal centerline of the flange face bisects the arc between flange bolt holes and is perpendicular to the closest structural wall (“Two-Holed”).

D. Clean flanges and gaskets prior to connection.

E. Lubricate gaskets with gasket manufacturer’s recommended lubricant and apply anti-seize compound to all bolts.

F. Bring flanges into close parallel and lateral alignment.

G. Tighten bolts progressively. Proceed from side to side of the flange.

H. Use proper length bolts for each size flange on flanged connections. Washers may not be used to take up excess bolt length. Provide approximately two full threads bolt projection beyond nuts. Bolts with excessive length of exposed threads will not be permitted. All-thread rod is not acceptable for bolting flanges.

I. When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

J. Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on the equipment.

K. Allow a minimum of 6 inches' clearance to face or 8 inches to edge of flange to wall, floor, or ceiling unless otherwise specified.

3.16 INSULATION

A. Insulate piping systems in accordance with the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99) and Section 40 42 00.

3.17 FLEXIBLE HOSE CONNECTORS

A. Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

B. Align and install each flexible connector in accordance with the manufacturer's instructions.

C. Support, anchor and guide the piping so that the flexible hose connectors are not required to absorb any axial compression or elongation.

D. Do not torque or twist the flexible connectors.

E. Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

3.18 EXPANSION JOINTS

A. Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping. Install expansion joints in accordance with manufacturer's instructions prior to releasing preload.

B. Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

C. On rubber expansion joints, check bolt tightness, and tighten where necessary one week after Commissioning is completed.

3.19 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance in accordance with specified standard (e.g. AWWA C210) or accordance with the lining manufacturer's directions, if no standard is cited.

B. Damaged glass lining cannot be repaired. Replace piping with damaged glass lining.

C. Patching inserts, overlays, or pounding out of dents is not be permitted.

D. Repair pipe with damaged protective coatings and holdback areas for welding and other field fabrication, as follows:
   1. For shop-applied coatings, not subject to Section 09 90 00 requirements, in accordance with specified standard (e.g. AWWA C210) or in accordance with the coating manufacturer's directions, if no standard is cited.
   2. For coatings applied pursuant to Section 09 90 00 requirements, apply repair coatings in conformance with the applicable Section 09 90 00 coating system, including thickness and stipulated preparation of the lowest full thickness coating layer (i.e. exposed metal would require full profile preparation and specified multi-layer coating restoration).
   3. Prepare areas to be repaired not less than 2-inches beyond damaged areas and feather repair coating into adjacent areas.
   4. Repair to provide equivalent protection to undamaged coatings and a uniform appearance when judged from 4 feet away.

E. Other requirements may be stipulated in related piping sections.

3.20 FIELD QUALITY CONTROL

A. Inspections:
   1. Inspect and provide reports as specified in Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.

3.21 TESTING

A. Provide 24 hours notice prior to testing.

B. Do not insulate or conceal work until piping systems are tested and have met all required criteria.

C. Complete any required weld tests.

D. Supply all water, air, and inert gases required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install air threadolets, air relief valves, and line fitting valves as necessary to complete testing. Remove after testing and plug threadolets.

G. Cap or plug all lines which are normally open ended. Remove on completion of testing.

H. Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

I. Test all underground lines prior to backfilling. Do not place concrete encasement until lines are tested and have met all required criteria.

J. Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Construction Manager of such failure.

K. Isolate all pumps and low pressure equipment and appurtenances during testing so as not to place any excess pressure or thrust forces on the equipment.

L. Where defective material or equipment is identified, repair or replace using new material.

M. Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests using inert gas.

N. Dispose of flushing water in manner approved by the Construction Manager, which causes no damage to buildings or siteworks.

3.22 HYDROSTATIC PRESSURE TESTING OF LIQUID LINES

A. Hydrostatically test all lines normally used for the conveyance of liquids using water as the test medium, unless otherwise specified in this Section.

B. Test pressures and durations as specified in the Piping System Schedules.

C. Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

D. Lined pipelines: Allow filled pipeline or section thereof to stand under a slight pressure for at least 8 hours (24 hours for cement mortar lining) to allow the lining to absorb water and to allow the escape of air from air pockets.

E. Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

F. Test drains in accordance with the Plumbing Code.

G. For hydraulic and lube oil systems, test using the medium of service. Provide zero loss of pressure throughout the specified test period.

3.23 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 6 inches and less than 24 inches by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater than 24 inches may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 6 inches an initial flush or purge.

B. After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

Suction size, in.	Maximum screen opening, in.
0 – 1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

C. Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Construction Manager's acceptance, screens may be removed for performance tests. Install screens for clear water testing and initial operation on liquid systems handling solids. Initial operation on solids systems following clear water testing may be without screens.

D. Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

E. Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Keep screens in place for 24 hours of clean water operation on solids handling systems; remove prior to placing the system into solids handling service.

F. In air or gas systems with pipe sizes less than or equal to 6 inches, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.0.01 standards for instrument air systems.

G. Clean and flush piping connecting to HVAC equipment in accordance with Division 23.

3.24 DISINFECTION

A. Flush and disinfect lines intended for potable water service after testing in accordance with AWWA C651.

END OF SECTION

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SECTION 40 05 02

PIPING SYSTEM SCHEDULES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

Process Service Identifier	Process Service	Piping System Schedule	Fluid Category	Pipe Marker Background Color
FW	Filtered Water	40 05 02.23	Water	Green
GFM	GAC Fresh Media	40 05 02.23	Slurry	Green
GSM	GAC Slurry Media	40 05 02.23	Slurry	Green
OF	Overflow	40 05 02.23	Water	Green
PD	Process Drain	40 05 02.23	Drain/Vent	Green
PEF	PFAS Effluent	40 05 02.23	Water	Green
RAW	Raw Water	40 05 02.23	Water	Blue
RWD	Rinse Water Discharge	40 05 02.23	Water	Green
RWS	Rinse Water Supply	40 05 02.23	Water	Green
SMP	Sample	40 05 02.23	Water	Green
VT	Vent	40 05 02.23	Drain/Vent	Dark Gray

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings Class 150 and 300

Reference	Title
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B16.12	Cast Iron Threaded Drainage Fittings
ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.9	Building Services Piping
ASME B32	Solder Metal
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME B36.19	Stainless Steel Pipe
ASME B1.1	Unified Inch Screw Threads
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A47	Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
ASTM A74	Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
ASTM A126	Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135	Electric-Resistance-Welded Steel Pipe
ASTM A139	Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)
ASTM A167	Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate
ASTM A181/181M	Forgings, Carbon Steel, for General Purpose Piping
ASTM A182/182M	Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/193M	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service High Pressure Service and Other Special Purpose Applications
ASTM A194/194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or High Temperature Service, or Both
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
ASTM A269	Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A307	Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A312/312M	Seamless and Welded Austenitic Stainless Steel Pipe
ASTM A320/320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

Reference	Title
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A536	Ductile Iron Castings
ASTM A563	Carbon and Alloy Steel Nuts
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM A1011/A1011M	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
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2996	Filament-Wound Reinforced Thermosetting Resin Pipe
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
ASTM D3261	Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
ASTM D3350	Polyethylene Plastics Pipe and Fittings Materials
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM D4174	Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
AWWA C104	Cement–Mortar Lining for Ductile-Iron Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings

Reference	Title
AWWA C115	Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids
AWWA C153	Ductile-Iron Compact Fittings
AWWA C200	Steel Water Pipe, 6 Inches and Larger
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
AWWA C301	Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
AWWA C303	Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe - A Guide for Design and Installation
CISPI 301	Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 6
FSA	Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division
FEDSPEC, L-C-530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL-H-13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL-S-8660C	Silicone Compound
MIL-STD-810C	Environmental Test Methods
MSS SP-25	Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	Wrought Stainless Steel Butt Welding Fittings
MSS SP-97	Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends
MSS SP-114	Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000
NSF/ANSI 61:	Drinking Water System Components – Health Effects
SSPC	Society for Protective Coatings
SAE J1227	Assessing Cleanliness of Hydraulic Fluid Power Components and Systems

Reference	Title
2021 UPC	2021 Uniform Plumbing Code

1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Pipe Connections and Joints:
   1. BABS – Bell and Ball Spigot
   2. BAS – Bell and Spigot
   3. BFW – Butt Fusion Weld
   4. BSS – Bolted Split Sleeve Coupling
   5. BW – Butt Weld
   6. BSW – Butt-Strap Weld
   7. CGRV – Cut (or Cast) Grooved End Coupling
   8. CPLG – Coupling
   9. CPO – Compression Type Push-On
   10. CPRSN – Compression
   11. DLW – Double Lap Weld (Bell and Spigot)
   12. EFSW - Electro-Fusion Socket Weld
   13. FLG – Flanged
   14. FLRD – Flared
   15. FP – Full Penetration
   16. FSW – Fusion Socket Weld
   17. HAS – Hub and Spigot, Compression (Cast Iron Soil Pipe)
   18. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
   19. HGRV – HDPE Groove Coupling
   20. HLF CPLG – Half Coupling
   21. HPEG – HDPE Plain End with Gripping Teeth
   22. HXGT - HDPE by Grooved End Transition
   23. LR ELL – Long Radius Elbow
   24. MJ – Mechanical Joint
   25. PGRV - Proprietary Groove Coupling
   26. PO – Push-on
   27. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
   28. RGRV – Rolled Grooved End Coupling
   29. RJC – Ring Joint Coupling
   30. RMJ – Restrained Mechanical Joint
   31. RPO – Restrained Push-On joint
   32. SLV – Solvent Weld
   33. SLDR – Solder or Brazing
   34. SLW – Single Lap Weld (Bell and Spigot)
   35. SR ELL – Short Radius Elbow

36. SW – Socket Weld
37. THD – Threaded
38. UN – Union

C. Flanges:
   1. FF – Flat Face
   2. LF – Loose Flange
   3. LJ – Lap Joint
   4. LWN – Long Weld Neck
   5. RF – Raised Face
   6. SO – Slip-On
   7. THD – Threaded
   8. WN – Weld Neck

D. Materials:
   1. DI – Ductile Iron
   2. RCP – Reinforced Concrete Pipe
   3. RCP-LHP – Reinforced Concrete Low Head Pressure Pipe
   4. SS – Stainless Steel
   5. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
   1. FP – Full Penetration
   2. SML – Seamless
   3. WLD – Welded

F. Other:
   1. CFT – Cured Film Thickness
   2. DFT – Dry Film Thickness
   3. Dim – Dimensions
   4. M or E Pipe – Matches or exceeds rating of connecting pipe
   5. Thk – Thickness
   6. Sch – Schedule
   7. Std – Standard
   8. STD – Standard Weight or Standard

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe size (nominal diameter) and the Process Service Identifier for the contents of the pipeline are specified in pipe line labels on the drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

PART 3 NOT USED

PART 4 SCHEDULES

4.01 PIPE SPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this Section. Piping System Schedules are assigned a Section number in the range from 40 05 02.00 through 40 05 02.99.

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Section 40 05 02.23

Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

General Requirements

A. Testing Requirements:

Pressure: 150 psi. Duration: 120 min. Medium: Water

- Testing for Pressure Vessel Piping System (**RAW, PEF, FW)**
- Testing for Rinse Water Supply (**RWS**)/Rinse Water Discharge (**RWD**) piping
- Testing for GAC Slurry (**GSM**)/GAC Fresh Media (**GFM**) Lines
- Testing for Sample Lines (**SMP**)

Pressure: 5 psi. Duration: 15 min. Medium: Water

- Testing for Vent Piping (**VT)**
- Testing for Overflow (**OF**) piping
- Testing for Process Drain Lines (**PD**)

B. All materials, piping, and pipe appurtenances in contact with water shall be ANSI/NSF/CAN 61/600 Certified unless otherwise noted.

C. Flat-Faced flanges mated with raised face flanges are not permitted.

D. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

E. Threads per ASME B1.20.1.

F. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel. Weld Type 316L to Type 316L pipe material.)

G. Solvent welding of PVC piping performed with Weld-On 724 (ASTM F 493, NSF/ANSI 14, NSF/ANSI 61) or Approved Equal. Universal plastic pipe solvent is not acceptable. Prior to solvent welding, clean pipe joints to remove all loose debris and prime with a compatible primer. Primer shall stain piping.

H. No wetted components shall be allowed which utilized per- or poly-fluoroalkyl substances (PFAS), including but not limited to PTFE, Viton,FKM, or Teflon.

I. Buried pipe refers to building subgrade piping. Refer to civil drawings for yard piping specifications.

J. The Vendor shall provide interconnecting skid piping for use in and around the Pressure Vessels as indicated on the Drawings.

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Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

Key Notes (Indexed to Key Notes in the Piping System Schedule)

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Provide long radius five cut mitered elbows for segmentally welded fittings.
4. Weld Threadolet or Half Coupling prior to installing lining and coating.
5. Provide concrete surround or encasement for pipe buried below structures.
6. Except at flanged connections at valves, flanged connections/joints not permitted on buried Ductile Iron Pipe.
7. FNPT tap at factory installed tapping boss. Taps at other locations on pipe and fittings are not permitted.
8. Provide magnetic tracer tape.
9. Bolts and nuts with metallurgy specified in AWWA C111.
10. NSF 61 certified.
11. Provide AWWA standard 2-inch square nut operator, extension stem, and valve box for buried valves.
12. Provide stainless steel flange bolts, nuts, and washers with stainless steel flanges.
13. Apply Anti-seize to stainless steel bolts before turning nut on flange bolts.
14. For Headspace and Submerged area exposures, use stainless steel flanges with stainless steel bolts and nuts.
15. PGRV (Proprietary Groove): Victaulic Advanced Groove System or Approved Equal.
16. Provide rigid couplings for 3-inch thru 12-inch except pipe installed on pipe racks (pipe/utility tunnels or chases) or for connections to pumps.
17. Coating may be omitted for pipe encased in concrete or grout.
18. Provide square nut operator, extension stem, and valve box for buried valves.

Section 40 05 02.23

Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

Area Exposure Types: Indoor Dry, Indoor Wet, Outdoor (Exposed), Submerged

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/4 thru 3	Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19	Sch. 40S	THD, FLG	40 05 23	10, 12
	4 thru 12	Steel: ASTM A53, Gr B, Type E or Type S, Dim. Per ASME B36.10	Sch. 40	FLG	40 05 24	
	14 thru 16	Steel: ASTM A53, Gr B, Type E or Type S, Dim. Per ASME B36.10	Sch. 40	CGRV, RGRV, PGRV, FLG	40 05 24	15
		Steel: AWWA C200	5/16 in. Thk.	CGRV, RGRV, PGRV, FLG	40 05 24	15
Lining for Pipe & Fittings	1/4 thru 3	None	—	—	—	
	Steel, 4 thru 16	Cement Mortar: Factory Applied, AWWA C205, NSF 61 certified	Thk. per Std.	—	40 05 24	
		Polyurethane: Factory Applied, AWWA C222, NSF 61 certified	Thk. per Std.	—	40 05 24	
External Coating	Steel, All	Polyurethane: Factory Applied, AWWA C222	Thk. per Std.	—	40 05 24	
	Valves	Epoxy: Manufacturer's standard, primer and finish coat, Factory Applied	—	—	—	
Fittings	1/4 thru 4	Wrought Stainless Steel: ASTM A403-WP316L, Dim. Per ASME B16.9	Sch 40S	BW, FLG		13
	4 thru 16	Wrought Steel Grooved End: ASTM A234-WPB, r/D dim. Per ASME B16.9, ASTM A53 grooved tangets per manufacturerer's standard dim.	Sch. 40 or Std. Wt.	CGRV, RGRV	40 05 24	
		Fabricated Steel Grooved End: ASTM A53, Gr B, Type E or Type S, Dim. Per manufacturer's standard	Sch. 40 or Std. Wt.	CGRV, RGRV	40 05 24	3
		Wrought Steel: ASTM A234-WPB, Dim. Per ASME B16.9	Sch. 40 or Std. Wt.	FLG	40 05 24	2
	14 thru 16	Fabricated Steel Grooved End: ASTM A53, Gr B, Type E or Type S, Dim. per manufacturer's standard	Sch. 40 or Std. Wt.	PGRV	40 05 24	3
Taps	1/4 thru 4	Forged Steel Tee: ASTM A105, galvanized, Dim. Per ASME B16.11	Class 3000	THD, SW	40 05 24	10
	4 thru 16	Forged Steel Threadolet or Half Coupling: ASTM A105, Dim. per ASME B16.11	Class 3000	FP Beveled Fillet Weld	40 05 24	4
Grooved Coupling	4 thru 16	Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV, RGRV	40 05 24	16

Section 40 05 02.23

Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

Area Exposure Types: Indoor Dry, Indoor Wet, Outdoor (Exposed), Submerged

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
		Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV, RGRV	40 05 24	16
	14 thru 16	Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per manufacturer's standard dim	150 psi	PGRV	40 05 24	15
	4 thru 16	Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV	40 05 19	16
		Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	CGRV	40 05 19	
	14 thru 16	Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per manufacturer's standard dim	150 psi	PGRV, RJC	40 05 19	15
Flanges	4 thru 16	Forged Steel: ASTM A105, FF, Dim. per ASME B16.5	Class 150	LWN, WN, SO	40 05 24	
		Plate Steel: FF, Material and Dim. per AWWA C207	Class D	SO	40 05 24	
FLG Bolts, nuts and hardware	All	Alloy Steel Bolts: ASTM A193-Gr B7 with Carbon Steel Nuts: ASTM A194-Gr 2H heavy hex	All	—	—	1
Flange gaskets	1/8 thru 10	Nitrile or Neoprene: NSF 61 certified	1/16 in Thk.	FLG	40 05 01	10
	12 thru 16	Nitrile or Neoprene: NSF 61 certified	1/8 in Thk.	FLG	40 05 01	10
Mechanical Coupling Gaskets	4 thru 16	EPDM: NSF 61 certified	—	CGRV, RGRV, PGRV	40 05 01	10
Compression and Push-On Gaskets	All	None	—	—	—	
Expansion Joints	All	—	—	—	40 05 06.23	
Valves	1/4 thru 3	Ball: Stainless Steel Body/Ball, 40 05 63.03	200 psi	THD	40 05 60	10
		Butterfly: AWWA C504, Class 150B, 40 05 64.05	125 psi	FLG	40 05 60	10
		Swing Check: Cast Iron 40 05 65.09	200 psi	FLG	40 05 60	10
	4 thru 16	Ball: Stainless Steel Body/Ball, 40 05 63.08	170 psi	FLG	40 05 60	10
		Butterfly: AWWA C504, Class 150B, 40 05 64.05	125 psi	FLG	40 05 60	10
		Swing Check: Cast Iron 40 05 65.09	200 psi	FLG	40 05 60	10
Insulation	1/4 thru 8	Fiberglass: ASTM C547-Type I Grade A with Aluminum Jacket/Covers. Insulation Service Type: Freeze Protection (ADDENDUM 2)	1 in. Thk		40 42 00	

Section 40 05 02.23

Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

Area Exposure Types: Indoor Dry, Indoor Wet, Outdoor (Exposed), Submerged

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
	10 thru 16	Fiberglass: ASTM C547-Type I Grade A with Aluminum Jacket/Covers. Insulation Service Type: Freeze Protection (ADDENDUM 2)	1 in. Thk		40 42 00	

Buried (Includes Embedded and Encased)

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1 thru 3	PVC: ASTM D1784-Class 12454-B, Dim. Per ASTM D1785	Sch. 40	SLV	40 05 31.13	8, 10
	4 thru 12	Ductile Iron: AWWA C151	Pr. Class 350	RPO, FLG	33 05 19	5, 6, 8, 17
	14 thru 16	Ductile Iron: AWWA C151	Pr. Class 250	RPO, FLG	33 05 19	5, 6, 17
Lining for Pipe & Fittings	1 thru 3	None	—	—	—	
	Ductile Iron, 4 thru 16	Cement-Mortar: AWWA C104, NSF 61 certified	—	—	33 05 19	
External Coating	1 thru 3	PVC tape, Field Applied on Installed Pipe	—	—	—	
	Ductile Iron, 4 thru 16	Polyethylene Encasement: AWWA C105, Field Installed	Thk. per Std	—	33 05 19	
	Valves	Epoxy: Manufacturer's standard, primer and finish coat, Factory Applied	—	—	—	
Fittings	1 thru 3	PVC: ASTM D2466	Sch. 40	SLV	40 05 31.13	10
	4 thru 16	Ductile Iron: ASTM A536-Gr 65/45/12, Dim. per AWWA C110 or AWWA C153	150 psi	CGRV, RMJ, FLG, RPO	33 05 19	2, 5, 6, 17
	14 thru 16	Ductile Iron Grooved End: ASTM A536-Gr 65/45/12, Dim. per manufacturer's standard	150 psi	CGRV, RML, FLG, RPO, PGRV	33 05 19	2, 5, 6, 17
Taps	1 thru 3	None	—	—	—	
	Ductile Iron, 4 thru 16	Steel Short Nipple: ASTM A53, seamless-Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10	Sch. 40	THD	33 05 19	7

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Piping System Schedule - Process Water

Process Service	Filtered Water	GAC Slurry Media/GAC Fresh Media	Overflow	Process Drain	PFAS Effluent	Raw Water	Rinse Water Discharge	Rinse Water Supply	Sample	Vent
Process Service Identifier	***FW***	***GSM/GFM***	***OF***	***PD***	***PEF***	***RAW***	***RWD***	***RWS***	***SMP***	***VT***

Buried (Includes Embedded and Encased)

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Flanges	1 thru 3	PVC: ASTM A1784-Class 12454-B, Dim. per ASME B16.5	Class 150	SLV x FLG	40 05 31.13	
	Ductile Iron, 4 thru 16	Ductile iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. per ASME B16.1 Class 125	150 psig	FLG	33 05 19	6
FLG Bolts, nuts and hardware	All, not submerged	Non-Corrosive, High-Strength, Low-Alloy Steel Bolts: ASTM A 449- Gr 3, Class C or Class D with Carbon Steel Nuts: ASTM A563-Gr C3, Class C or Class D	—	—	—	1, 9
		Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal, with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal	—	—	—	1
	All submerged	Stainless Steel Bolts: ASTM A193 Gr B8M Stainless Steel Nuts: ASTM A194 Gr 8M	—	—	—	14
Flange gaskets	1 thru 10	Nitrile or Neoprene	1/16 in Thk	FLG	40 05 01	10
	12 thru 16	Nitrile or Neoprene	1/8 in Thk	FLG	40 05 01	10
Mechanical Coupling Gaskets	4 thru 16	EPDM	—	CGRV	40 05 01	10
Compression and Push-On Gasket	4 thru 16	Neoprene or Nitrile	—	RMJ, RPO, RBAS, SR	40 05 01	10
Valves	1 thru 3	None	—	—	—	—
	4 thru 16	Gate: Ductile Iron, AWWA 509, 33 14 26	—	RMJ	40 05 60	6, 10, 11
Insulation	All	None	—	—	—	

END OF SECTION

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Piping System Schedule, Potable Water

Process Service	Potable Hot Water	Potable Water				
Process Service Identifier	***HW***	***PW***				

General Requirements

A. Testing Requirements: Pressure: 200 psig. Duration: 60 min. Medium: Water

B. Full-Faced flanges mated with raised face flanges are not permitted.

C. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.

D. Threads per ASME B1.20.1.

E. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel. Weld Type 316L to Type 316L pipe material.)

Key Notes (Indexed to Key Notes in the Piping System Schedule)

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Except at flanged connections at valves, flanged connections/joints not permitted on buried pipe.
4. Taps on pipe and fittings are not permitted.
5. Provide locate wire. Terminate at least one end of wire above grade.
6. Bolts and nuts with metallurgy specified in AWWA C111.
7. Provide AWWA standard 2-inch square nut operator, extension stem, and valve box for buried valves.
8. Hard, drawn, furnished in straight lengths.
9. PGRV (Proprietary Groove): Victaulic Advanced Groove System or Approved Equal.
10. Provide rigid couplings for 3-inch thru 12-inch except pipe installed on pipe racks (pipe/utility tunnels or chases) or for connections to pumps and blowers.
11. NSF 61 certified.
12. Coating may be omitted for pipe encased in concrete or grout.
13. Make material transition from underground to above ground 4” above the finish floor minimum with manufactured transition fitting.
14. Changes in direction on buried pipe to be bent pipe. Elbow fittings to be used only where pipe bends are not practical.

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Piping System Schedule, Potable Water

Process Service	Potable Hot Water	Potable Water				
Process Service Identifier	***HW***	***PW***				

Area Exposure Types: Indoor Dry, Indoor Wet, Outdoor (Exposed)

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/4 thru 3	Copper Tube: ASTM B88, Drawn	Type L	SLDR	40 05 17	13
Lining for Pipe & Fittings	1/4 thru 3	None	—	—	—	
External Coating	All	None				
Fittings	1/4 thru 1/2	Cast Copper Alloy (Brass or Bronze): Material and dim. per ANSI B16.26	—	SLDR	40 05 17	
	1/2 thru 3	Cast Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.18	—	SLDR	40 05 17	
Taps	1/4 thru 3	Cast Copper Alloy Tee (Brass or Bronze): Material and dim. per ANSI B16.26	—	SLDR	40 05 17	
Grooved Coupling	1/4 thru 2	None				
	2 1/2 thru 3	Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606	150 psi	RGRV	40 05 24	16
Flanges	1/2 thru 3	Wrought Bronze: ASTM B62, Dim. per ASME B16.5	Class 150	THD x FLG		
FLG Bolts, nuts and hardware	All	Alloy Steel Bolts: ASTM A193-Gr B7 with Carbon Steel Nuts: ASTM A194-Gr 2H heavy hex	All	—	—	1
Flange gaskets	1/8 thru 3	Nitrile or Neoprene: NSF 61 certified	1/16 in Thk.	FLG	40 05 01	17
Mechanical Coupling Gaskets	2 1/2 thru 3	EPDM: NSF 61 certified	—	CGRV, RGRV, PGRV	40 05 01	17
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	1/4 thru 3	Ball: Bronze Body/Ball, 40 05 63.02	—	THD	40 05 60	17
		Globe: Bronze, 40 05 66.01	—	THD	40 05 60	17
		Swing Check: Bronze 40 05 65.01	—	THD	40 05 60	17
Insulation	1/4 thru 3	Cellular Elastomeric: ASTM C534-Type I Grade 1, Low Temperature Range, Sweat Protection	1/2 in. Thk		40 42 00	

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Piping System Schedule, Potable Water

Process Service	Potable Hot Water	Potable Water				
Process Service Identifier	***HW***	***PW***				

Buried (Includes Embedded and Encased)

Component	Line Size, in	Material	Rating	Conn./Joints	Spec Section	Key Notes
Pipe	1/4 thru 3	High Density Polyethylene: ASTM D2239	SDR 9	BFW	40 05 33.13	5, 13
Lining for Pipe & Fittings	1/4 thru 3	None	—	—	—	
External Coating	All	None				
Fittings	All	Molded High Density Polyethylene: ASTM D2513 PE 4710, ASTM D3350-44557	SDR 11	BFW	40 05 33.13	13, 14
Taps	1/4 thru 3	Taps shall be made with Tee fittings only	—	BFW	40 05 33.13	
Grooved Coupling	1/4 thru 2	None				
Flanges	All	None	--	--		
FLG Bolts, nuts and hardware	All	None	--	—	—	
Flange gaskets	All	None	--	--	--	
Mechanical Coupling Gaskets	All	None	—	--	--	
Compression and Push-On Gaskets	All	None	—	—	—	
Valves	All	None	—	--	--	
Insulation	All	None	--		--	

END OF SECTION

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Section 40 05 02.89

Building Mechanical Drainage

Piping Service	Drain	Force Main Sanitary Sewer	Storm Drain	Sanitary Sewer	Vent
Piping Service Abbreviation	***D***	***FMSS***	***SD***	***SS***	***V***

Test Conditions

Pressure (psig)	Duration (min.)	Medium
5.0	15	Water

General Requirements

1. Minimum test conditions specified above. Comply with applicable local plumbing code.
2. Sleeve drain, waste and vent piping through structural concrete and masonry.
3. Provide copper tube for Outdoor HVAC equipment condensate drains.
4. Pipe Threads per ASME B1.20.1.

Notes:

1. Provide ductile iron pipe for buried pipe within 5 feet of building perimeter and between building perimeter and grinder pump station. Pipe materials transition to be at least 6 in above slab or 6 inches inside building perimeter wall.
2. Provide long radius elbows.
3. Provide locate wire for underground piping. Expose at least one end of the wire above grade.
4. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
5. Provide Non Corrosive, High-Strength, Low-Alloy Steel Bolts or fluoropolymer coated Carbon Steel Bolts for flanges installed in Buried Area Exposure.
6. Unreinforced Precast Concrete Manholes: 6 inch minimum wall thickness. Reinforced Precast Concrete Manholes: 4 inch minimum wall thickness. Provide Rubber gasket joints or mastic sealant joints between Precast Concrete Manhole Sections.
7. Bolts and nuts with metallurgy specified in AWWA C111.
8. Install per Cast Iron Soil Pipe Institute recommended practice specified in Cast Iron Soil Pipe and Fittings Handbook.
9. Lining not required for plumbing vents (V).
10. Changes in direction on buried pipe to be bent pipe. Elbow fittings to be used only where pipe bends are not practical.
11. Double-contained HDPE as noted on the drawings.

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Building Mechanical Drainage

Piping Service	Drain	Force Main Sanitary Sewer	Storm Drain	Sanitary Sewer	Vent
Piping Service Abbreviation	***D***	***FMSS***	***SD***	***SS***	***V***

Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, and Headspace – Exposed and Buried (Includes Embedded and Encased) Under Buildings and Between Building Perimeter and Grinder Pump Basin

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1/4 thru 1-1/2	Sch. 80	SLV	PVC: ASTM D1764-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785	40 05 31.13	
	2 thru 12	SV	HAS, HBLS	Ductile iron: AWWA C151, Dim. Per AWWA C150	40 05 19	1, 3
	14 thru 48	Thk. Class 53	FLG, CGRV	Ductile iron: AWWA C151, Dim. Per AWWA C150	40 05 19	
Lining for Pipe & Fittings	1/4 thru 1-1/2	—	—	None:	—	
	Ductile Iron, All	—	—	Ceramic Epoxy: Protecto 401, Factory Applied	40 05 19	9
External Coating	1/4 thru 1-1/2	2 wraps / layers	—	Pipe Wrap Tape: Polyethylene or PVC tape, Field Applied on Installed Pipe	—	
	Ductile Iron, All	Thk. per Std.	—	Metallic Zinc: Manufacturer's Standard, AWWA C151, Factory Applied	40 05 19	
	Valves	—	—	None:	—	
Fittings	1/4 thru 1-1/2		SLDR	Cast Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.18		
	14 thru 48	250 psi	FLG, CGRV	Ductile Iron: ASTM A536-Gr 65/45/12, Dim. per AWWA C110 or AWWA C153	40 05 19	2
Taps	All	—	—	None:		
Grooved Coupling	14 thru 36	M or E Pipe	CGRV	Flexible grooved coupling: ASTM A536-65/12, Dim. Per AWWA C606	40 05 19	
Flanges	14 thru 48	250 psi	FLG	Ductile iron: AWWA C115 for pipe or AWWA C110 for fittings	40 05 19	
FLG Bolts, nuts, and hardware	All	—	—	Carbon Steel Bolts: ASTM A307-Gr A with Carbon Steel Nuts: ASTM A563-Gr A, 1/4" thru 1-1/2" use Gr A hex nuts, 1-5/8" thru 3" use Gr A heavy hex nuts	—	6, 7
		—	—	Non Corrosive, High-Strength, Low-Alloy Steel Bolts: ASTM A 449- Gr 3, Class C or Class D with Carbon Steel Nuts: ASTM A563-Gr C3, Class C or Class D	—	6, 7
		—	—	Carbon Steel Bolts: ASTM A307-B with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal with Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal		6, 7
Flange gaskets	14 thru 48	1/8 in Thk.	FLG	Neoprene	40 05 01	

Section 40 05 02.89

Building Mechanical Drainage

Piping Service	Drain	Force Main Sanitary Sewer	Storm Drain	Sanitary Sewer	Vent
Piping Service Abbreviation	***D***	***FMSS***	***SD***	***SS***	***V***

Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, and Headspace – Exposed and Buried (Includes Embedded and Encased) Under Buildings and Between Building Perimeter and Grinder Pump Basin

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Mechanical Coupling Gaskets	14 thru 48	—	CGRV	Neoprene or Nitrile	40 05 01	
Compression and Push-On Gasket	2 thru 12	—	HAS, HBLS	Neoprene or Nitrile	40 05 01	
Valves	1/4 thru 1-1/2	130 psi	True Union	Ball Valve: Body and Ball: PVC, ASTM D1784 (Grade A), O-rings: EPDM, Seats: UHMWPE, Shafts: PVC, ASTM D1784 (Grade A), blowout-proof ball and stem, Full port, Non vented, bi-directional, floating ball, lever operator, IPEX Series VXE, or equal	—	
Insulation	½ thru 36	--.	—	None		

Buried (Includes Encased and Embedded) 5 feet Beyond Building Perimeter - Yard Piping

Component	Line Size, in	Rating	Conn./Joints	Material	Spec Section	Notes
Pipe	1 thru 2	SDR 11	BFW	High Density Polyethylene: ASTM D2513 PE 4710, ASTM D3350-44557	40 05 33.13	11
	4 thru 12	Class 350	PO, MJ	Ductile iron: AWWA C151	40 05 19	
Lining for Pipe & Fittings	Ductile Iron, All	—	—	Ceramic Epoxy: Protecto 401, Factory Applied	40 05 19	
External Coating	Ductile Iron, All	Thk. per Std.	—	Metallic Zinc: Manufacturer's Standard, AWWA C151, Factory Applied	40 05 19	
	Ductile Iron, All			Polywrap: AWWA C-600	40 05 19	
Fittings	2	SDR 11	BFW	Molded High Density Polyethylene: ASTM D2513 PE 4710, ASTM D3350-44557	40 05 33.13	10
	4 thru 12	350 PSI	PO, MJ	Ductile iron: AWWA C110, AWWA C111	40 05 19	
Valves	All	—	—	None	—	
Insulation	All	—	—	None	—	

END OF SECTION

Piping Service	Drain	Force Main Sanitary Sewer	Storm Drain	Sanitary Sewer	Vent
Piping Service Abbreviation	***D***	***FMSS***	***SD***	***SS***	***V***

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SECTION 40 05 06

SPECIALTY COUPLINGS AND ADAPTERS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes specialty couplings and adapters to provide electrical isolation, connect misaligned pipe, provide pipeline flexibility, provide disconnection/dismantling capabilities, and other specialty functions in pipelines.

B. Connections, couplings, and joints used to connect pipe segments and fittings that are not specifically designed to provide the capabilities of a specialty coupling are specified with the pipe materials.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 09 90 00 – General Coating Specification
   4. Section 40 05 01 – Piping Systems
   5. Section 40 05 02 – Piping System Schedules
   6. Section 40 05 02.23 – Piping System Schedule – Process Water

1.03 REFERENCE STANDARDS

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document

Reference	Title
ASME B31.1	Power Piping
ASME B31.9	Building Service Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM A36	Standard Specification for Carbon Structural Steel

Reference	Title
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
AWWA C153	Ductile-Iron Compact Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	AWWA M11 – Steel Pipe: A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
      a. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
      b. Manufacturers' product data, catalog cuts, typical installation details, and dimensions for each size and type of specialty coupling or adapter furnished for the project.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide new specialty pipe couplings and adapters, free from defects and conforming to the requirements and standards specified in this Section.

B. Provide specialty couplings and adapters at locations indicated on drawings.

2.02 MECHANICAL COUPLINGS

A. Fasteners and Gaskets
   1. Except as otherwise specified in this Section, fasteners specified by Area Exposure Type. See Section 01 61 45 – Area Exposure Designations.
      a. Indoor Dry, Indoor Wet, and Outdoor: Manufacturer's Standard

b. Process Corrosive, Headspace, Chemical Corrosive and Submerged: ASTM F593, Type 316 stainless steel, marking F593F.
c. Non-corrosive high-strength, Low-alloy steel, ASTM A449 Gr 3, Class C or Class D, with metallurgy specified in AWWA C111, regardless of any other protective coating.

2. Gasket material requirements for mechanical couplings are specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99).

B. Sleeve Couplings:
1. Candidate manufacturer:
a. Sleeve mechanical pipe couplings:
1) Xylem/Smith Blair Type 411.
2) Dresser Style 38.
3) Approved equal, with the stop removed from the middle ring.
b. Reducing Sleeve Couplings:
1) Xylem/Smith Blair Type 415.
2) Dresser Style 62.
3) Approved equal.
c. Sleeve Flanged Coupling Adapters:
1) Romac FCA 501.
2) Xylem/Smith Blair Type 913.
3) Dresser Style 128.
4) Approved equal.
d. Gaskets: Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.

C. Equipment Connection Fittings:
1. Equipment connection fittings join flanged pipe ends with both lateral and angular misalignment adjustment between the axes of the pipes. In addition, equipment connection fittings provide full pressure thrust restraint between the field piping connection and equipment connection flanges.
a. Equipment connection fittings consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint tie rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment.
b. Materials and features are to conform to the requirements established in this Section. Standard “dismantling joints” incorporate only one flanged coupling adapter and are not acceptable substitutes.
c. Candidate manufacturers:
1) Romac ECF Series
2) Baker Coupling Company, Los Angeles
3) Approved equal
2. Single sleeve of plain end piping conforming to the Piping System Schedule for the specified Process Service and of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with Sleeve Flange Coupling Adapters at each end.

3. Provide thrust restraint by means of all-thread rod spanning between flanges. Rod nuts and spherical washer sets provide a ball-joint type self-aligning feature for all-thread thrust restraint rods. All-thread thrust restraint rods project through the flange and mating flange coupling adapter bolt holes or through holes in the restraint lug plates that extend beyond the flange diameter. Secure all-thread thrust restraint rod to the flanges with flange nuts or lug plates.
4. Provide lock washers between spherical washer sets and fastening nuts at both ends of all-thread thrust restraint rods. Double nutting with non-locking nuts is not an acceptable method of providing a self-locking feature.
5. All-thread thrust restraint rod diameter provides freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust restraint rod tension take-ups.
6. Design equipment connection fittings per the requirements of AWWA C219.
7. Provide ASTM A193 grade B7, B8, or B8M thrust rods, ASTM A194 grade 2H, 8, or 8M nuts, with matching washers and lock washers to develop full rated piping system pressure thrust forces. For pump applications, select thrust rod quantities and diameters such that the thrust rod stretch under the piping system's operating pressure does not exceed 2.0 mils.
8. Factory apply dry film molybdenum disulfide anti-galling compound to ends of thrust rods, covering all threads subject to nut travel and tightening.
9. Gaskets:
    a. Flange gaskets: Match gasket material specified for Flange Gaskets in the Piping System Schedule for the associated Process Service.
    b. Follower gaskets: Compression Wedge. Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.
10. Provide schedule 40, ASTM A53, Grade B pipe sleeves with ASTM A536, Grade 65-45-12 or ASTM A36 flange bodies and end rings. Pressure rating of flange adapters meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of equipment connection fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

D. Dismantling Joints:
1. Dismantling joints may be used as takedown couplings in accordance with this Specification.
    a. Dismantling joints: fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment.
    b. Provide thrust restraint by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts.
    c. Design Dismantling Joints in accordance with AWWA C219.
    d. Provide schedule 40 ASTM A53 Grade B pipe sleeves with ASTM A536 Grade 65-45-12 or ASTM A36 flange bodies and end rings. The pressure ratings of the flange adapters are to meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of the fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

e. Candidate manufacturers:
    1) Romac DJ-400
    2) Smith Blair 975
    3) Crane-Viking Johnson Dismantling Joint
    4) Approved equal

E. Force Balanced Double Ball Expansion Joints
1. Install double ball expansion joints in the locations specified on the Drawings.
2. Provide foundry certification of material upon request. Materials as follows:
    a. Ductile iron joints conforming to the material requirements of ASTM A536 and AWWA C153.
    b. Type 410 stainless steel lock rings.
    c. EPDM molded watertight construction for ring gasket, casing, ball and cover.
3. Pressure test each expansion joint prior to shipment to a minimum of 250 PSI.
4. Flexible expansion joints consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, providing a minimum deflection of: 25 degrees per ball for 4-inch through 8-inch expansion joints; 20 degrees per ball for 10-inch and 12-inch expansion joints, and 15 degrees per ball for 14-inch and larger expansion joints. Two ball and socket joints are required for each Double Ball Expansion Joint.
5. Provide 10 inches minimum axial elongation capability with each single or double ball expansion joint. Furnish additional expansion sections as necessary to provide the specified minimum axial elongation capability.
6. Provide force balanced double ball expansion joint fittings that do not expand or exert an axial thrust under internal water pressure.
7. Line all metal surfaces, including the stainless steel lock rings, with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213. Provide EPDM sealing gaskets. Provide NSF 61 compliant coatings and gaskets.
8. Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to AWWA C116.
9. For buried installations, install polyethylene sleeve per AWWA C105, in accordance with the manufacturer's instructions.
10. Candidate manufacturers:
    a. Romac FJ Restraint
    b. Starflex Series 5000
    c. EBAA Iron, Flex-Tend
    d. Approved equal

2.03 UNIONS

A. 2-inch and Smaller: Ground joint screwed pattern unions.

B. 2 1/2-inch and Larger: Ground joint flange unions.

C. Dielectric Unions: Match the pipe material except bronze may be used with copper piping. Dielectric unions shall be EPCO, Capitol Manufacturing, or approved equal.

2.04 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Flange Insulating Kits: 2-1/2 inches and larger:
   1. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   2. In accordance with applicable piping material specified in Piping System Schedules (Section 40 05 02.00 through 40 05 02.99). Provide insulating flange assemblies per ASME B31.9 or B31.1. Flange assembly pressure/temperature rating equal to or greater than pipeline rating.
   3. Galvanically compatible with piping.
   4. Gaskets: Full-face, Type E, with elastomeric sealing element. Sealing element retained in a groove within retainer portion of gasket.
   5. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
   6. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
   7. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
   8. Manufacturers:
      a. Pipeline Seal and Insulator, Houston, TX
      b. Advance Products and Systems, Lafayette, LA
      c. Approved equal

B. Insulating Sleeve Couplings:
   1. Rockwell Type 416.
   2. Dresser Style 39.
   3. Approved equal.

C. Flexible Insulated Couplings:
   1. Dresser; STAB-39.
   2. Baker Coupling Company, Inc.; Series 216.
   3. Approved equal

D. Insulating Unions: Union Type, 2 inches and Smaller:
   1. Screwed or solder-joint.
   2. O-ring sealed with molded and bonded insulation to body.
   3. O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Co., Shawnee, OK.
   4. Approved equal

2.05 COATINGS

A. Field coat mechanical couplings in Buried exposure areas with System M-1 as specified in Section 09 90 00.

B. Field coat mechanical couplings in Indoor Dry, Indoor Wet, Outdoor, Submerged, and Headspace exposure areas as scheduled in Section 09 90 00.

PART 3 EXECUTION

3.01 FLEXIBILITY

A. Unless otherwise specified, pipe passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a double ball expansion joint) as specified on the Drawings. Locate pipe couplings within 24 inches of the structure for 2-inch through 6-inch diameter pipe and within 40 inches of the structure for 8-inch through 24-inch pipe. Where required for resistance to pressure, restrain mechanical couplings in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

B. Install Double Ball Expansion Joints with ¼ inch elongation/extension of the minimum axial elongation capability specified in this Section.

3.02 DIELECTRIC CONNECTIONS

A. Provide an insulating section of rubber or plastic pipe where a copper pipe is connected to steel or cast iron pipe. The insulating section shall have a minimum length of 12 pipe diameters.

B. Dielectric unions as specified in this Section may be used instead of the specified insulating sections.

END OF SECTION

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SECTION 40 05 06.23

EXPANSION JOINTS AND FLEXIBLE METAL HOSE

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies piping expansion joints and flexible metal hose.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules
   5. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   6. Section 40 05 07 – Hangers and Supports for Process Piping
   7. Section 40 05 07.13 – Seismic Restraints for Piping
   8. Section 40 05 07.16 – Expansion Control for Piping

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Expansion Joint: Any device used to absorb dimensional changes and/or misalignment.
   2. Pipe Section: the portion of pipe between two anchors.
   3. Lateral Direction: Direction perpendicular to the pipe axis.
   4. Longitudinal Direction: Direction parallel to the pipe axis.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, piping supports (hangers, guides, anchors, structural attachments, etc.), and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.
   3. Design and construction details of formed metal bellows type expansion joints.
   4. Percent enlongation over range of design temperatures.
   5. Pressure thrust force and spring rate data for formed metal bellows expansion joints.
   6. Materials, design and construction, and temperature and pressure rating for elastomer and fabric expansion joints.
   7. Details for the installation of all expansion joints.
   8. Listing of all flexible metal hose applications.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

PART 2 PRODUCTS

2.01 PERFORMANCE / DESIGN CRITERIA

A. General:
   1. All expansion joints and flexible hose materials shall be new, free from defects and conforming to the requirements and standards specified in this Section.
   2. Furnish expansion joints and flexible metal hose as specified in Part 4 of this specification.
   3. Provide control units (tie rods or restraints) to prevent excessive axial elongation and to accept the pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer.

B. Expansion Joints:
   1. Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Schedules (Section 40 05 02.23) without crimping of corrugations.
   2. Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).
   3. Supply bellows type expansion joints suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

C. Flexible Metal Hose:
   1. Flexible metal hose shall be suitable for a line pressure equal to the test pressure listed in the Piping System Schedules (Section 40 05 02.23).
   2. Live lengths for flexible metal hose shall be based on service as specified and a design life of 1,000,000 full displacement cycles.

2.02 EXPANSION JOINTS

A. Metal Construction
   1. Formed Bellows Type
      a. Bellows type shall be single metal bellows. Unless otherwise specified, end connections shall be flanged.
      b. Formed bellows-type expansion joints for temperatures up to 800 degrees F shall have 300 series stainless steel multi-ply bellows rated for the specified design temperature and pressure.
      c. Test pressures are specified in the Piping System Schedules (Section 40 05 02.23). Each expansion joint shall be factory tested at the test pressure.
      d. Minimum non-concurrent axial movement capabilities: not less than 2.5 inches.
      e. Acceptable manufacturers: Formed bellows type expansion joints shall be as manufactured by U.S. Bellows, Senior Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or approved equal.

B. Elastomer and Fabric Construction
   1. General Requirements:
      a. Standard spool arch type or the precision molded spherical design type as specified.
      b. Single arch and sphere type expansion joints, unless otherwise indicated, have 150-mm face-to-face dimension for pipe up to 200 and 200-mm face-to-face dimension for pipe 250 and 300. For use with larger diameters, Contractor must obtain approval from the Owner's Representative.
      c. Cover elastomer constructed of chlorobutyl, neoprene, or EPDM.
      d. Tube elastomer constructed of chlorobutyl or EPDM for temperatures between 80 and 115 degrees C. Neoprene or Buna N liners are acceptable for temperatures up to 80 degrees C.
   2. Spool Type:
      a. Resilient arch type and standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.

b. Constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body.

c. Provide retaining or backup rings for standard arch type expansion joints suitable for the specified temperature and pressure. Rings shall be 10-mm-thick steel, split, either galvanized or zinc shield coated.

d. Use filled arch type expansion joints on all piping systems carrying fluids containing solids.

e. Acceptable manufacturers for single, multiple, or filled arch: Unisource Series 1200, Garlock Style 204, Mercer Style 500, or approved equal.

f. Acceptable manufacturers for high pressure couplings suitable for 240 degree F operating temperatures: Unisource Series 1500, Mercer Style 510, Garlock Style 204-HP, General Style 1015, or approved equal.

3. Spherical Molded Type:

a. Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure.

b. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid.

c. Acceptable manufacturers for single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E-611, General Type 1010, Garlock Style 8100, or approved equal.

d. Provide double sphere or triple sphere connectors where required to provide for the specified movement.

C. Polymer Expansion Joints

1. Provide expansion joints for PVC or CPVC piping that are EPDM elastomer flexible double-bellows. Attach expansion joints to pipe using union-type couplings.

2. PVC/CPVC acceptable manufacturers: Spears; Flexicraft; Approved Equal.

2.03 FLEXIBLE HOSE

A. Flexible Metal Hose:

1. Unless otherwise specified, flexible metal hose shall be corrugated type 321 stainless steel with stainless steel fittings and shall be provided with stainless steel single braid.

2. Attach end connections by helical crest welding.

3. Provide bronze flexible metal hose for copper and brass systems.

4. Acceptable manufacturers: American BOA Series B, Flexonics, Unisource, Metraflex, or approved equal.

B. Flexible polymer hose

1. Provide UHMWPE flexible connectors consiting of molded UHMWPE bellows and 150-pound ductile iron flanges. The flanges shall be completely isolated from the chemical by the molded UHMWPE bellows.

2. Provide integral steel limit bolts and Monel reinforcing rings on the connectors. Provide connectors with nonasbestos gaskets. The connectors shall allow for an axial transverse movement of at least 1/2-inch, and an offset of at least 3/8-inch. The connectors shall be rated for a pressure of 130 psi, at a temperature of 70 degrees F.
3. Acceptable manufacturers: Jackson Industrial, Metraflex, Garlock, modified as necessary to provide the specified features, or approved equal.

2.04 FLEXIBLE METAL HOSE LOOP

A. Flexible metal hose loops consist of two parallel sections of corrugated stainless steel metal hose and single braid with 180 degree return bend, flanged inlet and outlet connections.

B. Furnish flexible metal hose loops that provide the amount and kind of movement (axial, lateral, angular, torsional) scheduled in this Section. Provide supports at 180 degree return bend per manufacturer's recommendations.

C. For loops using hanger supports, provide seismic break-away coupling to allow separation during seismic event.

D. Acceptable Manufacturers: Metraflex; Flexicraft; Anvil International; Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Located expansion joints as specified. Location and number of guides shall be determined from EJMA Standards.

B. For piping services operating at less than 170 degree F, do not install expansion joints during times of extreme temperature or in a fully compressed or fully expanded condition.

C. For piping services operating at over 170 degree F, install expansion joints at percent elongation corresponding to installation temperature as a percent of maximum operating temperature.

D. Unless otherwise specified, expansion joints 4 inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

A. Align piping systems prior to installation of expansion joints.

B. Do not use expansion joints to correct piping misalignment during installations.

C. Install expansion joints normally preset at the factory for rated axial compression and expansion in this preset condition.

D. Set control units/tie rods/restraints after all pressure testing of the piping system is complete.

PART 4 SCHEDULE

4.01 EXPANSION JOINT AND CONNECTOR SCHEDULE

A. Expansion joints and/or flexible metal hose connectors provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

B. Expansion joints and connectors shall be provided in accordance with the following table. If a particular joint or connector is shown or specified for a given location, that more detailed selection shall apply.

Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Elastomer spool arch (2.02 Spool Type.)	Expansion joints for piping 14 inch diameter and larger.
Elastomer spherical molded (2.02 Spherical Molded Type)	Expansion joints for piping 12 inch diameter and less.

END OF SECTION

SECTION 40 05 06.33

PIPING APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Section
   1. Review the process mechanical layout and the Process and Instrumentation Diagram(s) (P&ID) drawings within the Contract Documents that relate to the equipment specified in this Section to familiarize themselves with the location, arrangement and the application of the equipment specified and confirm that the equipment specified is appropriate for and coordinated with what is shown on the Drawings.
   2. This section specifies flow and level gauges, pressure gauges, vents, and drains.

B. Exclusions:
   1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Division 40. Instruments specified in Section 40 71 00 – Flow Measurement are identified in the instrument index in Section 40 06 70 – Schedules for Instrumentation of Process Systems.

C. Required Coordination
   1. Review the process mechanical layout and the Process and Instrumentation Diagram(s) (P&ID) drawings within the Contract Documents that relate to the equipment specified in this Section to familiarize themselves with the location, arrangement and the application of the equipment specified and confirm that the equipment specified is appropriate for and coordinated with what is shown on the Drawings.

1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related Sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 40 05 01 – Piping Systems
   5. Section 40 05 02 – Piping System Schedules
   6. Section 40 06 70 – Schedules for Instrumetnation of Process Systems
   7. Section 40 71 00 – Flow Measurement
   8. Section 40 72 00 – Level Measurement
   9. Section 40 73 00 – Pressure Measurement

1.03 REFERENCE STANDARDS

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
SAMA PMC 17-10	Bushings and Wells for Temperature Sensing Elements

1.04 SUBMITTALS

A. The following minimum documentation shall be submitted per Section 01 33 00 - Submittal Procedures

B. Action Submittals: The following shall be submitted prior to construction of this element of the Work.

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Locate appurtenances on the piping layout drawings by plant area and submit in accordance with Section 40 05 01 – Piping Systems.
3. Maufacturer's product data.
4. Operations and Maintenance Manuals (including Warranty) in accordance with Section 01 78 23 – Operation and Maintenance Data

C. Closeout Submittals: The following minimum submittals shall be submitted for inspection.

1. Final Operations and Maintenance Manuals (including final Warranty documents) in accordance with Section 01 78 23 – Operation and Maintenance Data.

1.05 SHIPMENT AND STORAGE

A. Ship and store products in accordance with Section 01 66 00 – Product Storage and Handling Requirements.

B. Provide the Contractor with detailed recommendations and instructions for product storage.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified or shown on the Drawings:
   1. All equipment shall be the same size as adjoining pipe.
   2. Body material of appurtenances shall match pipeline material.
   3. Pressure rating of appurtenances shall be no less than 150 psi.
   4. Electrical housings shall be as specified in Division 26.

B. All units shall have the name of the manufacturer and the size of the unit cast on the body or shown on a permanently attached plate in raised letters.

C. All equipment provided shall be equipped with flanges, integral unions, or other functional connections for removal.

2.02 FLOW METERS

A. See Section 40 71 00.

2.03 LEVEL INSTRUMENTATION

A. See Section 40 72 00.

2.04 PRESSURE DEVICES

A. See Section 40 73 00.

2.05 QUICK CONNECT FITTINGS

A. Air and water utility station quick connect fittings.
   1. Acceptable manufacturers:
      a. Dixon Air King.
      b. Chicago Pneumatic.
      c. Or Approved equal.

B. All other quick connect fittings:
   1. Type: Coupler type, with cam arms. Capable of connecting to a hose adapter without the use of tools.
   2. Size: The same size as the pipeline.
   3. Materials: Match pipeline material with EPDM gaskets.

4. Acceptable manufacturers:
    a. Kamlock.
    b. Chicago Pneumatic.
    c. Or Approved equal.

PART 3 EXECUTION

3.01 GAGE TAPS

A. Provide gage taps on the suction and discharge of pumps, whether shown or not on the Drawings.

B. Gage taps for water and air service shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment, or as indicated on the Drawings.

C. Gage taps and valves for gas service shall be in accordance with Section 40 73 00.

3.02 VENTS AND DRAINS

A. Vents:
    1. Provide manual air vents at the high points of each reach of pipeline shown on the drawings, and provide additional manual drains as required and specified by the Project Representative after completion of piping installation.
    2. Provide manual air vents between all double block valves, as indicated on the drawings.
    3. Air vents shall be 1-inch and shall consist of full port ball valve and copper tubing return.
    4. Air vents shall be taken to the nearest floor with ball valve mounted 4 feet above the floor.
    5. Fit vents in piping systems for fluids containing solids with quick couplers.

B. Drains:
    1. Pipe each drain to a sump, gutter, floor drain or other collection point with a valve mounted 4 feet above the floor.
    2. Drain valves in piping systems for fluids containing solids shall be threaded end full port plug valves of the size specified, fitted with quick couplers. All other drain valves shall be threaded end gate valves of the size specified, fitted with quick couplers.
    3. When a drain cannot be run to a collection point, route the drain to a point of easy access and install a valve, of the type and size specified, fitted with a male threaded nipple suitable for connection to a hose.

3.03 FLEXIBLE SLEEVE PRESSURE SENSORS

A. If system has not been factory filled, vacuum fill the system in the field. Solder filling connections shut after vacuum evacuation and filling.

END OF SECTION

SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies hangers and supports for all exposed piping systems specified in Section 40 05 01. This section does not include pipe supports for fire sprinkler systems, pipe anchors, guides or seismic restraints.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 05 05 20 – Anchor Bolts
   5. Section 40 05 01 – Piping Systems
   6. Section 40 05 07.13 – Seismic Restraints for Piping
   7. Section 40 05 07.16 – Expansion Control for Piping
   8. Section 40 42 00 – Insulation for Exposed Piping and Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed.
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture

1.04 DEFINITIONS

A. Not used.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, expansion joints, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Hanger and Supports Selection and Design for additional coordation requirements.

1.06 SUBMITTALS

A. Coordinate submittal requirements of this section with the following sections:
   1. Section 40 05 07.13 – Seismic Restraints for Piping
   2. Section 40 05 07.16 – Expansion Control for Piping

B. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.
   3. Identify hanger and support locations and components indicated on the piping layout drawings required by Section 40 05 01.

C. Informational Submittals:
   1. Procedures: Section 01 33 00.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN CRITERIA

A. Service Conditions:
   1. The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
      a. Hot Systems
         1) A - 1. 120 degrees F to 450 degrees F
         2) A - 2. 451 degrees F to 750 degrees F

3) A - 3. Over 750 degrees F

b. Ambient Systems

1) B. 60 degrees F to 119 degrees F

c. Cold Systems

1) C - 1. 33 degrees F to 59 degrees F

2) C - 2. -20 degrees F to 32 degrees F

B. Hanger and Support Selection:

1. The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in this section, the piping insulation thickness specified in Section 40 42 00, and any special requirements which may be specified in the project manual.
2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
3. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:
   a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
   b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
   c. Reaction forces due to the operation of safety or relief valves.
   d. Wind, snow or ice loadings on outdoor piping.
4. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.
5. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.
6. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.
7. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.
8. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.
9. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.
10. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
11. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
12. Stock hanger and support components shall be used wherever practical.

2.02 MATERIALS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e.

B. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

2.03 CONFIGURATION, COMPONENTS, FEATURES

A. General:
   1. Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Section 01 61 45 Area Exposure Designations or as shown on the drawings, which shall be type 304 stainless steel.

B. Pipe Hangers And Supports:
   1. Type 1 – Clevis Pipe Hanger: Clevis hangers shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 1.
      a. Steel pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.
      b. Steel pipe (uninsulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal.
      c. Cast and ductile iron pipe - shall be B-Line B3102, Grinnell Fig. 590, or equal.
      d. Copper pipe (uninsulated) - shall be B-Line B3104 CT, Grinnell Fig. CT-65, or equal.
      e. Copper pipe (insulated) - shall be B-Line B3100, Grinnell Fig. 260, or equal, with insulation shield.
      f. Plastic pipe - shall be B-Line B3100 C, Carpenter & Patterson Fig. 100PVC, or equal.
   2. Type 2 – “J” Pipe Hanger: Hangers shall be carbon steel with configuration and components equivalent to MSS Type 5.
      a. Steel pipe - shall be B-Line B3690, Grinnell Fig. 67, Michigan model 418, or equal.
      b. Copper and plastic pipe - shall be Michigan model 419, Unistrut J 1205N series, or equal.
   3. Type 3 – Double Bolt Pipe Clamp: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 3.
      a. Steel pipe (insulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield. Insulation shield is optional for hot and ambient systems.
      b. Steel pipe (uninsulated) - shall be B-Line B3144, Grinnell Fig. 295, or equal.
      c. Copper pipe (insulated only) - shall be B-Line B3144, Grinnell Fig. 295, or equal, with insulation shield.

4. Type 4 – Adjustable Roller Hanger: Rollers shall be cast iron, yoke and cross bolt shall be carbon steel. Configuration and components shall be equivalent to MSS Type 43 and FEDSPEC Type 44.
    a. Steel pipe (insulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.
    b. Steel pipe (uninsulated) - shall be B-Line B3110, Grinnell Fig. 181, or equal.
    c. Copper pipe (insulated only) - shall be B-Line B3110, Grinnell Fig. 181, or equal, with insulation shield.
    d. Plastic pipe - shall be B-Line B3110, Grinnell Fig. 181, or equal.
5. Type 5 - Single Pipe Roll: Rollers and sockets shall be cast iron, cross rod shall be steel. Configuration and components shall be equivalent to MSS Type 41 and FEDSPEC Type 42.
    a. Steel pipe (insulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal, with insulation shield.
    b. Steel pipe (uninsulated) - shall be B-Line B3114, Grinnell Fig. 171, or equal.
    c. Plastic pipe - shall be B-Line B3114, Grinnell Fig. 171, or equal.
6. Type 6 - Framing Channel Pipe Clamp: Pipe clamps shall be steel with galvanized finish and material thickness as listed below:
    a. Steel pipe (uninsulated) - Pipe size 3/8 inch and 1/2 inch shall be 16 gage; 3/4 inch through 1 1/4 inches shall be 14 gage; 1 1/2 inches through 3 inches shall be 12 gage; 3 1/2 inches through 5 inches shall be 11 gage; 6 and 8 inches shall be 10 gage; Michigan model 431, Powerstrut PS 1100, Unistrut P 1109 series, or equal.
    b. Steel pipe (insulated) - Pipe clamp shall be as described in paragraph 2.03 Steel Pipe (Uninsulated) with insulation shield.
    c. Copper (uninsulated) and plastic pipe - Pipe size 3/8 inch and 1 inch shall be 16 gage; 1-1/4 inches and 1-1/2 inches shall be 14 gage; 2 inches through 3 inches shall be 12 gage; 4 inches shall be 11 gage; clamp shall be copper-plated, plastic coated or lined with dielectric material; Michigan model 432, Powerstrut PS 1200, Unistrut P 2024C and P 2024PC series, or equal.
    d. Copper pipe (insulated) - Pipe clamp shall be as described in paragraph 2.03 Steel Pipe (Uninsulated) with insulation shield.
7. Type 7 - U-BOLT: U-bolts shall be carbon steel with configuration equivalent to MSS and FEDSPEC Type 24.
    a. Steel pipe (uninsulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal.
    b. Steel pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.
    c. Cast and ductile iron pipe - shall be Grinnell Fig. 137, B-Line B3188, or equal.
    d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 222 CT, B-Line B3501 CT, Grinnell Fig. 137C, or equal.
    e. Copper pipe (insulated) - shall be Grinnell Fig. 137, B-Line B3188, or equal, with insulation shield.
    f. Plastic pipe - shall be Grinnell Fig. 137C, Michigan model 151, B-Line B3188 C, or equal.

8. Type 8 - Adjustable Pipe Roll Support: Rollers and sockets shall be cast iron, cross rod and support rods shall be carbon steel.
    a. Steel pipe (insulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.
    b. Steel pipe (uninsulated) - shall be B-Line B3122, Grinnell Fig. 177, or equal.
    c. Copper pipe (insulated only) - shall be B-Line B3122, Grinnell Fig. 177, or equal, with insulation shield.
    d. Plastic pipe - shall be B-Line B3122, Grinnell Fig. 177, or equal.
9. Type 9 - Welded Pipe Stanchion: Minimum material thickness shall be standard schedule carbon steel pipe, cut to match contour of the pipe elbow. Use of this support shall be limited to ambient systems only.
10. Type 10 - Pipe Stanchion Saddle: Saddles and yokes shall be carbon steel and comply with MSS Type 37 and FEDSPEC Type 38.
    a. Steel pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.
    b. Steel pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.
    c. Cast and ductile iron pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090 NS, or equal.
    d. Copper pipe (uninsulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield or lined with dielectric material.
    e. Copper pipe (insulated) - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal, with insulation shield.
    f. Plastic pipe - shall be Carpenter & Patterson Fig. 125, B-Line B3090, or equal.
11. Type 11 - Offset Pipe Clamp: Pipe clamp shall be carbon steel with configuration and components as specified and shall be of standard design manufactured by a pipe hanger component manufacturer.
    a. Steel pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.
    b. Steel pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal.
    c. Cast and ductile iron pipe - shall be B-Line B3148 NS, Grinnell Fig. 103, or equal.
    d. Copper pipe (insulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, with insulation shield.
    e. Copper pipe (uninsulated) - shall be B-Line B3148, Grinnell Fig. 103, or equal, lined with dielectric material.
    f. Plastic pipe - shall be B-Line B3148, Grinnell Fig. 103, or equal.
    g. Vertical pipe support applications shall be as specified above except that insulation shields shall not be used for insulated pipe.
12. Type 12 - Riser Clamp: Riser clamp shall be carbon steel with configuration and components equivalent to MSS and FEDSPEC Type 8.
    a. Steel pipe (insulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.
    b. Steel pipe (uninsulated) - shall be B-Line B3373, Grinnell Fig. 261, or equal.
    c. Cast and ductile iron pipe - shall be B-Line B3373, Grinnell Fig. 261, or equal.
    d. Copper pipe (insulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

e. Copper pipe (uninsulated) - shall be B-Line B3373 CT, Grinnell Fig. CT-121, Michigan model 511, or equal.

f. Plastic pipe - shall be B-Line B3373, Grinnell Fig. 261c, or equal.

13. Type 13 - Framing Channel Pipe Strap: Pipe strap shall be carbon steel, with configuration equivalent to MSS Type 26.

a. Steel pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

b. Steel pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

c. Copper pipe (uninsulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield or lined with dielectric material.

d. Copper pipe (insulated) - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal, with insulation shield.

e. Plastic pipe - shall be Superstrut No. C-708-U, Powerstrut PS 3126, Kin-Line No. 477, or equal.

C. Rack And Trapeze Supports:

1. General: Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. Type 20 - Trapeze Pipe Support: Trapeze pipe support cross members shall be framing channel as specified in paragraph 2.03 Framing Channel. Flat plate fittings shall be 1 5/8-inch square carbon steel of standard design manufactured by framing channel manufacturer, Unistrut P2471, B-Line B202-2, or equal.

3. Type 21 - Pipe Rack Support: Post and cross members shall be framing channel as specified in paragraph 2.03 Framing Channel. Pipe rack fittings shall be carbon steel, of standard design manufactured by framing channel manufacturer. 90-degree fittings shall be gusseted Unistrut P2484, B-Line B844, or equal. Post base fittings shall be as specified in paragraph 2.03 Type E – Framing Channel Post Base.

D. Structural Attachments:

1. Type A - Malleable Iron Concrete Insert: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. Type B - Side Beam Bracket: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.

3. Type C - Malleable Beam Clamp With Extension Piece: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or equal.

4. Type D - Steel Beam Clamp With Eye Nut: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. Type E - Framing Channel Post Base: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B-Line B280, or equal. Double channel: Unistrut P2073A, B-Line B281, or equal.

6. Type F - Welded Beam Attachment: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.

7. Type G - Welded Steel Bracket: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.
8. Type H - Cast Iron Bracket: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.
9. Type J - Adjustable Beam Attachment: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.
10. Type K - Double Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.
11. Type L - Single Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.
12. Type M - Wall Mounted Channel: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel.
13. Type N - Pipe Stanchion Floor Attachment: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.
14. Type Q - Continuous Concrete Inserts: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. Accessories:
1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
2. Weldless Eye Nut: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or equal.
3. Welded Eye Rod: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or equal.
4. Turnbuckle: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or equal.
5. Framing Channel: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Single channel: Unistrut P1000, B-Line B22, or equal. Double channel: Unistrut P1001, B-Line B22A, or equal. Triple channel: Unistrut P1004A, B-Line B22X, or equal.

2.04 THERMAL PIPE HANGER SHIELD

A. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in Section 40 42 00. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

B. Standard Shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof
      b. Compressive strength: 100 psi average
      c. Flexural strength: 75 psi average
      d. K factor: 0.38 at 100 degrees F mean
      e. Temperature range: 20 degrees F to 500 degrees F
   2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

C. Vapor Barrier Shield:
   1. Insulation:
      a. Hydrous calcium silicate, high density, waterproof
      b. Compressive strength: 100 psi average
      c. Flexural strength: 75 psi average
      d. K factor: 0.38 at 100 degrees F mean
      e. Temperature range: 20 degrees F to 500 degrees F
   2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
   3. Connection: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

A. Locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

B. Locate at least one hanger or support within 2 feet from a pipe change in direction.

C. Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, support the piping in such a manner that temporary supports shall not be necessary for this procedure.

E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

A. Weld and bolt attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

B. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

C. Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

E. Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

J. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

A. Adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

A. Anchor bolts in new concrete shall be cast in place. Refer to Section 05 05 20.

END OF SECTION

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SECTION 40 05 07.13

SEISMIC RESTRAINTS FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies seismic restraints for bracing all piping systems specified in Section 40 05 01. This section does not include seismic restraints for fire sprinkler systems.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   4. Section 03 30 00 – Cast-in-Place Concrete
   5. Section 05 05 20 – Anchor Bolts
   6. Section 40 05 01 – Piping Systems
   7. Section 40 05 07 – Hangers and Supports for Process Piping
   8. Section 40 05 07.16 – Expansion Control for Piping

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ANSI A58.1-82	Minimum Design Loads for Buildings and Other Structures
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
SMACNA, PPIC	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Longitudinal direction: direction parallel to the pipe axis.
   2. Lateral direction: direction perpendicular to the pipe axis.
   3. Pipe support: a structural element or assemble that is required to absorb the piping system weight loads and contain sustained longitudianal stress within the allowable limits
   4. Pipe restraint: a structural element used to constrain or limit the thermal or seismic movement of a piping system.

1.05 ADMISTRATIVE REQUIREMENTS

A. Cordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.

1.06 SUBMITTALS

A. Coordinate submittal requirements of this section with the following sections:
   1. Section 40 05 07 – Hangers and Supports for Process Piping
   2. Section 40 05 07.16 – Expansion Control for Piping

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Seismic restraint locations and legend as specified in paragraph 3.01.
   3. Seismic restraint load calculations as specified in paragraph 1.07 Quality Assurance.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Seismic restraint load calculations specified in paragraph 3.01 shall be reviewed and signed by a structural engineer registered in the State of Washington.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:
   1. Provide seismic bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Designed seismic bracing for seismic loading as specified in Section 01 73 24. Seismic loading shall be assumed to be acting in the lateral, longitudinal, and vertical directions simultaneously.
   2. Provide all piping systems with seismic restraints conforming to governing state and local codes.
   3. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

B. Restraint Selection:
   1. Unless otherwise specified, the Contractor shall select, locate and provide seismic restraints for piping in accordance with the project manual.
   2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
   3. Seismic restraints may be omitted from the following installations:
      a. Gas piping less than 1-inch inside diameter.
      b. Piping in boiler and mechanical rooms less than 1 1/4-inch inside diameter.
      c. All other piping less than 2 1/2-inch inside diameter.
      d. All piping suspended by individual hangers 12 inches or less in length from the top of the pipe to the bottom of the support for the hanger.
   4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
   5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
   6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
   7. Branch lines shall not be used to brace main lines.
   8. Seismic bracing shall not limit the expansion and contraction of the piping system.

2.02 MANUFACTURERS

A. Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B-Line, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or approved equal. Pipe restraint materials shall conform to the requirements of MSS SP-58 and MFMA-1.

2.03 MATERIALS

A. General:
   1. Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication.
   2. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc-coated except for those subject to moisture or corrosive atmosphere, which shall be type 304 stainless steel.

B. Pipe Attachments:
   1. Type 1s: Clevis Restraint Attachment: Clevis attachment shall be Type 1, clevis pipe hanger, as specified in Section 40 05 07-2.03 Pipe Hangers and Supports.
   2. Type 3s: Double Bolt Restraint Clamp: Restraint clamp shall be Type 3, double bolt pipe clamp, as specified in Section 40 05 07-2.03 Pipe Hangers and Supports.
   3. Type 4s: Roller Restraint Attachment: Roller attachment shall be Type 4, adjustable roller hanger, as specified in Section 40 05 07-2.03 Pipe Hangers and Supports. Hold down strap shall be carbon steel and sized as follows: pipe size 1 inch through 2 inch shall be 1 inch by 1/8 inch thick, pipe sizes 2 1/2-inch through 4 inch shall be 1 1/4-inch by 3/l6 inch thick, 6 inch pipe shall be 2 inch by 3/l6 inch thick, 8 inch pipe shall be 2 1/2-inch by 3/16 inch thick, 10-inch through 16-inch pipe shall be 2 1/2-inch by 1/4 inch thick, 20-inch pipe shall be 3 inch by 1/4 inch thick, and 24-inch pipe shall be 3 inch by 3/8 inch thick.
   4. Type 7s: U-Bolt Restraint: U-bolt restraint shall be Type 7, U-bolt, as specified in Section 40 05 07-2.03 Pipe Hangers and Supports.
   5. Type 13s: Framing Channel Strap Restraint: Strap restraint shall be Type 13, framing channel pipe strap, as specified in Section 40 05 07-2.03 Pipe Hangers and Supports.
   6. Type 14s: Pipe Clamp Restraint: Pipe clamp shall be carbon steel, with configuration and components equivalent to MSS and FEDSPEC Type 4. Rod attachment and longitudinal brace connection stud shall be carbon steel, fabricated and welded by the manufacturer.
      a. Steel pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
      b. Steel pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.
      c. Cast and ductile iron pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.
      d. Copper pipe (insulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
      e. Copper pipe (uninsulated)--shall be Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield or dielectric lining.
      f. Plastic pipe--shall be Superstrut No. S-720, Kin-Line No. S475, or equal.

C. Trapeze Restraints:
   1. General: Unless otherwise specified, trapeze members shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

2. Type 20s: Single Channel Lateral Restraint: Trapeze restraint cross member shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 2.03 Pipe Attachments. Rod stiffeners and lateral brace shall be as specified in paragraph 2.03 Braces and Fittings.
3. Type 21s: Double Channel Lateral Restraint: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 2.03 Pipe Attachments. Rod stiffeners and lateral brace shall be as specified in paragraph 2.03 Braces and Fittings.
4. Type 22s: Double Channel Longitudinal Restraint: Trapeze restraint cross member shall be a double channel manufactured assembly such as Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal. Pipe attachments shall be Type 13s or Type 7s specified in paragraph 2.03 Pipe Attachments. Rod stiffeners, longitudinal and lateral braces shall be as specified in paragraph 2.03 Braces and Fittings.

D. Braces and Fittings:
1. Seismic Brace Fitting: Seismic brace fitting shall be manufactured for use with industry standard framing channel. The fitting shall be carbon steel, welded construction, two-piece linked fitting. A means to reduce noise and vibration transmission between the linked fitting parts shall be provided. Seismic brace fittings shall be Superstrut C-749N series seismic brace, Kin-Line No. 633 seismic connector fitting, or equal.
2. Hanger Rod Stiffener Assembly: Rod stiffener channel shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal. Rod stiffener clamps shall be complete with channel nut and shall be Superstrut ES-142, Kin-Line No. 635, or equal.
3. Type A1 Seismic Brace: Seismic brace shall be 1 5/8-inch square carbon steel framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, Kin-Line No. 4112, or equal.
4. Type A2 Seismic Brace: Seismic brace shall be 1 5/8-inch wide by 3 1/4-inch deep carbon steel framing channel, Unistrut P5000, B-Line B11, Superstrut H-1200, Kin-Line No. 8212, or equal.

E. Structural Attachments:
1. General: Unless otherwise specified, hanger rod structural attachments shall be as specified in Section 40 05 07. Structural attachments for longitudinal and lateral seismic braces shall be as specified in paragraph 2.03 Structural Attachments.
2. Type SA-1 Attachment: Brace fitting shall be as specified in paragraph 2.03 Braces and Fittings. Concrete anchors shall be as specified in Section 05 05 20 with embedment and location dimensions as specified.
3. Type SA-2 Attachment: Brace fitting shall be as specified in paragraph 2.03 Braces and Fittings. Concrete anchors shall be as specified in Section 05 05 20 with embedment and location dimensions as specified. Framing channel shall be as specified in paragraph 2.03 Accessories.
4. Type SA-3 Attachment: Brace fitting shall be as specified in paragraph 2.03 Braces and Fittings. Cap screw, lockwasher and hex nut materials and finish shall be compatible with structural steel material.

5. Type SA-4 Attachment: Brace fitting shall be as specified in paragraph 2.03 Braces and Fittings.
6. Type SA-5 Attachment: Brace fitting shall be as specified in paragraph 2.03 Braces and Fittings. Four-inch x 3-inch x 3/8-inch angle shall be carbon steel.

F. Accessories:
1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
2. Framing Channel: Framing channel shall conform to the Metal Framing Manufacturers Association standard MFMA-1. Framing channel shall be roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Channel shall be Unistrut P1000 series, B-Line B22 series, Superstrut A-1200 series, or equal.
3. Rod Coupling: Rod coupling shall be carbon steel, with sight hole in center of coupling body, Grinnell Fig. 135, Superstrut H-119, or equal.

G. Thermal Pipe Hanger Shield
1. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in Section 40 05 07. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

PART 3 EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

A. Locate the first seismic restraint on a piping system not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Brace ductile and cast iron pipe on each side of a change in direction of 90 degrees or more. Brace or stabilize joints in risers between floors.

C. At a minimum, brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20 feet and laterally every 10 feet.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

E. Indicate seismic restraint locations and components on the piping layout drawings required by Section 40 05 01.The Contractor shall provide a legend giving load information and restraint component selection at each restraint location.

3.02 INSTALLATION

A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 inches in length. Use a minimum of two rod stiffener clamps on any rod stiffener assembly.

B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging.

E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

END OF SECTION

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SECTION 40 05 07.16

EXPANSION CONTROL FOR PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies expansion control for the piping systems specified in paragraph 2.01 Service Conditions. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. All expansion control components shall be as specified on the Drawings and this Section.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 – Submittal Procedures
2. Section 01 61 45 – Area Exposure Designations
3. Section 01 66 00 – Product Storage and Handling Requirements
4. Section 05 05 20 – Anchor Bolts
5. Section 09 90 00 – Coating Systems
6. Section 40 05 01 – Piping Systems
7. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
8. Section 40 05 07 – Hangers and Supports for Process Piping
9. Section 40 05 07.13 – Seismic Restraints for Piping

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis
Thrust Tie	Attachments to expansion joints that allow joint to accommodate axial thrust due to internal pressure

1.05 ADMISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate expansion control systems shown on Drawings with hanger and support systems and seismic restraints.
   2. The piping system layout Drawings specified in Section 40 05 01 show the anchor and expansion control locations as well as the details of the supports, hangers and the seismic restraints.

1.06 SUBMITTALS

A. Coordinate submittal requirements of this section with the following sections:
   1. Section 40 05 07 – Hangers and Supports for Process Piping
   2. Section 40 05 07.13 – Seismic Restriants for Piping

B. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   3. Identify expansion control locations and components indicated on piping layout drawings as specified in Section 40 05 01.
   4. Expansion control schedules as specified in paragraph 4.01.

C. Information Submittals:
   1. Procedures: Section 01 33 00.

2. Anchor bolt calculations in accordance with Section 05 05 20 requirements.

1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

PART 2 PRODUCTS

2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:

1. This Section specifies minimum operating temperatures for piping services designed to operate at temperatures below ambient conditions and specifies maximum operating temperatures for piping services designed to operate at temperatures above ambient conditions. Piping services not listed in this Section operate within ambient temperature range. For the purposes of installing pipe hangers, supports, seismic, bracing, and expansion control components, ambient temperature conditions are defined as 60 to 120 degrees Fahrenheit.

Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
All Interior	35	110

2. Until completion of commissioning, the Contractor is responsible for protecting piping systems against damage resulting from expansion or contraction of pipe materials exposed to temperatures outside the temperature range between ambient temperature conditions and operating temperature conditions.

B. Design:

1. Expansion control as specified in this section and as specified on the Drawings control pipe movements and loads occurring as a result of pipeline temperature changes.
2. Provide expansion control as specified on the Drawings. Where anchors and expansion joints are not specified on the Drawings, expansion control is to be provided through deflection of the piping and pipe fittings. Where expansion control is provided through deflection of the piping and pipe fittings, support and brace piping such that thermal expansion movement is accommodated without application of excessive loads to piping, supports and bracing. Where expansion “U” loops are identified on the Drawings, weld all “U” loop elbows and piping connections. Weld piping connections at elbows within 10 diameters from an anchor.

3. Expansion control provisions are specified in Drawings and Specifications as necessary to accommodate expansion and/or contraction of pipe materials as a result of temperature changes between ambient temperature conditions and operating temperature conditions. Pipe hangers and supports shall be installed to accommodate expansion/contraction without interfering with expansion control functions. Following commissioning of piping systems, adjust pipe supports and hangers as necessary for proper installation at operating temperatures.

2.02 MATERIALS

A. Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support.

B. Structural anchors may be fabricated from structural steel and coated as specified in Section 09 90 00.

C. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Section 01 61 45 Area Exposure Designations, which shall be Type 304 stainless steel.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install the expansion control system components as specified in the Drawings and as specified within this Section and in related Sections.

B. Provide expansion control as specified on the Drawings.

3.02 INSTALLATION

A. Install expansion control, pipe support and seismic restraints to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

B. Metal-to-metal contact between a pipe and pipe anchor of dissimilar metals is not permitted.

C. Where pipe guides are specified on the Drawings, furnish and place them as specified and fasten them to structures to provide the maximum vertical and lateral load capacity of the specified pipe guides.

D. Install the expansion control system in accordance with the drawings requirements specified in this Section.

E. Weld and bolt attachments to the building structural steel in accordance with the requirements of the AISC Manual of Steel Construction (allowable stress design). No drilling or burning of holes in the building structural steel is allowed without approval of the Engineer.

F. Provide embedded anchor bolts instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submergence. Anchor bolt installation as specified in Section 05 50 20.

G. Install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

H. Connect anchors directly to the pipe as specified on the Drawings and details.

I. Components in contact with plastic pipe shall be free of burrs and sharp edges.

J. Provide roller assemblies for pipe hangers and supports as indicated in the Drawings. Roller assemblies are specified in the Drawings. Roller shall roll freely without binding.

K. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

PART 4 SCHEDULES

4.01 EXPANSION CONTROL SCHEDULES

A. General: Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by Section 40 05 01. In addition, schedules shall be prepared as specified below.

B. Anchors:
   1. The anchor schedule shall list as a minimum:
      a. Anchor Point Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Forces
      f. Load, pounds
      g. Direction
      h. Anchor Description
      i. Remarks

C. Guides:
   1. The guide schedule shall list as a minimum:
      a. Guide Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Guide Description
      f. Remarks

D. Expansion Joints:
   1. The expansion joint schedule shall list as a minimum:
      a. Expansion Joint Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Movement, inches
         1) Lateral movement
         2) Compression movement
         3) Extension movement
         4) Angular movement
      f. Maximum Spring Force, pounds
      g. Test Pressure, PSIG
      h. Pressure Force, pounds
      i. Total Forces
      j. Load, pounds
      k. Direction
      l. Expansion Joint Description
      m. Special Features
      n. Remarks

END OF SECTION

SECTION 40 05 17

COPPER PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies copper pipe, tube, and fittings.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

1.04 SUBMITTALS

A. Procedures: Section 01 33 00.
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager is the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturers' product data, catalog cuts, typical installation details, and dimensions demonstrating compliance with the requirements of this Section.
   3. Indicate on the submittal each piping system where the product will be used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are listed below for double ferrule compression fittings.
   1. Swagelok.
   2. Gyrolok.
   3. Equal.

2.02 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules specified in Section 40 05 02 .00 through Section 40 05 02.99.

B. Couplings and Fittings.
   1. Double ferrule compression fittings capable of holding the full bursting strength of connected tubing.
   2. Provide tapered piping reducers/enlargers. Bushing type adapters are not permitted.

C. Joint Solder
   1. Except where otherwise specified in the Piping System Schedules, use ASTM B32, Alloy Grade Sn95 solder for general use in copper piping.
   2. ASTM B32 Alloy Grade E, or Silvabrite 100, for high pressure and high temperature services, where specified.
   3. Brazing, for saturated steam, AWS Classification BCuP-5 (AWS A5.8/A5.8M) or Sil-Fos® 15, where specified.

PART 3 EXECUTION

3.01 INSTALLATION

A. Cleaning.
   1. Remove foreign material from the pipe interior prior to assembly. Swab the pipe interior.
   2. Deburr pipe end and sand using fine emery cloth.

B. Dielectric protection.
   1. Copper tubing or fittings in contact with dissimilar metal piping, reinforcing steel, or other dissimilar metal at any location is not permitted.
   2. Make electrical checks to assure no contact is made between copper tubing and ferrous elements.
   3. Wherever electrical contact is demonstrated by such tests, provide dielectric protection as specified in Section 40 05 06.16.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01.

3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

END OF SECTION

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SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies stainless steel pipe and fittings.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Product Storage and Handling Requirements

C. Section 40 05 01 – Piping Systems

D. Section 40 05 02 –Piping System Schedules

1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B31.3	Process Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Requirements
ASTM A480	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
AWWA M11	Steel Pipe-A Guide for Design and Installation
AWWA C222	Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
AWWA C227	Bolted, Split-Sleeve Restrained and Non-Restrained Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
CSA W48.3	Low Alloy Steel Covered Electrodes for Shielded Metal Arc Welding

1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The CITY shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.
   5. Pipe wall thickness calculations for pipe fabricated per AWWA C220. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.
   6. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C226. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
   7. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
   8. Submit calculations for engineered flange face rings in accordance with Appendix D of ASME Section VIII Division 1.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' certificates of compliance with specified industry standards.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

B. Deliver pipe and fittings with end protectors in place. Do not remove protectors until materials are about to be installed.

C. Prevent carbon steel contamination of stainless steel pipe and fittings during storage, handling, fabrication, and installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) and this Section.

B. Pipe.
   1. Use pickled and annealed sheet or plate for manufacture of fabricated stainless steel pipe.
   2. Finish.
      a. 8-gage through 16-gage material: No. 1 or 2B per ASTM A480.
      b. 3/16-inch and heavier plate material: No. 1 mill finish per ASTM A480, "Hot-Rolled or Cold-Rolled, and Annealed or Heat Treated, and Blast Cleaned or Pickled."

C. Shop-fabricated stainless steel pipe and fittings.
   1. Furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be provided.
   2. Manufacture using Weld Procedure Specifications (WPS) that have been qualified under ASME Section IX. Document qualifications in Procedure Qualification Reports (PQR). Use only certified welders who have successfully completed performance qualification tests per ASME Section IX for manufacture of stainless steel pipe.

D. Flanges.
   1. Plate steel backing ring flanges, ASME B16.5 Class 150 minimum thickness.
   2. Stub ends.
      a. Wall thickness equal to or greater than pipe or fitting to which it is welded.
      b. Lap face/gasket mating surfaces clean, free of debris, with welds ground flush and surface roughness between 3.18 and 12.7 microns RMS.

E. Fittings.
   1. Double ferrule compression fittings capable of holding the full bursting pressure of connected tubing.
   2. Candidate manufacturers for double ferrule compression fittings.
      a. Swagelok.
      b. Gyrolok.
      c. Approved Equal.
   3. Provide straight tapered reducers. Flanged & flued reducers and bushing type adapters are not permitted.
   4. Pressure rating and thickness of elbows, tees, crosses, and wyes equal to or greater than connecting pipe.

F. Grooved couplings and fittings.
   1. Flexible and rigid coupling with pipe grooves compliant with AWWA C606.
   2. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shoulder ends per the requirements of AWWA C606.
   3. Candidate manufacturers.
      a. Victaulic
      b. Gruvlok
      c. Approved equal.

G. Bolted split sleeve couplings.
   1. AWWA C227 compliant sleeve with single or double arch cross section of the same material as pipe. Body thickness equal to or greater than that of connecting pipe wall thickness.
   2. Candidate manufacturers.
      a. Victaulic, Style 231S through 234S.
      b. Approved equal.

2.02 SHOP FABRICATION

A. Metal forming processes.
   1. Use pinch rolls with a hard chrome finish to form cylinders. Thoroughly clean the rolls using Avesta BlueOneTM 130 Pickling Paste or approved equal, prior to roll forming the pipe. Alternatively, provide a protective barrier between the stainless steel plate/sheet and the plate rolls during the forming process.
   2. Provide a protective barrier between pipe welding rollers and the stainless steel pipe cylinder. Alternately, new rollers or rollers that have been turned down on a lathe to provide a new and clean working face may be used.

B. All saws, drills, files, wire brushes, grinding wheels, etc. will be free of carbon contamination and designated for stainless steel use only.

C. Provide nonferrous, stainless steel, or rubber-lined pipe storage and fabrication racks.

D. Use nylon slings or straps for handling stainless steel piping.

E. Preparation of surfaces to be welded.
   1. Surfaces of joints to be welded are to be free from mill scale, slag, grease, oil, paint, rust, and other foreign material.
   2. Use only stainless wire wheels and grinding wheels that have not come into contact with carbon steel.
   3. Flame cutting or any use of oxy-acetylene gas cutting tools is prohibited. Use plasma arc torch with a nitrogen or argon-hydrogen carrier gas, laser or waterjet processes for cutting and plate beveling.
   4. Air arc and gas backgouging are prohibited. Use grinding and plasma gouging methods to achieve full penetration welds.

F. Welding.
   1. Welding and production processes are to conform to ASME B31.3.
   2. Use of Solar Flux is prohibited.
   3. Use of FCAW welding is prohibited.
   4. Pipe and fittings with wall thickness up to 11-gage (1/8-inch): weld using the GTAW process.
   5. Pipe and fittings with wall thicknesses greater than 1/4-inch may be welded using an automated SAW process.
   6. Pipe and fittings with wall thickness greater than 11-gage (1/8-inch): Bevel and complete root pass using the GTAW process, followed by subsequent passes with the GTAW, GMAW, or Metallic Arc SMAW process.
   7. Filler material:
      a. Add only ELC wire grades to provide a cross section at the weld equal to or greater than the parent metal.
      b. SMAW electrodes to conform to CSA W48.3.
   8. Make weld deposit smooth and evenly distributed and with a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices are not permitted.
   9. Full penetration butt welds: provide inert gas shielding to the interior and exterior of the joint.
   10. Lap joints: provide full thickness seal welds on both joints.

G. Remove excessive weld deposits, slag, spatter, and projections by grinding. Grind welds smooth on gasket surfaces. Tack welds, clips, and other attachments.
   1. Repair nicks, gouges, notches, and depressions in the base metal in the area before the joint weld is made.
   2. Remove tack welds, clips, and other attachments and repair defects, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Remove cracked tack welds.
   3. Grind those areas to be repaired down to clean metal and then repair by building up with weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.

H. Defects and repairs.
   1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications, by chipping or grinding throughout their depth to clean base metal.
   2. Do not perform calking or peening of welds to correct defects.
   3. Enlarge welds found deficient in dimension but not in quality by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
   4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe by grinding.

I. Finish.

1. Treat all welded joints with Avesta BlueOne™ 130 Pickling Paste or approved equal and rinse with clean water.
2. If rusting of embedded iron occurs, pickle the affected surface with Avesta BlueOne™ 130 Pickling Paste or approved equal.
3. Rinse clean using Avesta FinishOne Passivator 630 or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Use wooden scaffolding and/or ladders if possible to gain access to work areas. If metal scaffolding and/or ladders must be used, tape or otherwise shield the contact points between scaffolding/ladders and the stainless steel.

B. After installation, wash and rinse all foreign matter from the piping surface. Adhere to the passivation manufacturer's recommendations and local regulations for safety and disposal of any waste chemicals.

3.02 REPAIR/RESTORATION

A. Per Section 40 05 01 and as specified herein.

B. Paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09 90 00. Painting of the stainless steel pipe is not required.

C. Restore areas damaged or discolored by field welding or handling, iron contamination or soiled to a uniform surface finish and consistently clean surface with methods specified for shop fabrication.

D. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

END OF SECTION

SECTION 40 05 24

STEEL PROCESS PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies steel pipe and fittings.

1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related Sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 09 90 00 – General Coating Specification
   4. Section 40 05 01 – Piping Systems
   5. Section 40 05 02 – Piping System Schedules
   6. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping

1.03 REFERENCE STANDARDS

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the local building code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket-Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A197	Cupola Malleable Iron

Reference	Title
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger-- Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services--Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe--A Guide for Design and Installation
SSPC-SP10	Near-White Blast Cleaning

1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Piping layout drawings as specified in Section 40 05 01.
4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.
5. Pipe wall thickness calculations for pipe fabricated per AWWA C200 or ASTM A53. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.

6. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C28. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
7. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
8. Affidavits of Compliance with the provisions of AWWA C200, ASTM A53 as applicable for the specified pipe materials.
9. Product data for the following:
    a. Pipe:
        1) Material data.
        2) Chemical and physical test reports showing data consistent with specified requirements for each sheet or coil of steel proposed for use.
    b. Coatings and Linings:
        1) A list of the materials which indicates the manufacturer, product numbers, thickness, and recommended quality control testing procedures of the materials.
        2) Technical data sheets itemizing technical and performance information that indicates compliance with this Specification, and recommended application procedures.
        3) For each coating system, furnish a Safety Data Sheet (SDS).
        4) Color chart, if applicable.
        5) Manufacturer's name, product number or name, and thickness.
10. Layout Drawings shall be submitted and shall include the following; Pipeline layout showing stations and elevations, and details of standard pipe, joints, specials and fittings.

B. Informational Submittals:
1. Certificates:
    a. Certificate of Compliance that products furnished meet requirements of this Specification.
    b. Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with ANSI/NSF/CAN 61/600 and satisfies current applicable governmental health and safety requirements for use in potable water.
    c. Coating Materials: Certification that all work performed complies with the requirements of this Section and the appropriate AWWA standards. For all personnel applying tape to field joints, provide documentation of proper training by tape manufacturer's technical representative.
2. Main Pipe Supplier (MPS)'s written Quality Assurance/Control (QA/QC) Plan.
3. Reports:
    a. Source Quality Control Test Reports:
        1) Hydrostatic testing.
        2) Destructive weld testing.
        3) Nondestructive weld testing.

b. Field Quality Control Test Reports:
    1) Weld tests, including re-examination of repaired welds, on each weld joint for the following tests, as applicable:
        a) Visual Testing (VT).
        b) Radiographic Testing (RT).
        c) Ultrasonic Testing (UT).
        d) Magnetic Particle Testing (MT).
        e) Liquid Penetrant Testing (PT).
        f) Leak Testing (LT).
    2) Applicator's quality control records, including environmental conditions, dry film thickness, and adhesion tests, when requested by Engineer.
c. Cement-mortar lining compressive strength tests in accordance with AWWA C205.
d. Cement-mortar coating absorption tests in accordance with AWWA C205.

4. Statements of Qualification:
    a. Pipe manufacturer.
    b. Fittings and specials fabricator.
    c. Welders or Welding Operators:
        1) Name of welder.
        2) Welding procedures/positions for which welder is qualified to weld.
        3) Assigned certification stamp number.
        4) Certification date.
        5) Current certification status.
    d. Certified Welding Inspector.
    e. NDT Quality Control Personnel.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for Shipment and Storage.

B. Deliver pipe and fittings with end protectors in place. Do not remove end protectors until materials are about to be installed.

1.06 QUALITY ASSURANCE

A. Testing:
    1. Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 05 01.

B. Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

A. Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 05 01. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

B. AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

A. Connections shall be as specified in Section 40 05 01 and shall conform to Section 40 05 06. Coating for buried connections shall be as specified in Section 40 05 06-2.06.

2.04 FITTINGS AND APPURTENANCES

A. Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

B. Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

C. Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

D. Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.
      b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
   2. The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Cement Mortar:
   1. Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furring wire mesh reinforcement for hand-applied lining.

C. High Temperature Service Epoxy:
   1. Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. Glass Lining:
   1. Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.
   2. Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.
   3. Glass lining shall be Ferrock MEH-32, Vitco SG-14, or equal.

2.06 PIPE COATING

A. Provide pipe with coating as specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99. Requirements for each coating type are specified in this Section. Apply coatings to steel pipe at the factory or fabrication shop. Unless specifically prohibited in this Section, repair of steel pipe coatings damaged after the pipe has left the factory or fabrication shop may be performed at the project site.

B. Acceptable Coating Systems
   1. General: As required by Section 09 90 00. Where discrepancies exist with this section and Section 09 90 00, the most stringent requirements shall take precedence.
   2. Polyurethane Coating:
      a. Coat pipe and fittings as specified in AWWA C222.

2.07 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.
   2. Contractor's layout drawings as specified in Section 40 05 01-2.04.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 05 06.
   2. Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 40 05 06-2.02 Sleeve-Type Couplings.
   3. Pipe lining and coatings at field joints shall be applied as specified in paragraphs 2.05 and 2.06.
   4. Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in Section 40 05 06-2.06.

B. Anchorage:
   1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

3.02 TESTING

A. Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.

END OF SECTION

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SECTION 40 05 31.13

SOLVENT CEMENT WELDED PVC AND CPVC PRESSURE PIPE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) pipe and fittings with solvent cement welded or threaded connections/joints.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 09 90 00 – General Coating Specification
   4. Section 31 21 33 – Trenching, Bedding, Backfilling, and Compacting for Buried Piping
   5. Section 40 05 01 – Piping Systems
   6. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME B31.3	Process Piping
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic

Reference	Title
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride
   2. CPVC: Chlorinated Polyvinylchloride

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.

1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide PVC and CPVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

2.02 COMPONENTS

A. CPVC Solvent Weld Cement:
   1. Pipe and fittings 6-inch diameter and smaller: IPS 724 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 6-inch diameter: IPS 729 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM F493, 100 percent solvent and CPVC resin. No fillers permitted.

5. Universal plastic pipe solvent is not acceptable.
6. Formulated for use with sodium hypochlorite solution and other caustic solutions.

B. PVC Solvent Weld Cement:
1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
2. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
3. Heavy bodied, medium setting.
4. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
5. Universal plastic pipe solvent is not acceptable.

C. Primer:
1. Staining solvent conforming to standard ASTM F656.
2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.

B. Make solvent-cemented joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

C. Connections:
1. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
2. Provide threaded by solvent-welded socket joint adapters at connections to equipment and appurtenances with threaded connections.
3. Foreign material to be removed from the pipe interior prior to assembly.

D. Plastic pipe installation personnel trained to ASME B31.3.

E. Bedding and Backfill: As specified in Section 31 21 33. Blocking under pipe is not permitted.

3.02 FIELD QUALITY CONTROL

A. Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

END OF SECTION

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SECTION 40 05 31.17

PVC GRAVITY SEWER PIPE AND DWV (DRAIN, WASTE, AND VENT) PIPE AND FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Polyvinylchloride (PVC) Gravity Sewer Pipe and DWV (Drain, Waste, and Vent) Pipe. This Section also specifies fittings and joints for Polyvinylchloride (PVC) Gravity Sewer Pipe and DWV (Drain, Waste, and Vent) Pipe.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 09 90 00 – Painting and Coating Systems
   4. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2321	Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic
ASTM F679	Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.

1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide PVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

2.02 COMPONENTS

A. PVC Solvent Weld Cement:
   1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
   5. Universal plastic pipe solvent is not acceptable.

B. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drain, Waste and Vent Pipe
   1. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.
   2. Make solvent-cemented joints in compliance with the manufacturer's/supplier's instructions and recommended procedures.
   3. Connections:
      a. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
      b. Foreign material to be removed from the pipe interior prior to assembly.
   4. Bedding and Backfill: As specified in Section 31 21 33. Blocking under pipe is not permitted.

B. Gravity Sewer Drainage Pipe
   1. Join by means of Push-On Joints with Flexible Elastomeric Seals conforming to ASTM D3212.
   2. Make push-on joints in compliance with the pipe manufacturer’s recommended installation practice.
   3. Connections:
      a. Connect to different pipe materials by means of specified adapters, or transition fittings.
      b. Foreign material to be removed from the pipe interior prior to assembly.
   4. Bedding and Backfill: As specified in ASTM D2321 and Section 31 21 33. Blocking under pipe is not permitted.

3.02 FIELD QUALITY CONTROL

A. Conduct tests in accordance with Section 40 05 01.

END OF SECTION

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SECTION 40 05 31.19

POLYVINYLCHLORIDE DOUBLE CONTAINMENT PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Polyvinylchloride (PVC) pipe and fittings for double containment piping systems.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 09 90 00 – Painting and Coating
   4. Section 40 05 02 – Piping System Schedules

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASME B31.3	Process Piping
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2855	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40, and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F656	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Checkmarks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.
   5. Double containment piping system manufacturer's experience. Document years of experience manufacturing double containment piping systems.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Double containment pipe system manufacturer must have a minimum of five years' experience producing double containment pipe systems.

1.07 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. IPEX Guardian Centra-Lok system.

2.02 MATERIALS

A. Furnish PVC and CPVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

B. Carrier Pipe as specified in Piping System Specification Sheets.

C. Secondary Containment Pipe and Fittings: PVC Pipe, ASTM D1784-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785.

2.03 COMPONENTS

A. Secondary Containment Fittings:
   1. Secondary Containment Fittings manufactured by the double containment pipe system manufacturer.
   2. Molded components. Materials per ASTM D184.

B. Carrier Pipe Support at Fittings:
   1. Match Carrier Pipe materials for Secondary Containment Supports at Fittings.
   2. Designed for field assembly of carrier pipe fittings in secondary containment fittings using self-centering, locking support clips.
   3. Carrier pipe fittings and secondary containment pipe fittings anchored together using support clips.
   4. Support clips consist of male by female, solvent weld, socket fittings with centering legs.
   5. Support clips must permit uninterrupted drainage along the invert of the secondary containment pipe.

C. Carrier Pipe Support Clips:
   1. IPEX Guardian Centra-Guide or approved equal.
   2. Carrier pipe supports to support and center the carrier pipe inside the secondary containment pipe.
   3. Carrier pipe supports must permit uninterrupted drainage along the invert of the secondary containment pipe.
   4. Provide carrier pipe supports at intervals recommended by the double containment system manufacturer.

D. Leak detection:
   1. Provide 24 VDC plastic encapsulated proximity type leak detections sensors consisting of an external clip-on sensor, drip leg, and drain valve with hose connection.
   2. Each sensor removable for periodic testing and provided with LED testing lamp and adjusting potentiometer.
   3. IPEX Guardian Centra-Guard or approved equal.
   4. Leak detection sensors mounted on the exterior of the secondary containment pipe using a saddle mount configuration.
   5. Penetration of the secondary containment pipe is not permitted for leak detection sensor installations.
   6. Install leak detection sensors at leak detection station locations indicated on the Drawings.
   7. Slope pipe system down toward leak detection stations.
   8. Provide NEMA 4X FRP control panel with leak detection sensitivity adjustment and 24 VDC SPDT general alarm relay switch for communication with the plant control system.

9. Consolidate leak detection sensors at each cluster of leak detection wells into a single control panel.

E. CPVC Solvent Weld Cement:
   1. Pipe and fittings 6-inch diameter and smaller: IPS 724 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 6-inch diameter: IPS 729 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM F493, 100 percent solvent and CPVC resin. No fillers permitted.
   5. Universal plastic pipe solvent is not acceptable.
   6. Formulated for use with sodium hypochlorite solution and other caustic solutions.

F. PVC Solvent Weld Cement:
   1. Pipe and fittings for use to contain sodium hypochlorite piping: IPS 724 Weld-on Cement or Approved Equal
   2. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
   3. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
   4. Heavy bodied, medium setting.
   5. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
   6. Universal plastic pipe solvent is not acceptable.

G. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Solvent Cement Welded PVC and CPVC Pipe:
   1. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.
   2. Make solvent-cement welded joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

B. Connections:
   1. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
   2. Foreign material to be removed from the pipe interior prior to assembly.

C. Plastic pipe installation personnel trained to ASME B31.3.

D. Bedding and Backfill: As specified in Section 31 21 33. Blocking under pipe is not permitted.

3.02 FIELD QUALITY CONTROL

A. Carrier Pipe Testing: Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

B. Secondary Containment Pipe Testing: Pneumatic Test.
   1. Medium: Instrument Grade Air or Nitrogen.
   2. Test Pressure: 5 psig maximum.
   3. Duration: 2 hours.
   4. Maximum Allowable Pressure Drop: 0.1 psig over 2 hours.
   5. Maintain 10 psig, minimum, in primary containment pipe during testing of secondary containment pipe.
   6. Test Safety: As specified in Section 40 05 01 for Pneumatic Pressure Testing.
   7. Conform to double containment pipe system manufacturer's compressed gas testing procedures.

END OF SECTION

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SECTION 40 05 33.13

HIGH DENSITY POLYETHYLENE PIPE - SOLID WALL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Heat fusible, uniform thickness, solid wall, constant outside diameter, high-density polyethylene (HDPE) pressure pipe, fittings, and appurtenances.
   2. This Section does not specify HDPE pipe with a corrugated, tubular, or structured wall profile.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 31 23 00 – Excavation, Trenching, and Backfill
   2. Section 40 05 01 – Piping Systems
   3. Section 40 05 02 – Piping System Schedules
   4. Section 40 05 07 – Pipe Hangers and Supports

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
   1. ANSI/AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution
   2. AWWA M-55 - PE Pipe – Design and Installation
   3. ASTM D2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   4. ASTM D2513 - Polyethylene Gas Pressure Pipe, Tubing, and Fittings
   5. ASTM D2657 - Heat Joining Polyolefin Pipe and Fittings
   6. ASTM D2774 - Underground Installation of Thermoplastic Pressure Piping
   7. ASTM D3035 – Polyethylene Plastic Pipe Based on Controlled Outside Diameter
   8. ASTM D3261 - Butt Heat Fusion Polyethylene Plastic Fittings for PE Plastic Pipe and Tubing
   9. ASTM D3350 - Polyethylene Plastics Pipe and Fitting Materials
   10. ASTM F1055 - Electrofusion Type Polyethylene Fittings for OD Controlled PE Pipe and Fittings
   11. ASTM F1668 - Construction Procedures for Buried Plastic Pipe
   12. ASTM F2164 - Standard Practice for Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure.
   13. ASTM F2206 - Fabricated Fittings of Butt-Fused Polyethylene

14. ASTM F2620 - Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
15. ASTM F714 - Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
16. PPI TR 31 - Underground Installation of Polyolefin Piping

1.04 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Qualifications of the certified fusion technician.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate each piping system where the product will be used on the submittal.
   5. Pipe Manufacturers' joint assembly procedure.

C. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Records of each field butt-fusion joint installation, as specified in this specification.
   3. Manufacturer's affidavit affirming that the materials furnished for the project comply with the standard specified in the Piping System Schedule (Section 40 05 02.00 through 40 05 02.99).

D. Qualifications: Field welding by butt fusion and/or electrofusion performed by a factory trained and certified fusion technician. Training and/or certification by fusion equipment manufacturer or pipe manufacturer.

E. Certifications: Furnish affidavit (as specified in AWWA C901 and AWWA C906) documenting compliance AWWA C901 and/or AWWA C906, as appropriate for the pipe material specified in the Piping System Schedule (Section 40 05 02.00 through 40 05 02.99).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Store on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, stack in accordance with the pipe manufacturer's recommendations.

C. Prevent damage to pipe from dragging over sharp objects or cutting by chokers or lifting equipment while handling pipe.

D. Handle pipe in accordance with pipe manufacturer's recommendations.

E. Pipe with gouges, cuts, or scratches deeper than 10% of the pipe wall thickness will be rejected.

F. Pipe with cuts, gouges, and/or scratches of the pipe interior will be rejected.

G. Store pipe in accordance with pipe manufacturer's recommendations until installation.

H. Store pipe at ambient outdoor temperature.

I. Provide temporary shading.

J. Avoid coverings that will raise pipe temperature over ambient temperature.

PART 2 PRODUCTS

2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in this identified in the Piping System Schedules (Section 40 05 02 through 40 05 02.89).

B. Pipe Color:
   1. Black
   2. Where specified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.89), provide co-extruded longitudinal color stripes equally spaced around the circumference of the pipe. Stripe color as specified in the Piping System Schedules.

C. Fittings:
   1. Provide ARC™ sweep bends manufactured by Pipestar International, or approved equal, for 2-inch through 14-inch long radius bends. Bend radius 3 times the nominal pipe size, measured to the centerline of the bend.
   2. Increase wall thickness to next nominal pressure rating (next lower SDR) for mitered bends and fabricated fittings. 2 miter segments, minimum for deflections of 45 degrees or less. 4 miter segments, minimum for deflections greater than 45 degrees.

D. Flange Ends:
   1. HDPE stub end flange adapter and back up ring.
   2. Furnish beveled flange adapters for disk clearance on flanged connections to butterfly valves.
   3. Furnish stub end flange adapters with radius or chamfered outer diameter transition from pipe wall to stub end.
   4. Chamfer or radius flange ring bore to match transition on stub end flange adapter.
   5. Ductile iron back up rings encapsulated in polypropylene or CF8 (304) Stainless Steel back up rings: Improved Piping products – PPDI, Improved Piping Products - SS-SDR, or approved equal.

E. Couplings:
   1. HGRV – HDPE Groove Coupling
      a. HGRV couplings consist of two coupling halves and gasket. Designed to join double-grooved HDPE pipe ends.
      b. HGRV (HDPE Grooved Coupling): Victaulic Style 908 or Approved Equal.

2. HPEG – HDPE Plain End with Gripping Teeth
    a. HPEG couplings consist of two coupling halves, gasket, and gripping teeth that engage and grip the exterior of plain end HDPE pipe segments.
    b. HPEG (HDPE Plain End with Gripping Teeth): Victaulic Style 995N, Victaulic Style 905, or Approved Equal.
3. HXGT – HDPE by Grooved End Transition
    a. HDPE by Grooved End Transitions consist of a carbon steel grooved end pressed onto a plain end HDPE pipe stub. Join HDPE by Grooved End Transitions with Flexible Grooved End Coupling.
    b. Carbon steel grooved end transition furnished with cut grooves and fitted with multiple rows of integral circumferential barbs on the inside diameter.
    c. Coat carbon steel components with NSF 61 compliant epoxy prior to pressing onto HDPE pipe.
    d. HDPE by Grooved End Transition: Poly-Cam Series 701 or Approved Equal.
    e. Flexible Grooved End Couplings: Victaulic Style 77, Anvil Gruvlok Figure 7001 or Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION, BURIED

A. Install piping system in accordance with ASTM D2321, AWWA C901 or AWWA C906 and the pipe manufacturer's recommendations.

B. Joining:
    1. Join pipes and fittings above grade, out of the trench.
    2. Butt fusion welds in accordance with the pipe manufacturer's recommendations and ASTM D2657
    3. Obtain optimum fusion parameters from the pipe manufacturer, with regard to fusion temperature, interface pressure, and cooling time.
    4. Follow the manufacturer's recommendations with regard to the optimum fusion parameters, and use proper equipment for the fusion process.
    5. Provide record of each butt fusion joint using McElroy Datalogger, or equal. Record date, time, joint number, operator identification, fusion machine make and model, pipe size and SDR, interfacial pressure during fusion and cooling, and fusion temperature.
    6. Butt fusion joint strength exceeds tensile strength of pipe.
    7. Extrusion welding and hot gas welding is not permitted.
    8. Pipe joints completed by factory trained and certified fusion technicians.
    9. Provide flange joints for connections to different pipe materials, equipment, valves, and other appurtenances unless otherwise specified on the Drawings.
    10. Install electrofusion welds where required for closures and joining HDPE to fixed/installed HDPE pipe or where specified on the drawings. Electrofusion welds installed in accordance with manufacturer's instructions and ASTM F1055.

C. Trench Excavation: per Section 31 21 33.

D. Location and Alignment: Place pipe and fittings in the trench with the invert conforming to the elevations, slopes, and alignments specified on the Drawings.

E. Bedding and Backfill:
   1. Bedding and backfill per Section 31 21 33 Trenching, Bedding, Backfilling, and Compacting for Buried Piping will not disturb or damage the pipe.
   2. Adjust temperature of HDPE pipe to the temperature of the surrounding soil at the time it is backfilled and compacted.
   3. Work in and tamp the bedding material in the area under the pipe and up to the spring line before placing and compacting the remainder of the embedment.
   4. Blocking under the pipe is not permitted.
   5. Place sufficient backfill to prevent damage, excessive deflections, or other disturbances of the pipe before using heavy compaction or construction equipment directly over the pipe.
   6. Control flotation of pipe when backfilling with flowable materials. Provide sufficient pipe weight, anchor blocks, fill with water, or backfill in lifts.

3.02 INSTALLATION, EXPOSED AND SUBMERGED

A. Install piping system in accordance with Chapter 8 of the Plastic Pipe Institute *PE Handbook*, ASTM F2620, AWWA C901 or AWWA C906, and the manufacturer's recommendations.

B. Joining:
   1. Butt fusion welds in accordance with the pipe manufacturer's recommendations and ASTM D2657
   2. Obtain optimum fusion parameters from the pipe manufacturer, with regard to fusion temperature, interface pressure, and cooling time.
   3. Follow the manufacturer's recommendations with regard to the optimum fusion parameters, and use proper equipment for the fusion process
   4. Butt fusion joint strength exceeds tensile strength of pipe.
   5. Extrusion welding and hot gas welding is not permitted.
   6. Pipe joints completed by factory trained and certified fusion technicians.
   7. Provide flange joints for connections to different pipe materials, equipment, valves, and other appurtenances unless otherwise specified on the Drawings.
   8. Install electrofusion welds where required for closures and joining HDPE to fixed/installed HDPE pipe or where specified on the drawings. Install electrofusion welds per the manufacturer's instructions and ASTM-F1055.

C. Pipe Support:
   1. Conform to Section 40 05 07.
   2. Accommodate thermal expansion and contraction movement.
   3. Support pipe at intervals of 8 feet or less.
   4. Provide pipe cradles supporting the bottom 120 degrees of pipe circumference.
   5. Cradle length (measured parallel to pipe axis) not less than half of the pipe's outside diameter.
   6. Edges of pipe cradles rounded or rolled to prevent cutting or gouging pipe.

3.03 SYSTEMS START UP

A. Procedures: Section 01 45 20 Pressure Testing:
   1. Pressure test pipe per Section 40 05 01.
   2. Install pipe supports, anchors, seismic bracing, and flexibility provisions prior to pressure testing.
   3. Perform pressure testing prior to encasement in concrete or backfilling buried pipe.
   4. Retest following repair of leaks.
   5. Apply initial pressure without makeup pressure for 1-2 hours to allow for diametric expansion or pipe stretching to stabilize.
   6. After the equilibrium period, restore the test section to the test pressure.
   7. Makeup water quantities during the pressure test per the Plastic Pipe Institute Technical Report TR 31-88. No visual leaks or pressure drops permitted during the final test period.

B. Deflection Testing for Buried Pipe:
   1. Perform deflection testing for the entire length of buried pipe, where specified in the Piping System Schedule (Section 40 05 02.00 through 40 05 02.89)
   2. Deflection testing performed not less than 30 days after completion of any work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads.
   3. Maximum permissible pipe deflection: 4.0 percent of the average inside diameter of the pipe.
   4. Deflection testing device capable of detecting pipe internal dimensions to within 1 percent of the average internal diameter of the specified pipe dimensions.
   5. Remove, replace, and retest pipe sections that fail the deflection testing.

END OF SECTION

SECTION 40 05 45

PIPING SYSTEM IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies the supply and installation of permanent identification labels and markers for piping systems.

B. Requirements for the supply and installation of permanent identification tags for valves are specified in Section 40 05 60.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 40 05 02 – Piping System Schedules
   4. Section 40 05 60 – Valves

1.03 REFERENCE STANDARDS

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI Z535.1	Safety Colors/APWA Uniform Color Code for Marking Underground Utilities
ASME A13.1	Scheme for the Identification of Piping Systems
MIL-STD-810	Environmental Engineering Considerations and Laboratory Tests

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Embedded/Encased piping: Piping enveloped in concrete, typically under structures or under roadways.

2. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.
3. Buried: Below grade walls or roofs; locations covered and in contact with earth/soil.

1.05 SUBMITTALS

A. Submit the following minimum documentation per Section 01 33 00.

B. Action Submittals: Submit the following prior to construction of this element of the Work.
   1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations. Checkmarks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration
   2. Provide a full line product brochure showing available Piping System Marker and Detectable Warning Tape standard text and color options. Submit all text and colors proposed for use.
   3. Provide manufacturer's recommended installation instructions for Detectable Warning Tape.
   4. Provide product brochures and data sheets for tracer wire and splice kits. Submit all wire insulation colors proposed for use.
   5. Submit proposed tracer wire access box(es) for test leads. Submit electrical continuity test results upon completion.

C. Informational Submittals: Submit the following for inspection.
   1. Electrical continuity test results.
   2. Sample of each piping identification plastic marker used.
   3. Sample of each detectable warning tape used.

PART 2 PRODUCTS

2.01 PIPING SYSTEM MARKERS FOR EXPOSED PIPE

A. Pipe labeling shall follow the color scheme identified in Section 40 05 02.23.
B. Identify material contained in exposed piping systems using a colored plastic marker legend system conforming to ASME A13.1.
C. For exposed piping, provide pre-coiled mechanically attached type-colored markers that are easily removable. Adhesive type markers are not acceptable.
   1. Resistant to petroleum-based oils and grease and meet criteria for humidity, solar radiation, rain, salt, fog, leakage and fungus specified by MIL-STD-810.
   2. Withstand a continuous operating temperature range of -40 to 250 degrees.

3. Manufactured and applied in one continuous length of plastic including directional arrows. Markers comprised of letters and directional arrows individually applied to the maker are not acceptable. Legends and arrows printed on polyester subsurface and over laminated with Tedlar.
4. Text size per ASME A13.1.
5. Marking Services Style MS-995, Brady Style B-689, or approved equal.

D. Each piping system marker to be color coded for identification and labelled with the Process Service Identifier and directional flow arrows indicating the direction of flow in the pipe. Piping System marker background colors are specified in Section 40 05 02 for each process service. Except for piping system markers with an orange, yellow or white background color, provide white text and directional arrows for all piping system markers. Provide black text and directional arrows for pipe markers with an orange, yellow or white background.

2.02 DETECTABLE WARNING TAPE AND TRACER WIRE FOR BURIED PIPE

A. Provide Detectable Warning Tape for all buried piping:
1. Detectable Warning Tape shall be 6 inches wide, colored per ANSI Z535.1 and made of inert plastic material suitable for direct burial with solid aluminum foil core. Minimum 5 mil laminate thickness. Tin- or nickel-plated clips for joining sections of tape, as provided by the tape manufacturer.
2. Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or approved equal.
3. Print two messages on buried Detectable Warning Tape. The first message reads **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. Fill the blank with the Process Service name. The second message reads **"CALL____"** with letters approximately 3/4 inch high. Both messages printed at maximum intervals of 2 feet. Fill the blank with phone number provided by the Construction Manager.

B. Install tracer (locate) wire along the buried portion of pipe alignments as identified in Section 40 05 02.23.
1. Direct burial rated, 12-gauge solid copper, 600-volt UF tracer wire with heavy-duty PVC insulation. Tracer wire insulation color-coded to match each utility service as designated in ANSI Z535.1.
2. SPLICES: Silicone-filled UL-Listed product specifically designed for waterproof direct bury splicing of tracer wire. 3M DBR-6; or approve equal.
3. WIRE ACCESS BOXES: Cast iron valve box top piece frame and cover set within a concrete ring cast flush with grade, as appropriate for the location in which it will be installed and for the traffic loading it may be subject to, and in accordance with the applicable elements of the Standard Detail for valve box installations. Mark lids in raised or recessed lettering with the word “Test”. Submit all wire access boxes proposed for use to the Construction Manager for review.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM MARKERS

A. Provide piping system markers and direction arrows at locations conforming to ASME A13.1 and at the following locations:
   1. Apply intermittent markings on straight pipe runs, close to all valves, fittings, and adjacent to all changes in direction.
   2. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
   3. At point of entry and leaving each pipe chase and/or confined space and piping accessible at each access opening.
   4. Adjacent to valves and where valves are in series at intervals of no more than 6 feet.
   5. At least once in each room and at maximum spacing of 40 feet. Exception: gas piping to be identified at 6-ft intervals in ceiling plenums.
   6. Spacing for markings not less than 1 foot.
   7. At the beginning and end points of each run; and, at each piece of equipment in each run.

B. Visibility
   1. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.
   2. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.
   3. Place identification at approximate line of sight for vertical pipe systems.

3.02 INSTALLATION OF DETECTABLE WARNING TAPE

A. Install a continuous ribbon of Detectable Warning Tape as specified for ALL buried piping.

B. Multiple pipes less than 4 inches in diameter installed in a common trench may be provided with a single ribbon of tape per trench. If the total width of such utilities within the common trench exceeds 3 feet, provide two parallel ribbons of tape spaced equally.

C. Provide a separate detectable warning tape for each pipe that is 4 inches or greater in size.

D. Install the tape in accordance with manufacturer recommendations.

E. At end-to-end and branch connections, provide electrical continuity connectors for detectable tape to connect ends mechanically and electrically together as recommended by the manufacturer.

F. Provide a single line of tape 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Spread tape flat with message side up before backfilling.

3.03 INSTALLATION OF TRACER WIRE

A. Tracer wire shall be a continuous, fully functioning, and tested system to include all appurtenances including splices and wire access boxes at grade.

B. Tracer wire laid along the top of the pipe prior to backfilling. Secure in place with tape every 20 feet. Where the pipe is encased or provided with concrete collars or cut-off walls, lay the wire on top of the encasement (do not encase the wire). Do not pull the wire taut; leave sufficient slack to allow for pipe movement and future repairs.

C. Splice tracer wire using the specified silicone-filled splice kits in accordance with manufacturer recommendations. Ensure the silicone fully encapsulates un-insulated wire ends and are made watertight.

D. Pull tracer wire up into all valve boxes, cleanout access boxes, and into all utility cabinets and meter boxes installed on the pipeline. For each wire end, provide an 18-inch-long length of extra wire (coiled and tucked out of the way in an accessible location) for connection to utility locating equipment.

E. Where the pipeline enters structures, vaults, tanks, or buildings, provide a wire access box at grade adjacent to the structure or building for termination of the tracer wire. Provide an 18-inch-long length of extra wire (coiled and tucked into the box) for connection to utility locating equipment. Also provide boxes at each pipeline branch, cross or tee, and at intermediate spacing along the pipeline not to exceed 1,000 feet (except where pipeline valves with valve boxes provide the required wire access at those locations and intervals).

F. Upon completion and backfill of the pipeline, test, and demonstrate electrical continuity of each segment of tracer wire. Submit test results to the Owner indicating the location of the tested segment. Use conductive testing method; inductive test methods are not acceptable. Repair all faulty work at no additional cost to the Owner until the system is functional and approved.

3.04 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified herein.

END OF SECTION

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SECTION 40 05 57.13

MANUAL ACTUATORS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems

1.03 SUBMITTALS

A. As required in Section 40 05 60 – Valves

B. Action Submittals
   1. Procedures: Section 01 33 00 – Submittal Procedures

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.

C. Information Submittals: None

PART 2 PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. General:
1. Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. Wrench Nuts:
1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. Chain Wheels:
1. Chain wheels shall be ductile iron. Operating chains shall be galvanized.

2.03 OPERATOR APPURTENANCES

A. Valve Boxes:
   1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

B. Floor Boxes:
   1. Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. Adjustable Shaft Valve Boxes:
   1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. General:
   1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Wrench Nuts:
   1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

C. Chain Wheels:

1. Unless otherwise specified, valves with centerlines more than 7 feet, 6 inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. Valve Boxes:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. Floor Boxes:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

SECTION 40 05 57.23

POWERED ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes requirements for electric motor actuators to produce rotary and linear motion to activate quarter-turn and multi-turn valves and gates in open-close, throttling, and modulating services.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 45 23 – Testing and Inspection Services

C. Section 01 66 00 – Product Storage and Handling Requirements

D. Section 01 78 23 – Operation and Maintenance Data

E. Section 01 79 00 – Demonstration and Training

F. Section 01 99 90 – Reference Forms

G. Section 40 06 20.13 – Power Actuated Valve and Gate Schedule for Process Services

H. Section 40 61 21 – Process Control System Testing

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

B. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/AWWA C542-16	Electric Motor Actuators for Valves and Slide Gates.
ANSI/NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum).
ANSI/NEMA MG1	Motor and Generators.

Reference	Title
ANSI/NFPA 70	National Electrical Code.
OSHA	Occupational Safety and Health Administration
UL 429	Electrically Operated Valves.
UL 1002	Electrically Operated Valves for Use in Hazardous (Classified) Locations.
NEMA ICS-2	Industrial Control Devices, Controllers and Assemblies

1.04 DEFINITIONS:

A. Use ANSI/AWWA C542-16, Electric Motor Actuators for Valves and Slide Gates definitions, unless otherwise noted.

B. For purposes of this Section, the word “valve” refers to both valves and gates.

C. Electric motor actuators are defined using the following code system which appears in the actuator specification (ACTUSPEC) sheets:

Actuator Type (ACTUSPEC)	Service	Definition
EQTM	Modulating	Electric motor quarter-turn

D. Service:
   1. Modulating: Operation characterized by the continuous positioning of a valve between fully open and closed, in response to a continuous control signal.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Provide unit responsibility for the valve specified in Section 40 06 20.13 and the electric motor actuator specified in this section.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 46 05 11-C, Section 01 31 30).

B. Coordination:
   1. Data: Ensure the valve data is provided to the actuator manufacturer. Transmit the required torque or thrust, shaft diameter, thread characteristics (including right or left-hand), keyway dimensions, seating requirements (torque or position) for open and close.
   2. Conditions: Identify most adverse conditions to be encountered at any time when actuation is necessary.
      a. For quarter-turn, the following additional data is required for actuator sizing:
         1) The required actuator torque over the full cycle of operation.
         2) Desired speed of actuation or stroking time.

1.06 SUBMITTALS

A. Procedures: Submittal shall be provided in accordance with Section 01 33 00 and the following:

B. Action Submittals.
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required".
   3. Manufacturer's catalog information and other data confirming conformance to design and material requirements.
   4. Actuator Data Sheet: An information data sheet for each actuator showing required mounting, operating torque for driven equipment, torque capacity of actuator, actuator speed, associated valve torque ratings, motor data (power, hp; full load amps, locked rotor amps, rpm, duty rating). Provide actuator identification (tag) number clearly for each application on the actuator data sheet.
   5. List of components being provided for each actuator.
   6. Shop drawings:
      a. Actuator assembly.
      b. Dimensions.
      c. Electrical wiring diagrams.
   7. Actuator sizing report correlating to the coupled valve or gate type, operating torque and specified safety factor.

C. Informational Submittals:
   1. Application manuals for configuring and set up of actuator for control, monitoring and alarming.
   2. Application software and software manuals for programming communication network bus when specified. Include electronic data sheet or generic station description files for network configuration.
   3. Recommended storage practice. In addition, place this information on the outside of the actuator or shipping container as delivered to the site.

D. Closeout Submittals:
   1. Operation and Maintenance Data: Submit manufacturer’s standard operating and maintenance instructions as specified in Section 01 78 23.
   2. Training Certification Section 43 05 11-Form B.
   3. Maintenance Material:
      a. Spare Part Inventory Listing.
      b. Spare Parts.
      c. Special Tools.
      d. Lubrication guide.
      e. Certified drawings.
   4. Actuator Configuration Settings: The final settings used for configuration of the actuator to meet field operation requirements. Include both the electronic files and a hard copy printout in pdf format.

5. Window-based software program for allowance of uploading, reading settings, include ability to modify and store. Product manufacturer downloadable software or physical software media such as CD.

1.07 QUALITY ASSURANCE

A. Identification of Listed Products:
   1. Provide equipment and materials listed for the purpose for which they are to be used, by an independent nationally recognized testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent nationally recognized testing laboratory acceptable to the inspection authority having jurisdiction.
   2. Provide certified Profinet actuator meeting PROFIBUS and PROFINET testing through PI, www.profibus.com.

1.08 DELIVERY, STORAGE AND HANDLING

A. Procedures: In accordance with Section 01 66 00.

1.09 WARRANTY

A. Manufacturer to warrant all actuators furnished under this Section against defects in materials and workmanship for a period of two years, unless otherwise specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the actuator specification (ACTUSPEC) sheets. The manufacturer's standard models or products may require modification to conform to the specified requirements.

2.02 PERFORMANCE

A. Size actuators to produce an operating torque equal to twice the maximum required valve operating torque under the specified flow and pressure conditions. Specific requirements for each type of actuator are specified on the actuator specification (ACTUSPEC) sheets located at the end of this Section.

B. Seat valve or stopping method based on valve manufacturer's recommendation:
   1. Torque
   2. Position/Limit

C. Ambient Temperature Range: -20 to +140 degree Fahrenheit (up to 100% relative humidity).

D. Travel Speed: Refer to Section 40 06 20.13.

E. Rotation:
   1. Quarter-Turn: 90 degrees, with +/- 5 degree adjustable mechanical travel stops. Stops designed to withstand maximum actuator torque.

2.03 CONFIGURATION, COMPONENTS AND FEATURES

A. General: Unless otherwise specified, provide electric motor actuators in accordance with the actuator specification (ACTUSPEC) sheets and the following requirements.

B. Motor:
   1. General:
      a. Specifically designed for valve actuator service.
      b. Totally enclosed, non-ventilated construction.
      c. Internal heater for anti-condensation protection in outdoor installations.
      d. Compliance to ANSI/NEMA MG1.
   2. Duty Rating based on Actuator Service:
      a. Modulating: 50% (30 minutes) or 100% (continuous) duty motor rated for minimum of 900 starts per hour.
   3. Motor Starter: Provide actuator with a full voltage reversing starter rated for the motor's locked rotor and full load currents for 10,000 cycles with mechanical and electrical interlocks and overload protection in each phase pole.
   4. Three Phase:
      a. Reversible, Squirrel Cage Motor.
         1) 480 volt, 3 phase, 60 hertz power with +/- 10 percent voltage fluctuation.
         2) Four-pole 1800 RPM or provide pole-speed as required for the application.
         3) NEMA Class F insulation.
         4) Thermistor or thermostat for thermal protection embedded in the motor windings.
         5) Automatic motor thermal reset once motor has cooled sufficiently after overload.
         6) Three conduit openings, minimum.
      b. Control Transformer:
         1) Epoxy encapsulated and impregnated with short-circuit and overload protection.
         2) Rated, at a minimum, to handle 80 percent of the connected load with 120 VAC secondary or other secondary voltage of 24 VDC as required.
         3) Adequately rated to provide power for the following functions:
            a. Energizing of the contactor coils.
            b. Internally sourced power for remote controls.
            c. Internal electrical circuits.
            d. Heater.

C. Enclosure: Provide NEMA 250 electrical enclosures rated for the application and location specified:
   1. Non-hazardous, indoor and outdoor locations.
      a. Type 4, Weatherproof.
      b. Type 6, Submersible, rated for 20-foot head for 72 hours.
   2. All external fasteners zinc plated stainless steel.

D. Disconnect Switch: Provide a lockable, heavy-duty, NEMA 4X, non-fused, UL listed disconnect switch for mounting near actuator. Where actuated valve is out-of-reach, locate the disconnect switch on an adjacent wall at an accessible level.

1. Where depicted on the drawings provide auxiliary contact. The contact to close when disconnect switch is in close position. The contact to open when disconnect switch is in open position.

E. Gearing:

1. Totally enclosed in an oil or grease filled gearcase suitable for operation at any angle.
2. All drive gearing and components must be of metal construction and machine cut.
3. For rising stem valve (multi-turn), provide hollow output shaft accepting a rising stem and incorporating thrust bearings of the ball or roller type at the base of the actuator. Permit the opening of the gearcase for inspection, and disassembly without releasing the stem thrust or taking the valve out of service.
4. For quarter-turn, self-locking drive gearing to prevent the valve back-driving the actuator. Multi-turn actuator combined with part-turn gearbox for 90-degree rotation can be used for high torque applications or for large nominal diameter quarter-turn valves being used for throttling or modulating service.
5. Design all gearing to withstand a 100 percent overload.

F. Torque Switches: Provide electric motor actuators with a double-torque switch set to disengage motor power at 40 to 100 percent of actuator rated torque and less than 75 percent of the shaft's design torque. Operate the torque switch in both the opening and closing directions and operate during the complete cycle without the use of auxiliary relays, linkages, latches, or other devices.

1. Provide each side of the torque switch with a numbered dial for set point adjustment. Mount a calibration tag near each switch for correlating the settings with output torque activation.

G. Position Switches: Provide electrical or electro-mechanical confirmation of valve position. Position limit switches to indicate various positions between the fully opened and fully closed. Provide limit switches for visual local position indication of the valve and for external position monitoring through solid-state relay or electro-mechanical relays. Provide at least two relays with dry contacts for external position monitoring.

H. Hammer Blow Device: Provide electric motor actuators with a built-in lost-motion device that allows sufficient travel of the motor, prior to engaging the stem nut, for the motor to reach full speed. This action to impart a "hammer blow" to start the valve in motion in either direction. Share the load equally by two lugs cast integrally on the drive sleeve.

I. Handwheel: Provide electric motor actuators with a handwheel for manual operation. Do not rotate the handwheel during motor operation. Do not prevent handwheel operation when motor is locked. Accomplish motor or manual selection by a positive declutching knob or lever which disengages the motor and motor gearing mechanically but not electrically. Prohibit manual and motor simultaneous operation. Do not require more than 80 pounds of rim effort at maximum torque for hand operation.

2.04 CONTROL PANEL

A. Provide an integral operator control unit to serve as a control station for each actuator unless otherwise specified.

B. Control station to include pilot devices:
   1. LOCAL (or HAND), OFF, REMOTE (or AUTO), STOP, OPEN, and CLOSE controls through selector switches and/or pushbuttons.
      a. In LOCAL, use the control station's OPEN and CLOSE devices to position the valve to full open or full close. Configure for inching "maintained or sealed in" action in either travel direction.
      b. In REMOTE:
         1) Modulating or Throttling Service:
            a) Digital Bus-Network: Use the network communication in lieu of analog to position the valve when specified for remote control. On loss of network provide adjustable configuration to fail to the "open", "closed", "% open" or "last" position. Unless otherwise specified initially set to fail to the "last" and reconfigure during system start-up if required for operations to go to a percent open position on loss of communication.
         2) Prevent the controls station's local OPEN and CLOSE devices from operating the valve.
      c. In STOP, prevent travel in either open or close direction in both LOCAL and REMOTE.
      d. Provide lock in OFF position.
   2. Indication:
      a. OPEN and CLOSE Status Lights: Color of lights per Division 26.
      b. Position for Modulating/Throttling/Regulating Service: In addition to the above status lights, provide digital readout display for the valve position in 1 percent increments from 0 to 100 percent.
      c. Digital Bus-Network: Provide indication to show network communication is active and enabled when specified for remote monitoring or control.

C. Location of Control Station:
   1. Local: NEMA 4X Control station factory mounted directly to the electric motor actuator.
   2. Remote: NEMA 4X Control station mounted separate from the electric motor actuator when specified. Provide one of the following options:
      a. Add another control station if the factory mounted control station cannot be detached from the electric motor actuator. If two control stations are provided, then both control stations must have identical operations.
      b. Remote mount the entire actuator control package compartment including control power transformers, motor contactors and positioners.

D. External Monitoring:
   1. Status and Alarms: Provide single pole double throw (SPDT) or single pole single throw (SPST) dry contacts rated at 0.5 amps for 24V DC, and 3 amps for 120 V AC. Provide contacts as normally open or normally closed for the following when specified:
      a. Open Status: Representing valve in fully open position.
      b. Close Status: Representing valve in fully close position.
      c. Remote or Auto Status: LOR or HOA in Remote or Auto, representing actuator operation from external source enabled.
      d. Local or Hand Status: LOR or HOA in Local or Hand, representing actuator operation from the control station enabled.
      e. Alarm Status: Representing valve or actuator trouble.
   2. Position:
      a. Modulating or Throttling Service: In addition to the above external status and alarms, provide a 4-20 mA DC isolated output signal to indicate valve position at a minimum impedance of 500 ohms.
   3. Torque:
      a. Provide torque indication as Digital Bus-Network data for isolating, modulating, and throttling services.

2.05 NETWORK COMMUNICATIONS

A. Provide Profinet digital bus-network and use for REMOTE operation and external monitoring when specified.
   1. Configuration: Electronic Data Sheet (EDS), Generic Station Description (GDS) or Device Type Manager (DTM) files for bus.
   2. Compliance: IEC 61158.
   3. Connection: Open Terminal Style.
   4. Baud Rates: Manual selection and automatic baud rate detection for communication data exchange speeds.
   5. Node Address: Change default address by coordinating node address with System Integrator specified in Section 40 61 13.
   6. Programmable action of actuator on loss of communication as specified. Allow remote operation of actuator to return without fault on communication recovery.
   7. Termination Resistor: Default in the off position for serial based communication protocols.
   8. I/O Data Exchange Requirements: Coordinate with the Division 40 system integrator.

2.06 CONFIGURATION

A. Features:
   1. Non-intrusive or wireless access to view and setup the actuator parameters.
   2. Transfer diagnostic data logged in the actuator memory to a personal computer (PC).
   3. PC graphical user interface software allowing actuator set-up configuration and data logging information to be reviewed, analyzed and reconfigured.

2.07 NAMEPLATES

A. Control Station: Provide nameplates for each control station.
   1. Functional Nameplate: Engrave a white phenolic plate with black 5/32-inch-high lettering with valve functional description and valve equipment number as specified or shown. Permanently fasten functional nameplate to control station. Nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving.
   2. Marking Nameplate: Engrave or stamped stainless steel. Permanently fasten nameplate to the control station. Provide the information on nameplate as required by NFPA 70 (NEC) for industrial control panel markings.

B. Motor: Engrave or stamped stainless steel. Permanently fasten nameplate to the motor frame and ensure visibly positioned for inspection. Provide the information on nameplate as required by NFPA 70 (NEC).

C. Actuator: Engrave or stamped stainless steel. Provide the following information on nameplate: manufacturer, model number, serial number, ambient temperature minimum/maximum, rated torque, and opening time.

2.08 ASSEMBLY/FABRICATION

A. Factory-mount electric motor actuators on the valve as a unit. Provide each valve body or actuator with the word "OPEN" cast thereon, an arrow indicating the direction to open, and flow direction arrows.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to installation of the electric motor actuator assemblies, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for electric motor actuators.

3.02 INSTALLATION

A. Equipment Mounting.
   1. Locate actuator with unobstructed access for operation and maintenance.
      a. Do not obstruct walkways.
      b. Do not attach to handrails, process piping, or mechanical equipment.
      c. Do not locate where shock or vibration impairs its operation.
   2. Locate remote control station with unobstructed access for operation and maintenance between 48 inches and 60 inches above the floor or a permanent work platform, and within site of the actuator.
   3. Mount actuators to have their manual operating accessory, where possible, located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Nameplates: Locate nameplates in a clearly visible location. If necessary, reposition and reattach with stainless steel screws or wire.
   1. Electrical Interconnection: Comply with Division 26 for power wiring, control wiring and signal wiring.

3.03 FIELD QUALITY CONTROL

A. Provide a factory-trained manufacturer's representative at the site for the following activities.
   1. Inspect actuator's electrical power, control, signal, communication and grounding wiring for proper termination.
   2. Configure actuator and include:
      a. Actuator Settings: Limit switch, torque position, travel speed, emergency shutdown function, loss of position signal function, and relay functions.
      b. Network Settings: Address, transmission rate, bus loss action, heartbeat interval, consumed path, and production path.
   3. Test actuator network in compliance with Section 40 61 21.

3.04 SYSTEM START UP

A. General Requirements:
   1. Perform testing in accordance with Section 01 45 23, and this Section. Apply no required test without prior notice to the Construction Manager to witness any test. At least 14 days before the commencement of any testing activity, provide a detailed step-by-step test procedure, complete with forms for the recording of test results. Provide all equipment necessary to perform the required tests.
   2. Test each electric motor actuator for each mode of operation including but not limited to both local and remote- open, close, stop, emergency shutdown, position control, and network operation, as well as, the travel rates, limit switches, jam and torque settings, and loss of control signals. Provide testing collaboration for remote operation with Section 40 61 21.
   3. Ensure electric motor actuator control can be re-initiated locally and remotely after power loss recovery without faulting.
   4. Provide a factory-trained manufacturer's representative at the site to re-adjust actuator setting under normal operating conditions with the specified design process fluid.

3.05 TRAINING

A. Provide operation and maintenance training for the equipment provided under this Section for the Owner's personnel in accordance with Section 01 79 00 and taught by a factory-trained manufacturer's representative. Certify training on Form 43 05 11-B specified in Section 01 99 90.

B. Include in training sessions preventive maintenance requirements, overhaul and troubleshooting instructions, normal operating practices, actuator parameter configuration set-up, changing actuator parameter settings, network configuration.

PART 4 APPENDIX – ACTUSPECS

4.01 ACTUATOR SPECIFICATION SHEETS (ACTUSPEC)

A. General requirements for actuators specified in this Section are listed on ACTUSPEC sheets herein.

Table A

ACTUSPEC Symbol	Actuator Description	Actuator Service Power
EQTM	Electric Quarter-Turn Actuator for Modulating Service	480 V AC, 3 phase

4.02 ACTUATOR IDENTIFICATION: EQTM (480V)

A. Actuator Description: Electric Quarter-Turn Actuator or Multi-Turn Actuator with 90-Degree Gearbox for Modulating Service.

B. Manufacturers:
   1. AUMA, SGR, SAR/GS or SQR.
   2. Approved equal.

C. Features:
   1. Power Supply: 480 V AC, 3-phase, 60 Hz.
   2. Controller: Solid-state electronic, servo-amplifier comparator and an electro-mechanical reversing starter.
   3. Controls:
      a. Power Source: Internal or external 120 volts AC or 24 volts DC.
      b. Remote Control Type: Digital Bus-Network.
      c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
      d. Location of Control Station: Local unless otherwise specified in Section 40 06 20.13.
   4. Gear Train: 90-degree gear box if required.

END OF SECTION

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SECTION 40 05 60

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the supply, installation and testing of valves. Materials and performance requirements for valves are specified in Detailed Valve Specifications. Detailed Valve Specifications are provided in Sections 40 05 61.01 through 40 05 89.99. Additional Detailed Valve Specifications for some valves used for HVAC service are provided in Division 23.

B. Determining Valve Type:
   1. Drawings specify valve types (gate, plug, butterfly, check, globe, etc.) used in each pipeline. Process fluids that will be conveyed in pipelines are identified by the Process Service Identifiers shown on the Drawings.
   2. Piping System Schedules (Sections 40 05 02.23) specify piping system materials and components, including valve requirements, based on the Process Service Identifier specified on the Drawings for the pipeline or piping system. Piping System Schedules reference Detailed Valve Specifications that specify requirements for each valve type used in the pipeline or piping system.
   3. Provide valves conforming to the Detailed Valve Specifications listed in the Piping System Schedule for the valve/line size, process service, and valve type specified on the Drawings. Example: The Drawings specify a ball valve on a 1-inch line. The Piping System Schedule for the process service specified on the Drawings refers to Section 40 05 63.01 for 1/2 through 2 1/2 inch ball valves. For this example, provide the subject ball valve per the requirements specified in 40 05 63.01.

C. Section 40 06 20.13 specifies electric, pneumatic, and hydraulic powered control valves, complete with valve, actuator, and other ancillaries.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 40 05 02.23 – Piping System Schedule – Process Water
   5. Section 40 06 20.13 – Power Actuated Valve and Gate Schedule for Process Services

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI 16.10	Face-to-Face and End-to-End Dimensions of Valves
ANSI B1.20.1	Pipe Threads, General Purpose
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.34	Valves—Flanged, Threaded, and Welding End
API 607	Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat Resisting Steel Bars and Shapes
ASTM A351	Castings, Austenitic, for Pressure-Containing Parts
ASTM A516	Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	Ductile Iron Castings
ASTM A571	Austenitic Ductile Iron Castings
ASTM A995/A995M-13	Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts
ASTM B124	Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B148	Aluminum-Bronze Sand Castings
ASTM C283	Resistance of Porcelain Enameled Utensils to Boiling Acid
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D5162	Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C504	Rubber-Seated Butterfly Valves
AWWA C507	Standard for Ball Valves

Reference	Title
AWWA C508	Swing Check Valves for Waterworks Service, 2 – 24 Inches NPS
AWWA C517	Resilient-Seated Cast Iron Eccentric Plug Valves
AWWA C550	Protective Interior Coatings for Valves and Hydrants
MSS SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-81	Stainless Steel, Bonnetless, Flanged, Knife Gate Valves
MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
NSF 61	Drinking Water System Components - Health Effects
UL 429	Electrically Operated Valves
UL 1002	Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G

1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00
2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal will be sufficient cause for rejection of the entire submittal with no further consideration.
3. Catalog cuts and/or shop drawings for each type of valve indicating the valve type (Detailed Valve Specification Section Number), materials of construction, dimensions, operating torque, valve end connection configuration, pressure rating, and operating temperature range.
4. An amended Detailed Valve Specification for all valve types provided for this contract. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
5. Factory Acceptance Test results and/or Certified Statement of Proof-of-Design testing results when specified in Detailed Valve Specifications.
6. Action Submittal Items listed on Detailed Valve Specifications

B. Informational Submittals:

1. Affidavits and registration numbers as specified.
2. Operating and Maintenance data for incorporation in operation and maintenance manual, as specified in Section 01 78 23. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.
3. Informational Submittal Items listed on Detailed Valve Specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Deliver valves to site in accordance with Section 01 66 00 and using loading methods which do not damage any valve components or coatings.

C. Tag loose valves as specified in Section 01 66 00, stating size, type, coatings and mating parts shipped loose or separate.

D. Store on site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

1.06 WARRANTY

A. Where a warranty duration is specified by the Detailed Valve Specification, provide a special warranty valid for the specified duration.

B. Where no special warranty requirements are specified in the Detailed Valve Specification, provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 VALVE CONFIGURATION REQUIREMENTS

A. General
   1. Provide valves of the same type, size range and service from a single manufacturer.
   2. Provide new, unused valves for the work.
   3. Provide valve materials free from defects or flaws, with true alignment and bores.
   4. Provide valves that open by turning the valve shaft to rotate counterclockwise unless otherwise specified in the Detailed Valve Specification Section.

B. Provide padlockable lockout feature on all valves.

C. Manual Operators
   1. Provide valves with manual operators as specified in the Detailed Valve Specification, unless specified otherwise in Section 40 06 20.13.
   2. For hand wheels, clearly show the direction of opening in raised lettering and symbols.
   3. The maximum rim pull on a hand wheel is not to exceed 65 lb. when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater force to operate, provide a torque reduction gearbox operator. Unless different operators are scheduled or specified on the Drawings, conform to the following minimum requirements.
   4. Provide 6 (total) eight-point operating wrenches for use on all valves with square nut operators.
   5. Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.

6. Provide butterfly valves with 10 position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.
7. The maximum pull at the end of the lever arm is not to exceed 65 lb. when one side of the valve is at test pressure and other side is at atmospheric pressure. Where greater force would be required to operate the valve with a lever, provide a torque reduction gearbox operator.
8. Provide grease lubricated, worm gear type operators for torque reduction gearbox operators. Gearbox operators equipped with a hand wheel and a visual indicator of the valve position. Provide gear operators with adjustable mechanical stop-limiting devices to prevent over travel of the disc/ball/plug in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Where gearbox operators are intended for direct bury or submergence, seal units with long life lubricant.
9. For manual valves on lines 3 inches and greater, mounted over 6.0 feet above the operating floor, provide chain wheel gear operators. Design chain wheel operators so that a force of 30 lb. is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide chain pulley that positively engages the chain links. The chain will extend from the valve operator to an operating height of 4 feet above the floor or as directed by the Owner. The exact dimensions will be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.
10. Where manual operators are installed over 6.0 feet above the operating floor and the Drawings specify a vertical valve shaft, revise the gear operator and/or chain wheel position to provide a horizontal chain wheel shaft. Retain the valve orientation specified on the Drawings.
11. Provide ductile iron chain wheels. Provide galvanized steel operating chains.

D. Valve Stem Extensions and Wrench Nuts
   1. Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult; and in manholes.
   2. Where angle valve stem extensions are employed, they will be angle geared. Universal joint types are not permitted.
   3. Wrench nuts shall comply with AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of wrench nut operated valves.
   4. Provide intermediate guides and adjustable steady bearings as recommended by the manufacturer.

E. Operator Appurtenances
   1. Valve Boxes: Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized. Valve boxes extending to finished surfaces shall be provided for buried valves.

2. Floor Boxes: Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.
3. Adjustable Shaft Valve Boxes: Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.02 VALVE IDENTIFICATION TAGS

A. Provide valve identification tags for all valves with an identification tag number on the drawings (Mechanical and PI&D drawings).

B. Match tag numbers shown on the drawings.

C. Type 316 stainless steel tags, minimum 2.5-inches x 0.75 inches, with 0.1875 inch numbers and letters. Complete tag number shall be embossed on the tag. Tags shall be attached using stainless steel wire.

PART 3 EXECUTION

3.01 PREPARATION

A. The valve and piping arrangement indicated on the Drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

B. Prior to installation of valves, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for hydraulic, pneumatic, and electric power actuators.

C. Where conflicts are identified, inform the Owner.

3.02 INSTALLATION

A. Install valves in conjunction with the piping specified in the Piping System Schedules (Section 40 05 02.23), and with control valves and their appurtenances specified in Section 40 06 20.13.

B. In horizontal pipe runs, other than in locations where space does not permit, install all valves (except for butterfly valves, eccentric plug valves, and trunnion ball valves) with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator below the valve.

C. Unless otherwise specified on the drawings, install butterfly valves, eccentric plug valves, and trunnion ball valves with the shaft in a horizontal orientation. Install eccentric plug valves with the plug above the valve shaft centreline when the valve is full open.

D. When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

E. Support valves in position using temporary supports until valves are fixed in place.

F. Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

G. Where valves are installed in plastic pipelines (PVC, CPVC, HDPE, polypropylene etc.) greater than 4-inch diameter, support valves independent of the piping and brace valves against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

H. Install valves which are bubble tight in one direction to provide bubble tight seal of flow in normal direction of flow unless otherwise noted or directed by the Owner.

I. Unless otherwise specified, install single seated valves with the seat downstream. Install valves at tank connections with seat away from tank. Install valves on pump discharge and suction lines with seat end towards the pump.

J. Install all valves in accordance with the manufacturer's recommendations.

K. Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tape wrap.

L. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

3.03 FIELD QUALITY CONTROL

A. Field or Site Tests and Inspections per Detailed Valve Specifications.

B. Pressure test all valves in conjunction with the pipes in which the valves are installed at test pressures specified in the applicable Piping System Schedule.

END OF SECTION

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40 05 63.03

BALL VALVE, STAINLESS STEEL THREADED

GENERAL

1. Line Size: ½ through 3 inches
2. Rated Limits: Pressure 200 psi; Temperature 100 °F (WOG)
3. Valves shall be lockable when specified on the drawings.

VALVE MATERIALS

1. General: No materials containing per- or poly-fluoroalkyl chemicals, including PFAS, PTFE, and Teflon, shall be allowable for wetted valve components.
2. Body: Stainless Steel (304 or 316)
3. Ball: Stainless Steel (304 or 316)
4. Seats: UHMWPE
5. Packing: UHMWPE
6. Stem: Stainless Steel (304 or 316); blowout-proof stem

VALVE CONFIGURATION

1. Valve End/Connections: Threaded, Female
2. Pattern: Compact, Regular Port
3. Ball Mount: Floating
4. Manual Operator: Lever/Handwheel

SUBMITTALS

1. Action Submittals:
   a. Manufacturer's data including product literature, materials of construction, construction details of equipment, and weight of equipment.
   b. Affidavits of compliance with NSF 61.
2. Information Submittals:
   a. None
3. Closeout Submittals:
   a. Operation and Maintenance information.

CANDIDATE MANUFACTURERS

1. Apollo 76J-100
2. Bray Series 7000
3. Or approved equal

END OF SECTION

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40 05 63.08

BALL VALVE, STAINLESS STEEL FLANGED

GENERAL

1. Line Size: 4 through 6 inches
2. Rated Limits: Pressure 170 psi; Temperature 120 °F

VALVE MATERIALS

1. General: No materials containing per- or poly-fluoroalkyl chemicals, including PFAS, PTFE, and Teflon, shall be allowable for wetted valve components.
2. Body: Stainless Steel (304 or 316)
3. Ball: Stainless Steel (304 or 316)
4. Seats: UHMWPE
5. Packing: UHMWPE
6. Stem: Stainless Steel (304 or 316); blowout-proof stem

VALVE CONFIGURATION

1. Valve End/Connections: Flange, ANSI 16.1 Class 150
2. Pattern: Full Port, Split Body
3. Ball Mount: provide trunnion-mounted ball on all valves sizes 8 inches and greater, provide floating ball on all valves sizes 6 inches and smaller
4. Manual Operator: Lever/Handwheel; provide lever operators for valves 4 inches and less, provide geared operators for valves 6 inches and greater

SUBMITTALS

1. Action Submittals:
   a. Manufacturer's data including product literature, materials of construction, construction details of equipment, and weight of equipment.
   b. Affidavits of compliance with NSF 61.
2. Information Submittals:
   a. None
3. Closeout Submittals:
   a. Operation and Maintenance information.

CANDIDATE MANUFACTURERS

1. Kitz 150UTDZM
2. Velan SB-150
3. Elite E9200
4. Or approved equal

END OF SECTION

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40 05 64.05

BUTTERFLY VALVE, AWWA C504, CLASS 150B

GENERAL

1. Line Size: 3 through 16 inches
2. Rated Limits: Pressure 125 psi; Temperature 120 °F

VALVE MATERIALS

1. General: No materials containing per- or poly-fluoroalkyl chemicals, including PFAS, PTFE, and Teflon, shall be allowable for wetted valve components.
2. Body: Cast Iron or Ductile Iron
3. Disc: Cast Iron or Ductile Iron
4. Disc Trim: Stainless Steel (304) or Nickel
5. Seats: Neoprene, EPDM, or Buna-N
6. Shaft: Stainless Steel (304 or 316)

VALVE CONFIGURATION

1. Valve End/Connections: Flange or Lug, ASME B16.1 Class 125
2. Type of Disc: Eccentric
3. Manual Operator: Lever/Handwheel; provide geared operators for valves 6 inches and larger
4. Reference Standard: AWWA C504

SUBMITTALS

1. Action Submittals:
   a. Manufacturer's standard data including product literature, materials of construction, construction details of equipment, wiring diagrams, and weight of equipment.
   b. Affidavits of compliance with AWWA C504.
   c. Affidavits of compliance with NSF 61.
2. Information Submittals:
   a. None
3. Closeout Submittals:
   a. Operation and Maintenance Information.

CANDIDATE MANUFACTURERS

1. Homestead Series 820
2. DuZurik BAW
3. Pratt XR-70
4. Pratt 2FII

END OF SECTION

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40 05 64.07

BUTTERFLY VALVE, HIGH-PERFORMANCE METAL-SEATED

GENERAL

1. Line Size: 4 through 16 inches
2. Rated Limits: Pressure 125 psi; Temperature 400 °F

VALVE MATERIALS

1. Body: Stainless Steel ASTM A351 Gr. CF8M
2. Disc: Stainless Steel ASTM A351 Gr. CF8M
3. Seats: Stainless Steel 316, ANSI/FCI 70-2 IV and V unidirectional shutoff
4. Shaft: Stainless Steel 316
5. Packing: Multiple v-ring PTFE or braided carbon graphite including anti-extrusion ring.
6. Bearings: PTFE/Fiberglass

VALVE CONFIGURATION

1. Valve End/Connections: Lugged API 609 or Flanged, ANSI B16.34 Class 150.
2. Stem: Blowout proof per API 609
3. Type of Disc: Offset.
4. Manual Operator: Lever/Handwheel; provide geared operators for valves 6 inches and larger

SUBMITTALS

1. Action Submittals:
   a. Manufacturer's standard data including product literature, materials of construction, construction details of equipment, and weight of equipment.
   b. Affidavits of compliance with NSF 61.
2. Information Submittals:
   a. None
3. Closeout Submittals:
   b. Operation and Maintenance Information.

CANDIDATE MANUFACTURERS

1. DeZurik BHP, Metal-Seated
2. Approved Equal

END OF SECTION

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40 05 65.09

CHECK VALVE, AWWA C508 SWING

GENERAL

1. Line Size: 2 through 16 inches
2. Rated Limits: Pressure 200 psi; Temperature 125 °F

VALVE MATERIALS

1. Body: Cast Iron; valves shall be provided with a clear opening equal to or greater than the connecting piping
2. Disc: Cast Iron or Ductile Iron
3. Seats: Aluminum Bronze, Stainless Steel (316), or Buna-N; seats shall be threaded onto the body or fitted with an O-ring seal and locked in place with stainless steel screws or pins and shall be replaceable
4. Hinge Shaft: Stainless Steel (301, 303, or 304); shafts shall be provided with stuffing box and packing or O-ring seals at each end, seals shall be externally replaceable
5. Shaft Bushings: Bronze

VALVE CONFIGURATION

1. Valve End/Connections: ANSI Class 125# Flange
2. Check Mechanism: Weighted Swing
3. Operator: Air Cushion Swing Arm; swing arm shall be field convertible from right- to left-side of valve and horizontal or vertical positioning
4. Reference Standard: AWWA C508; only applicable for valves sizes 2 through 24 inches

SUBMITTALS

1. Action Submittals:
   a. Manufacturer's data including product literature, materials of construction, details of construction, and weight of equipment.
   b. Affidavits of compliance with NSF 61.
2. Information Submittals:
   a. None
3. Closeout Submittals:
   a. Operation and maintenance information.

CANDIDATE MANUFACTURERS

1. Golden Anderson 250D
2. APCO Series 6000
3. Crispin SWC Series

END OF SECTION

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SECTION 40 05 67.36

PRESSURE-RELIEF AND PRESSURE-REGULATING VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies direct acting and pilot controlled pressure relief and pressure regulating valves for water service.

1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.5	Pipe Flanges and Flanged Fittings

B. Performance:
   1. Direct acting type pressure regulating valves shall control the discharge pressure within ±5 percent of set pressure.
   2. Pilot controlled type pressure regulating valves shall maintain the set discharge pressure regardless of fluctuations in inlet pressure.

C. Testing:
   1. Hydrostatic tests shall be conducted by the manufacturer for one valve of each type supplied for a particular service. Steel-bodied valves shall be hydrostatically tested in accordance with the requirements of ANSI B16.5. Aluminum-, bronze-, and brass-bodied valves shall be hydrostatically tested at double the MAX pressure specified. Leakage, sweating or visible deformation at any point on the valve shall be cause for rejection of valves of that type and manufacture.

1.03 SCHEDULE

Valve number	Service	Valve size, inches	Maximum flow, SCFM or GPM	Inlet pressure range, PSIG	Outlet pressure, PSIG
PRV0001	Water	8	1,000 GPM	40 - 125	< 120
PRV0002	Water	12	4,000 GPM	80 – 95	65
PRV0101	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
PRV0201	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
PRV0301	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
PRV0401	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
PRV0501	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
PRV0601	Water	4	1,100 GPM	40 – 125	0 (atmospheric)
BPV005	Water	2	45 GPM	40 – 90	0 (atmospheric)

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. General:
   1. Pressure relief / pressure regulating valves shall be flanged or threaded connections as specified. Moving parts requiring lubrication shall have means provided for lubrication and shall be lubricated prior to delivery.
   2. Backpressure regulating valves shall have threaded connections. Valve shall feather a non-wetted u-cup seal. Acceptable manufacturers are Plast-O-Matic or approved equal.

B. Water Service:
   1. Valves less than 1-1/4 inches shall be direct acting, spring-operated type. Valves less than 1-1/4 inches shall be Cash-Acme E-41 Series 3, Watts 223, or equal, with separate Y-pattern strainer.
   2. Valves 1-1/4 inches and larger shall be pilot-controlled type, unless otherwise specified. Valves 1-1/4 inches and larger shall be diaphragm actuated type or differential piston pressure type and shall be Cla-Val Co. Clayton 90-01 Series, GA Industries, Inc., or equal. Valves 1-1/4 inches and larger shall include a pressure indicator unless otherwise noted.
   3. Valves on water service shall be NSF 61 certified.

2.02 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data.
   2. Hydrostatic test results.
   3. Documentation of compliance with ANSI/NSF 61.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pressure relief and pressure regulating valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

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SECTION 40 05 72.01

ELASTOMERIC CHECK VALVES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
NSF 61	Drinking Water System Components – Health Effects

PART 2 PRODUCTS

2.01 ELASTOMERIC CHECK VALVES

A. Elastomeric check “Duckbill” valves shall be used on all equipment as called out by Engineer in drawings. Standard materials of construction will be Neoprene with NSF61-approved nitrile tube reinforced with multiple plies of NSF 61 approved reinforcement with a NSF61-approved nitrile cover as an alternate for potable water projects.

B. When internal pressure inside the valve exceeds the backpressure being exerted on outside of the valve by a definite amount; the internal pressure opens the valve’s bill or flaps and allows water to flow out. When backpressure surpasses the internal line pressure by at least the same amount, the bills or flaps of the valve will close and remain that way until the internal pressure is again greater.

C. Manufacturer shall have significant experience in the production of “Duckbill” style elastomeric valves. Manufacturer shall have compatibility with NSF 61 standards. Manufacturer shall perform hydraulic tests on valves, with diameter not less than 60cm, for flow capacity, head loss, and jet velocity at a qualified flow test laboratory. Manufacturer shall provide test data upon request. Manufacturer shall provide, at his own cost, an independent licensed hydraulics engineer to review the application parameters and sign off on the valve being suitable for the application.

2.02 PRODUCT DATA

A. Manufacturer's product data shall be provided in accordance with Section 01 33 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 40 05 78.13

AIR/VACUUM VALVES FOR WATER SERVICE

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies air release valves, air and vacuum valves, and combination air valves for clean water service, pumping, and storage applications.

B. Types:
   1. Air Release Valves: Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.
   2. Combination Air Valves: Combination air valves (CAV) shall have operating features of both the air and vacuum valve and the air release valve. They include both single- and dual-body construction. Size and capacity shall be as specified.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

1.03 SUBMITTALS

A. As required in Section 40 05 60 – Valves

B. Action Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.

C. Information Submittals:
   1. Procedures: Section 01 33 00 – Submittal Procedures
   2. Applicable O&M instruction manuals per Section 01 78 23.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Air release and vacuum valves shall be APCO as manufactured by Valve and Primer Corporation, Crispin as manufactured by Multiplex Manufacturing Company, or equal, modified to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.03 CONSTRUCTION

A. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

B. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shutoff into the seat.

C. Combination air valves, unless otherwise specified, shall be single-body construction in sizes 1- through 6-inch and dual-body construction in sizes 8-inch and larger. Single-body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be designed so that during large orifice closure, the small air release orifice will open to allow small amounts of air to escape. Dual-body construction shall combine one air and vacuum valve and one air release valve with interconnecting piping and gate valve.

D. Air valves for vertical turbine pumps (sizes 3-inch and less) shall be designed and constructed as specified for air and vacuum valves except the discharge orifice shall be fitted with a throttling device to regulate and restrict air venting and establish a pressure loading on the rising column of water on pump start. Unless otherwise specified, air valves, 4-inch and larger, shall be dual body combination air valves except the inlet shall be fitted with a surge check to prevent water column entering the valve on pump start.

E. Valves shall be suitable for pressures up to 150 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves per Section 40 05 01 shall be provided below each air valve.

PART 4 SCHEDULE

Valve Number	Valve size, inches	Type	System press, PSI	Capacity, SCFS
CAV0101	3	Combination Air Valve	80	7.13
CAV0201	3	Combination Air Valve	80	7.13
CAV0301	3	Combination Air Valve	80	7.13
CAV0401	3	Combination Air Valve	80	7.13
CAV0501	3	Combination Air Valve	80	7.13
CAV0601	3	Combination Air Valve	80	7.13

END OF SECTION

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SECTION 40 06 20.13

POWER ACTUATED VALVE AND GATE SCHEDULE FOR PROCESS SERVICES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section specifies requirements for actuators for valves and gates that are positioned or controlled by means other than manual actuation. For the purposes of this Section, actuated valves and gates include valves and/or gates that are operated and/or controlled using hydraulic, pneumatic, or electric power.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 78 23 – Operation and Maintenance Data

C. Section 40 05 02 – Piping Systems Schedules

D. Section 40 05 57.23 – Powered Actuators

E. Section 40 05 60 – Valves

F. Section 43 05 11 – General Requirements for Equipment

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

Reference	Title
ISA-S75.02	Standard Control Valve Capacity Test Procedure

1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:
   1. Assign Unit Responsibility, as specified in Section 43 05 11, to the actuator manufacturer. The actuator manufacturer has Unit Responsibility, as defined in Section 43 05 11, for each valve or gate and the associated actuator. Assemble the valve/gate and actuator at the factory for shipment to the project site.

1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00

2. Valve Specifications for all valve types (Valve Specifications in Sections 40 05 60 through 40 05 78.13). Indicate with check marks (✓) where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
3. Catalog cuts and/or shop drawings for each valve type listed in the Actuated Valve and Gate Schedule. For each valve type (Valve Specification in Sections 40 05 60 through 40 05 78.13) indicate materials of construction, dimensions, operating torque, fail position, valve end connection configuration, pressure rating, and operating temperature range.
4. Open/Close time. Where open/close times are specified in the Actuated Valve and Gate Schedule, submit information documenting valve operating speed. Include information on motor operating speed, gear ratio, exhaust port flow restriction, or other means of speed control.
5. For each solenoid valve type and size combination, submit manufacturer's literature listing enclosure type, solenoid valve model number/type, maximum differential operating pressure, and minimum operating pressure.
6. List actuator type for each equipment number listed in the Actuated Valve and Gate Schedule.
7. Submittal information listed in actuator specification.
8. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11.

B. Closeout Submittals:
1. Procedures: Section 01 78 23.
2. Operating and maintenance submittals per Section 01 78 23.

1.06 ACTUATED VALVE AND GATE SCHEDULE

A. Furnish valves and gates conforming to the requirements specified in the Actuated Valve and Gate Schedule.

B. Equipment Tag:
1. Refer to Section 40 05 60 for identification requirements.

C. Valve / Gate Type:
1. The Gate/Valve Type column identifies a Valve Specification or Gate Specification for each Valve/Gate and Actuator combination.
2. Refer to the listed specification for the required valve or gate characteristics (i.e. valve/gate materials, dimensions, and configuration).

D. Powered actuator types are specified in Section 40 05 57.23. Actuator types used in the valve and gate schedule are defined as follows:

Actuator Type (ACTUSPEC)	Service	Definition
EQTM	Modulating	Electric motor quarter-turn

E. Actuator Enclosure, NEMA Type: Enclosure requirements for actuators are specified by NEMA enclosure type.

F. Maximum Pressure Differential: Pressure drop across each valve is specified for the purpose of actuator and gear box sizing. If no value is specified in this column, use the test pressure from the specified Piping System Schedule (Section 40 05 02.00 through 40 05 02.23) as the maximum pressure differential. Seating and unseating head requirements for gates are specified in the gate specification and are not included in this Section.

G. Open/Close Time: The open/close time refers to the time required for the valve to travel from full closed to full open. Open/close times are based on continuous operation of the actuator. Entries in this column are minimum values. Configure the actuator to provide an open/close time greater than the value listed in this column. Actuators that include programmed stops or steps are not acceptable.

H. Fail Position: Fail position indicates the position that the actuator will default to upon loss of electric, pneumatic, or hydraulic power supply for control of the actuator:
   1. Closed. (Fail Closed) Configure actuator to close upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   2. Open. (Fail Open) Configure actuator to open upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   3. Last. (Fail Last Position) Configure actuator to remain in the position last held by the actuator prior to loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.

I. Voltage: This column specifies the supply power voltage and number of phases for the power supply to solenoids, electric motor actuators, and electro-hydraulic actuators. Provide actuators for operation with the specified power supply voltage and phase.

J. Maximum Power Demand: This column specifies the maximum amperage rating for the electric power supply to the actuator. Provide actuators with electric power requirements that do not exceed the specified amperage rating listed in this column.

K. Network Communication: This column specifies which actuators are to be furnished with network communication capabilities. If a check mark (✓) or "yes" appears in the schedule, furnish the associated actuator with network communications capabilities as specified in the actuator specification.

PART 2 NOT USED

PART 3 NOT USED

PART 4 SCHEDULE

4.01 ACTUATED VALVE AND GATE SCHEDULE

Equipment Number	Valve/Gate Specification	Actuator Type	Actuator Enclosure NEMA Type	Maximum Differential Pressure (psi)	Open/Close Time (seconds)	Fail Position	Voltage (Voltage / Phase)	Maximum Power Demand, Amps	Network Communication	Remote Control Station	Notes
2167-P01-FCV0502	40 05 64.05	EQTM	4	150	30	Last	460 / 3	1.2	Yes	No	
2167-P01-FCV0302	40 05 64.05	EQTM	4	150	30	Last	460 / 3	1.2	Yes	No	
2167-P01-FCV0102	40 05 64.05	EQTM	4	150	30	Last	460 / 3	1.2	Yes	No	
2167-P01-FCV0010	40 05 64.05	EQTM	4	150	30	Last	460 / 3	1.2	Yes	No	

Notes:

1. *None.*

END OF SECTION

SECTION 40 06 70

SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Instrument schedule showing equipment specified as instrumentation for process control systems listed in the related sections.
   2. Instrument schedule does not include vendor package instrumentation specified per other equipment sections.

B. Instrumentation list:
   1. The instrument schedule (index) is located at the end of this Section as Attachment A.

1.02 RELATED SECTIONS:

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 40 61 13 – Process Control Systems General Provisions
   2. Section 40 61 21 – Process Control System Testing
   3. Section 40 67 00 – Control System Equipment Panels and Racks
   4. Instrumentation for process control systems:
      a. Section 40 71 00 – Flow Measurement
      b. Section 40 72 00 – Level Measurement
      c. Section 40 73 00 – Pressure, Strain, and Force Measurement
      d. Section 40 79 00 – Miscellaneous Instruments, Calibration Equipment, Instrument Valves, and Fittings

1.03 DEFINITIONS

A. Instrument Schedule Column Headings:

Instrument Field or Heading	Description
Item No.	Row number reference.
Equipment Tag	Unique instrument identifier which includes Facility Code, Area Code, ISA Prefix, Number, Suffix.
Description	Explanation of equipment function.
Size or Connection	Application data relative to sizing the instrument; flow tube diameter, probe length, associated pipe sizes, etc. 4-inch, 6-inch flange, 3/4-inch tap
Operating Range or Setpoint	25 to 65, -10 to 90, etc.
Units	mgd, kW, psi, etc.
Signal Type	Instrument signal output interconnecting to the process control system: 4-20 mA, Profibus DP, Profinet, discrete contact, etc.
Power Requirements	None, loop, 120-volt, 24-volt, internal battery, etc.

Instrument Field or Heading	Description
INSTRUSPEC Type	Instruspec type in specification listed in the specification section
Specification Section	Specification under which instrument is provided or specified.
P&ID	Piping &instrument diagram where instrument is shown.
Interconnection Diagram	Interconnection diagram where instrument wiring is shown.
Installation Detail	Detail number representing instrument installation requirement.
Comments	Provides the features, interlocks, and information applicable to the instrument, analyzer, or device. Describes special installation instructions, area classifications, modifiers to standard instrument specs, Owner-supplied, existing, accessories, signal surge protection, options, etc.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the instrument schedule and the PCS IO list for instrumentation measurement ranges and set points with the PCS's application programming for supervisory control and data acquisition (SCADA) and ensure all PCS instrumentation is tested as specified in Section 40 61 21.

B. Coordinate the vendor package instrumentation interconnecting with the PCS's PLC and SCADA specified per other equipment sections to provide measurement ranges and set points with the PCS's application programming for supervisory control and data acquisition (SCADA) and ensure tested as specified in Section.

1.05 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Requirements: Section 40 61 13 and related sections for instrumentation for process control systems.

B. Action Submittals:
   1. Submit instrument schedule under related sections for instrumentation for process control systems matching equipment being provided.

C. Informational Submittals:
   1. Provide a copy of the latest electronic version of the instrument schedule (or index), at least monthly, when requested.

D. Closeout Submittals:
   1. Provide record of the instrument schedule (index) following project startup, but prior to acceptance of the work, showing the final constructed state of the process instrumentation and control systems.

1.06 QUALITY ASSURANCE

A. Maintain a copy of the complete instrument schedule (index) with modifications during construction in Excel format that has heading filters to allow user to select different sorts.

PART 2 NOT USED

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Refer to Section 40 61 21 for requirements.

3.02 NAVIGATION

A. The instrument schedule (index) is organized based on the alpha-numeric equipment tag.

END OF SECTION

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SECTION 40 06 70_ SCHEDULES FOR INSTRUMENTATION OF PROCESS SYSTEMS

ATTACHMENT A

Item No.	Equipment Tag	Description	Size or Connection	Operating Range or Setpoint	Units	Signal Type	Power Req.	INSTRUSPEC Type	Specification Section	P&ID	Interconnection Diagram	Installation Detail	Comments
1	2167-B02-PI001	Rinse Water Pump Outlet Pressure Gauge	See P&ID	0-60	psig	--	--	PI	40 73 00	I-P02-101	--	I-000-005 (I31002)	
2	2167-B02-PSL003	Rinse Water Pump Inlet Pressure Switch Low	--	1.25	feet of WC	Discrete 24Vdc	--	PS	40 73 00	I-P02-101	I-W01-802 (B)	I-000-005 (I31002)	
3	2167-B02-FE102	Rinse Water Tank Discharge Flow Element	See P&ID	See Transmitter	--	--	See FIT0102	FM	40 71 00	I-P02-101	--	I-000-004 (I11001)	
4	2167-B02-FIT102	Rinse Water Tank Discharge Flow Indicating Transmitter	--	0 to 60	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-P02-101	I-W01-803 (A)	Integral to Flow Element	
5	2167-P01-PIT0002	PFAS Treatment Inlet Pressure Indicating Transmitter	--	0-200	psig	Analog 4-20 mA	Loop	PGT	40 73 00	I-P01-101	I-W01-803 (B)	I-000-004 (I31001)	
6	2167-P01-PIT0011	Pressure Vessels Rinse Water Supply Pressure Indicating Transmitter	--	0-100	psig	Analog 4-20 mA	Loop	PGT	40 73 00	I-P01-101	I-W01-803 (B)	I-000-004 (I31001)	
7	2167-P01-FE0012	Pressure Vessels Rinse Water Supply Flow Element	See P&ID	See Transmitter	--	--	See FIT 0012	FM	40 71 00	I-P01-101	--	I-000-004 (I11001)	
8	2167-P01-FIT0012	Pressure Vessels Rinse Water Supply Flow Indicating Transmitter	--	0 to 1800	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-P01-101	I-W01-803 (A)	Integral to Flow Element	
9	2167-P01-FE0103	Pressure Vessels F0100 and F0200 Inlet Flow Element	See P&ID	See Transmitter	--	--	See FIT103	FM	40 71 00	I-P01-101	--	I-000-004 (I11001)	
10	2167-P01-FIT0103	Pressure Vessels F0100 and F0200 Inlet Flow Indicating Transmitter	--	0 to 1800	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-P01-101	I-W01-803 (A)	Integral to Flow Element	
11	2167-P01-FE0303	Pressure Vessels F0300 and F0400 Inlet Flow Element	See P&ID	See Transmitter	--	--	See FIT 0303	FM	40 71 00	I-P01-101	--	I-000-004 (I11001)	
12	2167-P01-FIT0303	Pressure Vessels F0300 and F0400 Inlet Flow Indicating Transmitter	--	0 to 1800	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-P01-101	I-W01-803 (A)	Integral to Flow Element	
13	2167-P01-FE0503	Pressure Vessels F0500 and F0600 Inlet Flow Element	See P&ID	See Transmitter	--	--	See FIT 0503	FM	40 71 00	I-P01-101	--	I-000-004 (I11001)	
14	2167-P01-FIT0503	Pressure Vessels F0500 and F0600 Inlet Flow Indicating Transmitter	--	0 to 1800	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-P01-101	I-W01-803 (A)	Integral to Flow Element	
15	2167-P02-LIT101	Rinse Water Tank Level Indicating Transmitter	See P&ID	0 to 25 1.18 to 24.19	feet	Analog 4-20 mA	Loop	LFT	40 72 00	I-P02-101	I-W01-803 (B)	I-000-004 (I24001)	Zero offset - See drawings S-P02-101 & D-P02-301/2 for tank floor slope.
16	2167-U03-LSH003	Valve Vault 3 Level Switch High	--	12	inch	Discrete 24Vdc	--	LDFS	40 72 00	I-P01-101	I-W01-802 (B)	I-000-004 (I25001)	
17	2167-U04-FE102	Lift Station Grinder Pump Discharge Flow Element	See P&ID	See Transmitter	--	--	See FIT102	FM	40 71 00	I-U05-101	Wire per mfr for remote transmitter	I-000-004 (I11001)	
18	2167-U04-FIT102	Lift Station Grinder Pump Discharge Flow Indication Transmitter	--	0 to 20	gpm	Analog 4-20 mA	24 VDC	FM	40 71 00	I-U05-101	I-W01-803 (A)	E-000-004 (E25001)	
19	--												
20	--												

SECTION 40 41 13.13

PROCESS PIPING ELECTRICAL RESISTANCE HEAT TRACING

PART 1 GENERAL

1.01 DESCRIPTION

A. This performance section specifies self-regulating electric heat tracer tape with temperature control for protection of piping against freezing as shown on the drawings.

B. This section also specifies insulation for exposed piping and equipment. Insulation shall be classified as low-temperature insulation suitable for an ambient temperature range of -30 degrees-F to +100 degrees-F.

C. The heat tracing and insulation system shall maintain the water freeze protection at 40 degrees-F on the pipes specified in paragraph 3.04 herein.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI	American National Standards Institute
ASTM C552	Cellular Glass Thermal Insulation
ASTM E96	Water Vapor Transmission of Materials
FEDSPEC L-P-535E	Plastic Sheet (Sheeting) “Plastic Strip” Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid
NEC	National Electrical Code (NFPA 70)
NEMA	National Electrical Manufacturers Association
NEMA ICS 1	Industrial Control and Systems
NESC	National Electrical Safety Code
UL 746B, UL 508	Underwriters Laboratories, Inc.

1.03 PRODUCT DATA

A. The following information shall be submitted in accordance with Section 01 33 00:
   1. Manufacturer's product literature and method of installation.
   2. Certification that self-regulating heating cables can withstand temperature specified in paragraph 2.02 Controls.
   3. Submit 11" x 17" AutoCAD drawing with panel elevation, component and parts bill-of-material, schematic, and wiring diagrams.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. General:
   1. Tracer tape shall consist of self-limiting, parallel circuit construction with a continuous inner core of conductive material between two copper bus wires. The resistance and heating capacity of the heating material shall vary in response to piping temperature changes. Tape shall withstand continuous exposure to 150 degree F temperature. Tracer tape shall operate using 120 volt AC, 1 phase, 60 Hz power.
   2. Tracer tape shall be provided with copper shield and fluoropolymer jacket.
   3. Manufacturer shall be Chromalox or approved equal.

B. Type 1:
   1. Type 1 tracer tape shall have a thermal rating of 4 watts per foot at 50 degrees F.

C. Type 2:
   1. Type 2 tracer tape shall have a thermal rating of 8 watts per foot at 50 degrees F.

2.02 CONTROLS

A. General:
   1. The freeze protection system shall include the cable, the temperature control devices, the power distribution / control panel rated as NEMA 4X stainless steel enclosure for corrosion resistance and protection from moisture. Provide the appurtenances required for a complete system from the cable manufacturer.
   2. The control panel shall operate with ambient-sensing or proportional ambient-sensing controllers compatible with cables specifically identified for freeze-protection. Provide alarm horn and alarm relay for remote trouble alarm monitoring rated 24 Vdc at 0.5 amp. Provide HOA selector switch, power on light, main circuit breaker, power distribution circuit protection for each heat cable circuit.
   3. The wall mounted control panel shall be rated for 120 Vac input voltage and shall include power indicating light to validate power circuits, splices, or tee connections, connection kit.

B. Type A:
   1. Type A thermostat shall control by sensing ambient temperature with the following characteristics:
      a. Rating: 22 amperes at 480V AC

b. Control temperature range: 15 to 140 degrees F
c. Calibration tolerance: 2 degrees F
d. Sensor material: stainless steel
e. Exposure temperature: -65 to 140 degrees F
f. Temperature setting: 50 degrees F

C. Type B:
1. Type B thermostat shall control by sensing pipe temperature with the following characteristics:
a. Rating: 22 amperes at 480V AC
b. Control temperature range: 25 to 225 degrees F
c. Calibration tolerance: 1 percent of full scale
d. Bulb and capillary material: stainless steel
e. Control exposure temperature: -65 to 140 degrees F
f. Sensor overrange temperature: 325 degrees F maximum
g. Temperature setting: 50 degrees F

PART 3 EXECUTION

3.01 HEAT-TRACTING CABLE INSTALLATION

A. Tracer tape shall be fastened to pipe and valves as recommended by the manufacturer at intervals not exceeding 1 foot. Insulation shall be provided in accordance with Section 40 42 00 over the tracer tape.

B. Fasten heat tracer tape to pipe and valves as recommended by the manufacturer at intervals not exceeding 1 foot.

C. Provide insulation in accordance with Section 40 42 00 over the heat tracer tape.

D. Affix labels on surface indicating heat-traced pipe.

3.02 INSULATION INSTALLATION

A. General:
1. Insulation shall be applied over clean, dry surfaces. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

B. Piping Insulation:
1. General:
a. Pipe: Piping shall be continuously insulated along its entire length including all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive.

b. Fittings, Connections, Flanges, and Valves: Fitting, connection, flange and valve insulation shall be provided with PVC covers. Insulation shall be secured in place with 20-gage wire and a coat of insulating cement.

c. Covers: Covers shall overlap the adjoining pipe insulation and jackets and seams located on the underside of fittings and valves.

C. For additional insulation installation details, refer to Section 40 42 00.

3.03 HEAT-TRACING CABLE TESTING

A. In addition to any testing herein, perform all testing for this product or system consistent with the requirements of Section 01 45 23, applicable codes, and the manufacturer's current quality assurance program.

B. Heating cable shall be tested with a 2,500 VDC megohm-meter (megger) between the heating cable bus wires and the heating cable metallic braid. While a 2,500 VDC megger test is recommended, the minimum acceptable level for testing is 1,000 VDC. This test should be performed a minimum of three times:

1. Prior to installation while the cable is still on reel(s).
2. After installation of heating cable and completion of circuit fabrication kits (including any splice kits) but prior to installation of thermal insulation.
3. After installation of thermal insulation but prior to installation of wall or ceiling or backfill materials.

C. The minimum acceptable level for the megger readings is 20 megohms, regardless of the circuit length.

D. Self-regulating heating cable shall be designed for a useful life of 20 year or more with "power on" continuously, based on the following useful life criteria:

1. Retention of at least 75 percent of rated power after 20 years of operation at the maximum published continuous exposure temperature.

3.04 HEATING CABLE AND INSULATION SCHEDULE

A. Heating cable shall be provided in accordance with the following schedule:

Piping System Service	Piping Diameter, Inches	Location	Max Pipe Segment Length, Ft	Total Tracer Tape Length, Ft	Tracer Type	Thermostat Type
RAW/PEF	16	Common header to PFAS treatment	75	165	2	A
RAW/PEF	12	Common header to PFAS treatment	40	80	2	A
RAW/PEF/RWS/RWD	10	Valve manifold on PFAS treatment vessels, RWS/RWD common header	105	1,085	2	A
GSM/GFM/RWD	4	On PFAS treatment vessels, RWD from rinse water tank	30	350	2	A
PD	2	On PFAS treatment vessels	35	300	1	A

Piping System Service	Piping Diameter, Inches	Location	Max Pipe Segment Length, Ft	Total Tracer Tape Length, Ft	Tracer Type	Thermostat Type
SMP	1/2"	On PFAS treatment vessels	12	220	1	A

[1] Piping material shall be as specified in Section 40 05 01. Pipe insulation shall be as specified in Section 40 42 00.

END OF SECTION

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SECTION 40 42 00

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes thermal insulation for exposed piping, related equipment, and appurtenant surfaces.

1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 61 45 – Area Exposure Designations

C. Section 01 66 00 – Product Storage and Handling Requirements

D. Section 40 05 02 – Piping Systems Schedules

E. Section 40 05 07 – Hangers and Supports for Process Piping

F. Section 40 05 07.13 – Seismic Restraints for Piping

G. Section 40 05 45 – Piping System Identification

H. Section 40 41 13.13 – Electric Heat Tracer Tape

1.03 REFERENCES

A. This Section incorporates by reference the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of a listed document, the requirements of this Section prevail.

B. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation

D. ASTM C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

E. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation

F. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

G. ASTM C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation

H. ASTM C610 – Expanded Perlite Block and Pipe Thermal Insulation

I. ASTM C795 – Thermal Insulation for Use in Contact with Austenitic Stainless Steel

J. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

K. ASTM E96 – Water Vapor Transmission of Materials

L. FEDSPEC L-P-535E -- Plastic Sheet (Sheeting) “Plastic Strip” Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid

M. ASTM C1676 – Microporous Thermal Insulation

N. ASTM C1729 – Aluminum Jacketing and Insulation

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Low-temperature range: operating temperature range of -100 to +100 degrees F.

C. Medium-temperature range: operating temperature range of 100 to 800 degrees F.

D. High-temperature range: operating temperature range of 800 to 1200 degrees F.

E. Very-high-temperature range: operating temperature range of 1200 to 1800 degrees F.

F. Jacket: protective outer layer placed over insulation on straight runs of pipe

G. Cover: protective outer layer placed over insulation on valves, strainers, expansion joints, flanges, pipe fittings, couplings, and equipment.

H. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: After installation of insulation for pipe and equipment is complete, provide identification as described in Section 40 05 45.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Manufacturer’s descriptive literature, including insulation and jacket thickness, heat transfer coefficient, and methods of installation.
   3. Certification of jacket ratings for water vapor transmission, puncture and stiffness as specified.
   4. ASTM C795 certification, for insulation applied to stainless steel pipe.

C. Informational Submittals:
   1. Samples of each insulation material type and thickness along with typical jackets and covers for pipe, fittings, valves and appurtenances. Provide a full diameter segment for each insulation sample, 6 inches in length.

D. Closeout Submittals:
   1. Warranty Documentation

1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Deliver insulation, jackets and covering to site using methods which do not damage the materials.

C. Deliver insulation materials to site clearly identified as to type and temperature rating.

D. Store insulation materials on site as recommended by the manufacturer to prevent damage or and weathering.

E. Replace damaged or weathered insulation materials with new materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Candidate manufacturers and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.

B. Cellular Elastomeric Tube
   1. Armacell, AP Armaflex
   2. K-Flex, Insul-Tube
   3. Approved Equal

C. Fiberglass
   1. Johns Manville, Micro-Lok HP
   2. Owens Corning, FIBERGLAS
   3. Approved Equal

D. Cellular Elastomeric Flexible Blanket
   1. Armacell, AP Armaflex
   2. K-flex, Insul-Sheet
   3. Approved Equal

E. Fiberglass Flexible Blanket
   1. Amatex, Amamat
   2. Lewco, E Glass
   3. Approved Equal

2.02 INSULATION SERVICE CONDITIONS

A. Insulation Service Types

1. Insulation service types define the function of the insulation. The extent and location of insulation application is based on the function of the insulation. This Section specifies the following insulation service types: Condensate Control, Personnel Protection, Freeze Protection, and Energy Conservation. Insulation Service Types and insulation materials for piping systems are specified in Piping System Schedules.
2. Condensate Control is specified for piping that is to be insulated for condensate control. Where Condensate Control is specified for a piping service, furnish insulation for all pipe and pipeline appurtenances with a line size of ½-inch and larger that are located in Indoor Dry or Indoor Wet areas.
3. Personnel Protection is specified for piping that is to be insulated to protect personnel from injury related to exposure to temperatures above 140 degrees F or below 32 degrees F. Where Personnel Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances where all of the following conditions are present:
    a. Piping is connected to the discharge or exhaust of equipment (includes equipment and pipeline appurtenances).
    b. Equipment, pipe, or pipeline appurtenances are located within 0.0 to 8.0 feet above a floor, stair, landing, or other type of walkway accessible by plant staff, or within 4.0 feet of a guardrail or ladder cage. Pipe, pipeline appurtenances, joints, flanges, valves, and equipment in vaults, utilidors, and other spaces that are not designed for pedestrian access by plant staff are not insulated for Personnel Protection.
4. Freeze Protection is specified for piping that is to be insulated and heat traced to protect against freezing the contents of the pipe. Where Freeze Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all piping to be freeze protected by electric heat trace tape as specified in Section 40 41 13.13. Coordinate electric heat trace tape installation with specified insulation requirements for freeze protection to provide freeze protection for piping as specified in Section 40 41 13.13.
5. Energy Conservation is specified for piping that is to be insulated to conserve energy. Where Energy Conservation is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances for the entire portion of the piping system that is exposed.

2.03 MATERIALS

A. General:

1. Provide materials that are new and undamaged.
2. Match specified pipe insulation and jacket/cover material for insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings. Furnish flexible blanket insulation and soft covers if insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings is not available in the same materials as the specified pipe insulation and jacket/cover.
3. Provide rigid insulation and shields at pipe supports for insulated pipe. Match specified jacket/cover material for pipe shields at pipe supports.

4. Provide insulating and sealing materials, including cements, coverings, etc., that do not contain asbestos, mercury, or lead.
5. When covering stainless steel pipe, pipeline appurtenances, or equipment, use insulation that complies with ASTM C795.
6. Flame spread classification for insulation materials is not to exceed 25 when tested in accordance with ASTM E84.
7. Use fibrous loose fill insulation for joint filler around insulated expansion joints.

B. Fiberglass Flexible Blanket: Flexible fiberglass blanket insulation designed for continuous 1200-degree F service. 8.0 pounds per cubic foot density, minimum. Long fiber, random orientation, needled.

C. Aluminum Insulation Jackets/Covers
1. Aluminum jackets and covers constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 3003, or 3105 temper H14, with integral vapor barrier.
2. Pipe Insulation Jacket thickness per ASTM C1729, as follows.

Outer Insulation Diameter (inches)	Aluminum jacket thickness, rigid insulation (inch)	Aluminum jacket thickness, flexible and semi-rigid insulation (inch)
≤ 8	0.016	0.016
8 thru 11	0.016	0.020
11 thru 24	0.016	0.024
24 thru 36	0.020	0.032
≥ 36	0.024	0.040

3. Furnish 0.030 inch, minimum thickness, for aluminum insulation covers at valves, strainers, fittings, expansion joints, flanges, and other pipe couplings.
4. Aluminum or stainless steel sheet metal screws.
5. Jackets secured with 0.020 inch thick by ¾ inch wide Type 304 stainless steel expansion bands.
6. Flashing includes aluminum caps, sealant and reinforcing.
7. Provide aluminum caps, 20 gauge. Cut to completely cover the insulation.
8. Provide sealants as recommended by the insulation manufacturer.
9. Provide wire mesh reinforcement or nylon fabric reinforcement in sealant at jacket and cover joints. Reinforcement material as recommended by the insulation manufacturer.

D. PVC Insulation Jackets and Covers
1. One piece PVC covers and jackets. 20 mil thickness, minimum.
2. Pre-molded polyvinylchloride conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4.

E. Non-combustible Fabric Cover
1. Custom fit reusable covers. Sewn or stapled covers encapsulating insulation with stainless steel staples/hog rings. Close fit to the piping, pipeline appurtenance, or equipment housing.

2. Fabricated from 32 ounce TFE-coated or silicone coated fiberglass cloth with concealed/interior stitching, staples or hog rings (not exposed). For flexible blanket insulation installed for High-Temperature and Very High-Temperature Range applications, eliminate non-combustible fabric material on hot face of covers and provide stainless steel wire mesh on hot face of covers.
3. Fabric rated for continuous exposure to the temperature range of the insulation (Low, Medium, High, or Very High Temperature Range).
4. Secured in place with stainless steel lacing hooks, lock washers, and lacing wire.
5. Stitched or quilted to prevent consolidation, shifting, or settlement of insulation when subjected to vibration.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply insulation over clean, dry surfaces.

B. Ensure insulation is dry before and during application.

C. Do not apply protective pipe coatings to outside surface of insulation jackets or covers.

D. Do not paint PVC, aluminum, or fabric covers.

E. Do not install insulation or jackets/covers before piping and equipment has been tested and approved. Thermal shields at pipe hangers and supports may be installed prior to testing.

F. Provide thermal pipe hanger shields at pipe supports and bracing as specified on the Drawings, Details, Section 40 05 07 and Section 40 05 07.13.

3.02 INSTALLATION

A. General
   1. Where insulation thickness exceeds 3 inches, double layer insulation must be provided. Install double layer insulation with staggered section joints.
   2. Supply insulated thermal pipe hanger shields and install during pipe support installation. Where insulated thermal pipe hanger shields are used, apply the following to all butt joints:
      a. For pipe insulation with a medium, high, or very high Operating Temperature Range, apply 3 inch wide vapor barrier tape or band over the butt joints.
      b. For pipe with a low Operating Temperature Range, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

B. Protect insulation and jackets from crushing, denting, and similar damage during construction. Do not penetrate or otherwise damage vapor barriers. Remove any insulation, jacket, and vapor barriers damaged during construction and install new material.

C. Provide flashing at joints between insulation jackets, between insulation jackets and insulation covers, and at endcaps. Provide flashing around flange sets, pipe couplings/connections, and joint fittings. Allow adequate clearance between insulation rings, jackets and the joint connection for the removal and reinstallation of hardware during inspection and maintenance activities.

D. Piping Insulation
   1. Install uninterrupted (continuous) insulation as indicated for the specified Insulation Service Conditions (Condensation Control, Energy Conservation, Personnel Protection, or Freeze Protection). Insulate over pipe and all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Butt insulation firmly together and provide jacket laps and joint strips with lap adhesive. Provide a minimum of 2 inches of lap length. Install jackets with their seams located on the underside of pipe.
   2. Covers overlap the adjoining pipe insulation and jackets.
   3. Install covers with their seams located on the underside of valves, fittings, flanges, couplings, strainers and other piping appurtenances.
   4. Low Operating Temperature Range
      a. Seal off ends of pipe insulation with a vapor barrier coating.
      b. Seal covers at edges with vapor barrier adhesive. Secure the ends of covers with vinyl tape. Overlap the jacket and the cover at least one inch with vinyl tape. Do not penetrate vapor barrier.
   5. Medium, High, and Very High Operating Temperature Range
      a. Seal ends of insulation with end joint strips and use waterproof adhesive to hold them in place.
      b. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.
   6. Insulation for Outdoor Piping
      a. Where insulated pipe emerges from soil, concrete or asphalt terminate insulation for exposed pipe at the interface with insulation for buried pipe. If buried pipe is not insulated, extend insulation to within an inch above the finished surface. Do not push insulation into contact with soil, finished concrete, or asphalt surface.
      b. Provide heat tracing as specified in Section 40 41 13.13. Install insulation over heat tracing according to the specifications of the heat trace tape and insulation manufacturers.

E. Mechanical Equipment Insulation
   1. Unless otherwise specified in this Section, fit insulation to the contours of equipment and secure it with 1/2 by 0.015 inch stainless steel bands. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Stagger joints and fill voids with insulating cement.
   2. Overlap ends of blanket segments to prevent gaps and voids when the piping and equipment are heated.
   3. Secure blankets snugly under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids.
   4. Secure blankets in strict accordance with the manufacturer's instructions.

F. Flashing

1. Provide flashing at jacket penetrations and terminations. Provide clearance for flashing between insulation system and piping supports.
2. Form aluminum caps to fit over the adjacent jacketing and to completely cover coated insulation. Hold cap in place with a jacket strap.

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies general requirements applicable to Sections 40 06 70, 40 61 21 through 40 79 00 of these specifications for the process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a single Systems Integrator (SI) meeting the qualifications section of this specification, with the exception of the PLC, OIT and SCADA HMI programming work to be performed by the Owner, as specified below.

B. Electrical requirements applicable to this work are specified in Section 26 05 00.

C. Description of Work:
   1. This section covers general work requirements for the Process and Instrumentation Control System. Detailed requirements are in individual related specification sections.
   2. Systems Integrator: The scope of the work to be performed by the Systems Integrator in general, is as follows. Refer to the individual Division 40 specifications for the detailed scope of work assigned to the Systems Integrator.
      a. Field Instrumentation:
         1) Provide new field instrumentation.
      b. Process Control Hardware:
         1) Provide new control system hardware including programmable logic controllers (PLCs), input/output (I/O) modules, operator interface terminal (OIT), network switch, and uninterruptible power supplies (UPS).
         2) Provide and test custom fabricated enclosure assembly for new control panels, RIO panels, OIT panels, intrinsically safe panels, and communications panels.
      c. Process Control Software, PLC, OIT, SCADA HMI Programming, and Integration:
         1) Provide integration service to implement the specified process control descriptions between field equipment, process control hardware, vendor package instrumentation, and Owner's work.
         2) Integration with packaged system controls in other sections.
         3) Develop Functional Testing procedures and forms, as described in Section 40 61 21.
      d. Communications and Networking
         1) Modify an existing copper communications system to add the new process control hardware.
         2) Add new Profinet network for valve actuators to new PLC.

3. Owner: The scope of work to be performed by the Owner is as follows:
    a. PLC, OIT, SCADA HMI Programming and Integration:
        1) The Owner shall perform the PLC, OIT, SCADA HMI programming and integration to enable both local and remote control and monitoring of the site, including developing new OIT screens and new HMI screens for integration into the Owner's existing off-site SCADA system.

1.02 RELATED SECTIONS

A. The requirements of this section are applicable to work specified in Sections 40 06 70, 40 61 21 through 40 79 00.

B. Division 26 – Electrical.

1.03 REFERENCES

A. Standards:
1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).
3. If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
4. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA 5.1	Instrumentation Symbols and Identification
ISA 5.4	Instrument Loop Diagrams
ISA 20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA 51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems
NFPA 70	National Electrical Code (NEC)
NFPA 79	Electrical Standards for Industrial Machinery

1.04 DEFINITIONS

A. Abbreviations:
   1. A: ampere(s)
   2. HIM: human interface module
   3. HMI: human-machine interface
   4. IEEE: Institute of Electrical and Electric Engineers
   5. IO: input/output
      a. AI: analog input
      b. AO: analog output
      c. DI: discrete input
      d. DO: discrete output
      e. NW: network
         1) PN: Profinet
         2) EN: Ethernet
   6. ISA: International Society of Automation
   7. mA: milli-ampere
   8. NFPA: National Fire Protection Association
   9. OIT: operator interface terminal
   10. PCS: plant control system
   11. PICS: Process and Instrumentation Control System
   12. PLC: programmable logic controller
   13. RIO: remote input/output
   14. SCADA: supervisory control and data acquisition
   15. SI: Systems Integrator
   16. STP: shielded twisted pair
   17. VAC/Vac: volt(s) alternating current
   18. VDC/Vdc: volt(s) direct current
   19. VFD: variable frequency drive
   20. W: watt(s)

B. Definitions General:
   1. General: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA 51.1, and NEMA ICS 1.
   2. Data sheets: Data sheets refer to ISA 20 or ISA TR20.00.01, as referenced within ISA-20-1981 specification.
   3. Two-wire transmitter: A transducer that derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4- to 20-milliampere current regulated signal in a series circuit with a 24-volt direct current (VDC) driving potential and a maximum circuit resistance of 600 ohms.

4. Four-wire transmitter: A transducer that derives operating power from separate power supply connections. A four-wire transmitter produces a 4- to 20-milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120-volt alternating current (VAC) or 24VDC input power supply.
5. Galvanic isolation: An electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs that are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing a path for circulation of ground currents.
6. Panel: An instrument support system that may be a flat surface, partial enclosure, or complete enclosure for instruments and other devices used in process control systems including consoles, cabinets, and racks. Panels provide mechanical protection, electrical isolation, and environmental protection from dust, dirt, moisture, and chemical contaminants that may be present in the atmosphere.
7. Systems Integrator: A firm engaged in the business of detailed control system design and engineering, instrumentation component purchase, system and panel assembly, control device programming, and implementing of the specified process control and industrial automation systems.
8. Impulse line: A small-gauge pipe that is used to connect a point in a pipe in which the pressure is measured at an instrument. In flow measurement using a primary device such as an orifice plate, nozzle or Venturi meter, impulse lines are used to connect upstream and downstream (or throat) points of the meter to a secondary device for measuring the differential pressure.

C. Definitions—Signal Types:
1. Analog, low level: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.
2. Analog, high level: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
3. Digital code: Coded information from the output of an analog-to-digital converter or digital transmission terminal.
4. Discrete control or events: Dry contact closures and signals monitored by solid-state equipment, relays, or control circuits.
5. Discrete control or events, low voltage: Dry contact closures and signals monitored by solid-state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.
6. Modulated signals: Signals from modems or low-level audio signals. Normal signal level: plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.
7. Pulse frequency: Counting pulses emitted from speed or flow transmitters.

D. Definition—Drawing Types:
1. Elementary or schematic diagram:
   a. Use graphic symbols to indicate the electrical connections and functions of a specific circuit arrangement. The schematic diagram facilitates tracing of the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

b. Indicate connections to internal and external components connected to the panel. Note which devices are external to the panel.
c. Depicted in ladder logic format.
d. Indicates contact arrangement of internal and external devices such that circuits are complete and match equipment furnished.
e. Indicates equipment designations/tag numbers to match contract drawings and P&IDs.

2. Block diagram: A diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.
3. Network block diagram:
   a. A diagram of the overall control system, containing annotated boxes showing the primary network components (controllers, hubs, routers, switches, computers, displays).
   b. Include annotated interconnecting lines showing the system communication media and communication protocols.
   c. Indicate manufacturer and model of the primary network components and software.
   d. Indicates functions performed by each device (e.g., Historical Data Server, Field controller, Database Server, Operator workstation, etc.)
4. Connection diagram:
   a. Purpose is to show wiring requirements between internal panel components.
   b. Show components of a control panel in an arrangement similar to the actual panel layout.
   c. Indicate internal wiring between components.
   d. Show terminal blocks used for internal wiring and field wiring, with identification as such.
   e. Indicate insulation color code, signal polarities, wire numbers, and terminal block numbers.
5. Interconnection diagram:
   a. Purpose is to show wiring requirements between panels, standalone devices, components, and instruments.
   b. Indicate wire numbers, cable numbers, raceway numbers, terminal box numbers, terminal block numbers, panel numbers, and field device tag numbers.
   c. Show external connections between terminals of equipment and outside points, such as motors and auxiliary devices.
   d. Indicate references to connection diagrams that interface to the interconnection diagrams.
   e. Interconnection diagrams are to be of the continuous line type. Show bundled wires as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable.
   f. Show termination of each cable. Clearly mark each termination point. Show each wire's identification as actually installed. The wire identification for each end of the same wire shall be identical. Identify devices and equipment.
   g. Depict terminal blocks as actually installed and identified in the equipment with individual terminal identification.
   h. Indicate external jumpers, shielding, and grounding terminations.

i. Indicate polarities for signal and DC circuit.
j. Depict spare wires and cables installed or slated for installation.

6. Arrangement, layout, or outline drawings:
   a. Show the physical space and mounting requirements of a piece of equipment.
   b. Indicate ventilation requirements and space provided for connections or the location to which connections are to be made.
   c. Indicate clearance requirements for ventilation and access.
   d. Show the dimensioned external and interior control panel views with components and Bill of Material.
7. Loop diagrams:
   a. Prepared per ISA 5.4 – Loop Diagrams
   b. Show device element wiring of the system. Indicate device terminations, with terminal numbers.
   c. Show circuits for hardwired device interlocks.
   d. Show circuit cable and wire cable numbers, signal polarities, and terminal block numbers.
   e. Show connection to power supplies. Include alternating current (AC) and direct current (DC) power supplies and circuit information for instruments furnished under this contract.
   f. Indicate controller or I/O card address/node, rack, slot, and point wiring terminals.
   g. Show power supplies for signal loops. Indicate in which panel components reside and power originates with circuit numbering/name. Where new/modified loops connect to an existing power supply, show the existing power supply name, location, and circuit.
   h. Indicate surge protection type, manufacturer, and model number (i.e., types include floating ground reference or grounded reference).
   i. Show new and modified terminal blocks with numbering in new and existing panels.
   j. Indicate signal loop grounding terminations.
   k. Indicate loop numbers, wire numbers, and cable numbers used in field wiring and panel wiring.
   l. Indicate field element being controlled or monitored (i.e., normally open contact from relay CR17, or FIT 0365).

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the process and instrumentation control system for proper operation with related equipment, vendor package systems specified in other Divisions and Owner work.
   2. Integrate equipment in conformance with the drawings, specifications, and recommendations of the equipment manufacturer and the related processes equipment manufacturers.

3. Obtain manufacturer's technical information for items of equipment not provided with, but connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between equipment and the control system.
4. Coordinate interface requirements and schedule with other project subcontractors and equipment suppliers.
5. Present to the Owner's representative conflicts between the plans, specifications, manufacturer/vendor drawings, and installation instructions, etc. for resolution before proceeding.

B. Pre-submittal conference:
1. Schedule a pre-submittal conference with the Contractor, Systems Integrator, Owner, Owner's representative, and Construction Manager within 30 calendar days after Contract award to discuss the work, equipment, and submittal format, and to establish the framework for project coordination and communication.
2. Provide the following materials 10 days prior to the conference:
a. Proposed Systems Integrator that will meet the qualifications requirements of this section.
b. Indicate full conformance with the specification sections covered by this section with a contract deviations request. Requested contract deviations to reference and to be attached to the applicable contract specifications and drawings. Provide justification for requested deviations.
c. Proposed "equal" products that differ from specified manufacturers/models with comparative listing of the published specifications for the specified item and the proposed item.
d. Project schedule with deliverables and milestones through project completion.
e. Sample submittal drawings, as specified to be provided for this project. Samples can be a copy from a previous project provided that represents the format being proposed for this project.
1) Control system block diagram.
2) Documented controller and operator interface program.
3) Control panel schematic diagram.
4) Interconnection diagram.
5) Analog and discrete loop diagrams.
6) Control panel arrangement drawing.
3. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

1.06 SUBMITTALS

A. General:
1. Procedures: Section 01 33 00.

2. This article indicates general requirements applicable to all PICS submittals. Additional information to be submitted with each section will be listed under Action Submittals or Closeout Submittals in this and each related section.
    a. Submit all information for sections covered by a submittal as a complete package in one submittal. Partial submittals of a section from multiple vendors showing contractor's division of equipment, labor, or portions of the work are not acceptable.
    b. Include a table of contents in each submittal divided by specification section and content of each section such as drawings and components. Clearly indicate the article or paragraph to which each table of content item applies.
    c. Related sections indicate additional detail for each submittal.
    d. Bookmark PDF submittals to match the table of contents of each submittal. Submitted information is to conform to the following:
        1) Shop Drawings: Prepare drawings in AutoCAD version 2017 with borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Include a date and description for each revision of a drawing including the date and description of the revisions. Drawing prints shall be 11" by 17" with a minimum lettering size of 1/8".
        2) Product Literature: Provide manufacturer's specifications, data sheets, and catalog literature for the equipment and components that clearly and unambiguously show what is being provided and that it meets the requirements specified. Indicate provided and available options, materials of construction, environmental characteristics, electrical characteristics, and connection requirements. Include only applicable information.
    e. Conformance with Contract Documents:
        1) Provide a copy of sections applicable to the submittal group with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
        2) Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote them with a number in the margin to the right of the identified paragraph. Paragraph portions not underlined signify specification compliance. Include a detailed, written justification for each deviation. Show conformance with all paragraphs in a section. Failure to include a copy of the marked-up specification sections and justification(s) for requested deviations is cause for rejection of the entire submittal with no further consideration.
        3) Provide a marked up copy of the contract document instrumentation drawings and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings "no changes required." Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review. Contract drawings would include the following:
            a) Network system block diagrams
            b) Panel layout and arrangement drawings
            c) Panel power distribution connection diagrams

d) Analog and Discrete interconnection diagrams
e) Equipment interconnection diagrams
f) Piping and instrumentation diagrams
g) Equipment installation details

4) Show conformance across suppliers and vendors in one submittal. Partial submittals from multiple vendors showing contractor's division of labor or portions of the work are not acceptable.
5) Provide a detailed written request and explanation for each deviation. Failure to include a copy of the marked-up specification sections and drawings, along with justification(s) for requested deviations to the contract requirements, with the submittal, is cause for rejection of the entire submittal with no further consideration.

B. Action Submittals.
1. Procedures: Section 01 33 00.
2. Quality Assurance (within 30 days of contract Notice to Proceed):
a. Systems Integrator qualifications per paragraph 1.07, Quality Assurance.
b. Project personnel qualifications per paragraph 1.07, Quality Assurance.
3. System Overview
a. Network block diagram.
b. System description.
4. Interconnection Diagrams per paragraph 1.04.
a. Between all System Integrator furnished equipment.
b. Between all System Integrator furnished equipment and all other connected equipment. Include terminal numbers for all other connected equipment.
5. Provide Action Submittal packages specified in individual Division 40 specifications.

C. Closeout submittal general requirements.
1. Procedures: Section 01 78 23.
2. Provide Closeout Submittal packages specified in individual Division 40 specifications.
3. Provide record drawing prints of drawings and schedules following project startup, but prior to acceptance of the work, showing the final constructed state of the process instrumentation and control systems.
4. Include the following in each operation and maintenance manual:
a. Final reviewed submittals, including revised as-built record drawings.
b. Manufacturer's operation and maintenance instructions, edited for this project.
c. Written record of menu configuration, jumpers, switch settings, and other configurable parameters for each instrument.
5. Maintenance Material Submittals
a. Provide one listing of spare parts that is divided by specification section.
b. Include list prices for spare parts, expendable supplies, and tools.
c. Indicate spare parts packaging and storage methods.
d. Indicate spare parts or components that could be deleted or reduced based on manufacturer's recommendations.

e. Indicate where manufacturer's recommendations exceed the spare parts specified.

f. Obtain spare parts from the equipment manufacturer. Do not provide third-party equivalent replacements.

g. Packaging, Testing, and Storage:

1) Provide protective toolboxes for special tools.

2) Test spare boards, circuit cards, power supplies, and similar spare electronic assemblies on site prior to acceptance.

3) Carefully repackage operable parts. Immediately remove inoperable parts from the site and order replacement parts. Test replacement parts prior to acceptance.

4) Package spare parts for protection against dirt and moisture. Label each package as to its contents with a description and part number.

5) Do not place spare parts for different equipment items in the same package.

1.07 QUALITY ASSURANCE

A. All work covered by Sections 40 06 70, 40 61 13 through 40 79 00 shall be the responsibility of a single Systems Integrator as defined within this article.

B. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Division 40. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA 51.1, and NEMA ICS 1.

C. Demonstrate the overall system performance to the Owner for acceptance.

D. Systems Integrator Company Qualifications:

1. Evidence of Experience—Company specializing in the products and work of this section and related sections:

a. Minimum of 10 years of documented experience with the equipment specified as well as overall systems responsibility for systems of similar size and complexity.

b. Experience in performing three similar successful projects (equipment type, software type, Systems Integrator responsibilities, complexity, and dollar value of work performed by Systems Integrator) in the last 5 years. At least one project currently in progress or completed within the last 2 years.

c. End-user satisfaction of projects in the past 3 to 5 years based on end-user interviews by the Owner or Owner's representative. Submit project descriptions of projects completed within the past 5 years with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.

d. Panel fabrication and staging facilities adequate to provide services for this project. Demonstrate by including the following:

1) Panel shop shall be UL recognized to produce panels to UL 508A standards and labeling.

E. Systems Integrator Personnel Qualifications: Provide qualified personnel to complete the work specified for this project. Demonstrate by including the following:
   1. Organization chart and resumes for proposed project personnel showing experience for the proposed roles on this project.
   2. Training and certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:
      a. Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or Project Management Professional (PMP) certification.
      b. Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program as certified by ISA.
      c. Programmer: Certified by the software/hardware manufacturer for the software and hardware being used on the project, or Control System Engineer (CSE), or Professional Engineer (PE) registration.
      d. Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program as certified by ISA.
      e. Startup engineer: Experience on at least five separate projects, in managing the testing and startup of similar electrical, instrumentation, and process control systems.

1.08 ENVIRONMENTAL CONDITIONS

A. Ambient conditions: Per Section 01 11 80.

B. Corrosive locations: Per Division 26.

C. Seismic:
   1. Brace equipment and supports per Section 01 73 24.

PART 2 PRODUCTS

2.01 EQUIPMENT/MATERIALS

A. General requirements:
   1. New.
   2. Free from defects.
   3. Rated for the installed environment.

B. Similar control system components, instrument, instrument accessory, and devices used throughout the work shall be manufactured by one firm, where possible.

C. The components, modules, devices, and control system equipment shall be recognized industrial-quality products. Recognized commercial- or office-grade products are prohibited.

D. Identification of Listed Products: Provide process measurement devices listed and labeled for the purpose for which they are to be used and the installation environment, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Factory Mutual (FM). Independent testing laboratory need be acceptable to the inspection authority having jurisdiction.

E. Use electronic equipment of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

F. Equipment supports shall be 316L stainless steel, as shown or specified.

2.02 SOFTWARE

A. Software packages are to be latest versions available as specified in Section 40 63 43. All licenses shall be transferred to the Owner.

2.03 ENCLOSURES

A. Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application where not identified in other specification sections.

TABLE A

Location	Enclosure Material and NEMA Rating
Indoor: architecturally finished area	NEMA 12: mild steel
Indoor: electrical room	NEMA 12: mild steel
Indoor: process areas	NEMA 4X: 316 stainless steel
Indoor: corrosive area	NEMA 4X: 316 stainless steel
Outdoor: corrosive area	NEMA 4X: 316 stainless steel
Outdoor: non-corrosive areas	NEMA 4X: 316 stainless steel
Corrosive area (hypochlorite)	NEMA 4X: non-metallic

2.04 NAMEPLATES

A. Provide nameplates for field-mounted equipment covered by this section with the following requirements:
   1. Include the equipment description and the equipment tag, where nameplate engraving is not specified or shown.
   2. Machine engraved black phenolic with white stamped 5/32-inch-high lettering, as minimum, unless otherwise specified or shown.

B. Nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving.

C. Attach nameplates to support hardware with a minimum of two self-tapping type 316 stainless steel screws unless the panel has a NEMA 4 or NEMA 4X rating. Provide room-temperature-vulcanizing (RTV) sealant to adhere nameplates for NEMA 4 or NEMA 4X panels. Nameplates shall be located in a readily visible location so the nameplate will remain to identify the service when the device is removed. Attach field instrument nameplates with braided stainless steel straps where not stand-mounted.

2.05 SYSTEM INTEGRATORS

A. Candidate system integrators are listed below.
   1. Taurus Power and Controls
   2. S&B Incorporated
   3. Quality Controls Corporation (QCC)
   4. Technical System Incorporated (TSI)
   5. Approved equal

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements prior to fabrication.

3.02 INSTALLATION

A. General:
   1. Install equipment in locations that are accessible for operation and maintenance services.
   2. Installation, calibration, settings, and testing procedures are specified in Section 40 61 13, Section 40 06 70, and subsequent sections of Divisions 26 and 40.
   3. Equipment and instruments shall be installed in accordance with the manufacturer's requirements for installation. The installation shall meet the requirements for protection techniques or methods required by the NEC.

B. Field Equipment:
   1. Provide equipment with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 48 inches and 60 inches above the floor or permanent work platform. Equipment shall be mounted to avoid shock or vibration that may impair operation. Equipment shall be mounted for unobstructed access and walkways. Equipment support systems shall not be attached to handrails, process piping or mechanical equipment.
   2. Instruments and cabinets supported by concrete walls shall be spaced 5/8 inch by framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall.
   3. Support systems including panels shall be designed in accordance with Section 01 73 24 to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

4. In wet or outdoor areas, conduit penetrations for connection shall be made through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.
5. Provide nameplates for field-mounted equipment. Attach nameplates in a readily visible location, but such that if the field device is replaced, the nameplate will remain to identify the service.

C. Electrical Power Connections:
1. Equipment electric power devices and wiring shall comply with Division 26.

3.03 FIELD QUALITY CONTROL

A. Delivery Inspection:
1. Notify the Owner's Representative upon arrival of material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner's Representative may inspect such items.
2. Provide receipt verification prior to installation. Check:
a. Equipment received is equipment ordered.
b. Equipment meets specified requirements and approved submittals.
c. Equipment has correct manufacturer manuals.
d. Equipment has been factory calibrated, bench calibrated or has method for field calibration.

B. Inspection and Installed Tests:
1. Refer to Section 40 61 21.

3.04 CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean surfaces exposed to view, remove temporary labels, stains, and foreign substances.

C. Replace filters of operating equipment.

D. Remove waste and surplus materials, rubbish, and construction facilities from site.

3.05 TESTING AND COMMISSIONING

A. Refer to Section 40 61 21.

END OF SECTION

SECTION 40 61 21

PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies testing requirements applicable to Division 40 specification sections for the process control, instrumentation, communication, network, and signal systems. This work will be referenced as the Process and Instrumentation Control System (PICS) to be provided by a PICS Testing Manager meeting the Qualifications section of this specification. Section includes:
   1. Testing plan for organization, sequencing, and documentation.
   2. Performance testing - Factory Acceptance Testing (FAT).
   3. Phase 1 Commissioning – Component Testing.
   4. Phase 2 Commissioning – Functional Testing.
   5. Phase 3 Commissioning – Operational Testing.
   6. Phase 4 Commissioning – Acceptance Testing.

1.02 RELATED SECTIONS:

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 40 06 70 – Schedules for Instrumentation of Process Systems
   2. Section 40 61 13 – Process Control System General Provisions
   3. Section 40 61 93 – Process Control System Input/Output List
   4. Section 40 61 96 – Process Control Descriptions

1.03 REFERENCES

A. This section contains references to the following documents with additional references listed in Section 40 61 13.
   1. References are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the referenced documents, the requirements of this section prevail.
   2. Version: Latest documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no bids) unless noted otherwise.
   3. If referenced documents have been discontinued by the issuing organization, use the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
   4. Where document dates are given in the following listing, reference to those documents means the specific document version associated with that date, whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ISA 51.1	Process Instrumentation Terminology

1.04 DEFINITIONS

A. The term “instrumentation” covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate testing with Section 01 91 00 and integrate Owner for PLC, OIT, and SCADA HMI work in commissioning planning, scheduling, testing, startup, and optimization.
   2. Provide notice to the Construction Manager prior to conducting a test.
   3. Provide a detailed step-by-step test procedure, between 60 and 70 days before the commencement of testing activity, complete with forms for the recording of test results, testing equipment used, and a place for identification of the individuals performing and witnessing the test.
   4. Provide detail assistance to the Contractor in generating Section 01 45 20-Form A detailed in Section 01 99 90, customized for this project. Submit detailed form prior to testing per the requirements of Section 01 91 00.
   5. Equipment and System Performance, Functional and Operational Testing: Section 01 91 00 specifies testing of the mechanical, electrical, instrumentation, and HVAC systems. Coordinate, manage, and supervise the work with the quality assurance program including:
      a. Testing plan with the sequence for the test work.
      b. Calibration program for instruments and analyzers.
      c. Documentation program that records tests results.
      d. Performance testing program systems.

1.06 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Action Submittals:
   1. Quality Assurance submittal:
      a. PICS Testing Manager Qualifications.
      b. Testing Technician Qualifications.
      c. Network Testing Firm Qualification.
      d. Proposed process area and process system organization.
   2. Testing submittal:
      a. Submit detailed testing plan and proposed testing documentation after review of the Quality Assurance submittal showing conformance with Part 2 of this specification. Obtain approved submittal prior to testing. Separate submittals may be provided for each process area or test group:
         1) Control descriptions.

2) Input/Output (IO) interface.
3) Testing status spreadsheets.
4) Test procedures.
5) Proposed test forms per this section, detailed for each test for this project.
6) List of Certified Factory Calibration Reports for process instruments.

3. Factory Acceptance Test (FAT):
   a. FAT schedule and location.
   b. FAT procedures and test forms.

C. Closeout Submittals
1. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities for a process area.
   a. Label the binder cover and spine to identify the project name and process area. Include in the test report the applicable test procedures for the process area and the completed inspection and test report forms associated with the equipment and systems of that area.
   b. Organize test results by equipment item or system with individual, labeled tab dividers to identify each. The responsible testing entity is to acknowledge system deficiencies and noncompliant test results identified in the final test report as corrected.
   c. Documentation of network data communication nodes for network-type instruments, devices, and variable-frequency drives.
   d. Test equipment and test equipment calibration date.
   e. Certified factory calibration reports for process instruments.
   f. Performance test results (FAT).
   g. Phase 1– component testing results.
   h. Phase 2 - functional test results.
   i. Phase 3 - operational test results.

1.07 QUALITY ASSURANCE

A. Appoint a startup engineer or qualified specialist as PICS Testing Manager to manage, coordinate, and supervise the testing work.

B. The quality assurance program includes:
1. Definition of process areas and systems, with testing executed on an area-by-area basis, based on the P&ID drawings.
2. Testing for each process area executed in sequential tasks.
3. Regularly updated testing status tracking by process area, system, and task.
4. Regularly updated separate testing documentation for each process system.

C. PICS Testing Manager Qualifications:
1. The PICS Testing Manager shall have at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of similar electrical and instrumentation control systems.

D. Testing Technician Qualifications:
   1. Employ technicians who are qualified by completion and certification from training courses offered by the International Society of Automation (ISA), the instrumentation and analyzer manufacturer's training courses, or technician training courses at a recognized trade school that specializes in instrumentation calibration.

E. Network Testing Firm Qualification:
   1. Provide at least 5 years experience:
      a. Connectivity Testing: Check if properly wired connection is available from one end of the cable to the other. Measure the cable length, identify open circuits, short circuits, or reversed connections.
      b. Traffic Testing: Check if nodes are addressed and polled without traffic collisions, and without data error.
      c. Testing for both serial and ethernet communication platforms on both fiber optic and copper wire medias.

PART 2 PRODUCTS

2.01 GENERAL

A. Test forms: Conform to the requirements of Reference Forms 40 61 13-A through 40 61 13-K included in Section 01 99 90. Develop additional or detailed forms as necessary to suit complex instrumentation. Use terms on test forms that comply with ISA 51.1.

B. Project Labeling:
   1. The items specifying project labeling herein include the following as a minimum: Owner's name, facility name, project name, and project number.

2.02 TESTING DOCUMENTATION

A. Documentation Records:
   1. Develop a record-keeping system to document progress and completion for each task in each process area or system. Coordinate overall organization of areas and systems with overall testing required by Section 01 91 00, Commissioning, Testing and Start-up.
   2. Always keep documentation current and available for inspection on site in a location designated by the Construction Manager:
      a. PICS Testing Manager's qualifications, project startup, and testing history, including resume per paragraph 1.07.C PICS Testing Manager.
      b. List of names of Contractor's and System Integrator's personnel associated with final construction and testing, and normal and emergency contact telephone numbers.
      c. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
      d. Testing status specific to pre-loop test and loop testing status spreadsheet to include the IO list organized by area and system and loop number. Percent complete of the PICS system will be based on percentage of IO points tested.
      e. Test Report Volumes.

B. Test Report Volumes:
   1. Develop and maintain testing documentation for each process area or system in separate volumes. Always keep each volume current and available for inspection on site in a location designated by the Construction Manager. Include the following as a minimum:
      a. Three-ring binder with front cover and spine labeled: “Testing Documentation for (applicable) Process Area / Process System” including project labeling.
      b. Table of Contents with same labeling as the volume cover with tabs for each section:
      c. Section 1: Control Description
      d. Section 2: IO Interface
      e. Section 3: Instrument Index
      f. Section 4: Test Procedures and Forms
      g. Section 5: Certified Factory Calibration Reports
      h. Section 6: Test Report

C. Control Description:
   1. Provide a control description outlining operation for each process area’s system. The Control Description Specification Section 40 61 96 may be used as a basis.

D. IO Interface:
   1. Provide IO spreadsheets for each process area’s system. Spreadsheets are to include the following for each IO point:
      a. Information shown in Section 40 61 93.
      b. Signal number/tag.
      c. Annotation description that may be logically abbreviated and that is subject to approval.
      d. Complete physical IO channel designation and addressing or communication IO register designation.
      e. True/false status designations for digital IO.
      f. Process range; engineering units and multipliers; and raw signal range count for analog IO.
      g. Signals: Fixed point and scaled at the controller with minimum four significant implied digits of scaling, e.g., 0 to 1,400 at controller for a pH range of 0 to 14 at operator interface.
      h. Provide operator interface scaling to display decimal digits required.
      i. Indicate pass/fail for each point for both pre-loop test and loop tests.
      j. Indicate date of tests and comment for failed points.

E. Instrument Index:
   1. Provide a detailed Instrument Index. The Instrument Index from Section 40 06 70 may be used as a basis. Indicate actual calibration ranges, set points, and deadbands.

F. Field Test Procedure Documentation:
   1. Organize and assemble test procedures for each analog and discrete loop in the process control system in separate volumes for each process area or test group. Organize by IO point. Submit final test records in electronic form by scanning and converting the records and files to Adobe PDF format, to preserve actual signatures and signoffs.
   2. Include a detailed, step-by-step description of the required test procedure, panel and terminal block numbers for points of measurement, input test values, expected resultant values, test equipment required, process setup requirements, and safety precautions.
   3. Include test report forms for each loop, including forms for wiring, piping, and individual component tests, with the test procedure documentation. Record the actual test results on these forms and assemble them into final test reports.
   4. Preprint and populate information in the test report forms to the extent possible prior to commencing testing.
   5. Include on the test report forms:
      a. Project name.
      b. Process area associated with the equipment under test.
      c. Instrument loop description.
      d. Instrument loop identification number.
      e. Instrument nameplate data.
      f. Instrument setup and configuration parameters.
      g. Time and date of test.
      h. Inspection checklist and results.
      i. Reference to applicable test procedure.
      j. Expected and actual test results for each test point in the loop including programmable controller data table or register values.
      k. Test equipment used.
      l. Space for remarks regarding test procedure or results, observations, etc.
      m. Name, date, and signature of testing personnel.
      n. Test witness's name and signature.

2.03 SOURCE QUALITY CONTROL

A. Factory Acceptance Test (FAT):
   1. Provide a FAT with the test and subsequent retests witnessed by the Construction Manager and Owner.
   2. Coordinate with Owner for programming and load software and configuration for control system panels, controllers, network components, operator interfaces, servers, and the programming and graphic configuration application at the control system equipment supplier's factory prior to the FAT.
   3. Inspect equipment, panel instruments, panels, or cabinets with factory testing performed.

4. Provide written notice to the Construction Manager 30 working days before the commencement of the FAT activity and include:
    a. Schedule for the FAT.
    b. Location of the FAT.
    c. Testing equipment used.
    d. Detailed test procedure with forms for the recording of test results.
    e. Sign-off spaces for the individuals performing and witnessing the tests.
5. Network and interwire equipment and panels as applicable. Operate and check out equipment prior to the FAT. Submit certification indicating that the panels are ready for the FAT. Include the following:
    a. Visual inspection of equipment, instruments, control panels, PLC, and operator interface terminal.
    b. Validation of each input loop and output loop by simulated signals for analog inputs and by shorting discrete inputs.
    c. Validation includes:
        1) Monitoring state changes on operator interface terminal screens based on the inputs state change through the PLC.
        2) Observation of online controller programming application software with the associated outputs state change through the PLC.
        3) Outputs triggered by operator interface terminal software devices (pushbuttons, sliders, manually entered values, etc.)
        4) Calibration and operation of instruments on or in the control panels.
    d. Repair of loops that do not pass validation.
    e. Retest of the FAT at no additional cost.

PART 3 EXECUTION

3.01 GENERAL

A. General Requirements:
    1. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein.
    2. Inspect materials, equipment, and construction included under this specification in accordance with this section and subsequent sections of this division. Perform testing in accordance with this and subsequent sections of this division.
    3. Have a certified instrument technician qualified to calibrate the instrumentation calibrate and set up field instruments and analyzers.

B. Test Equipment and Materials:
    1. Provide test equipment to conduct the specified tests that simulate inputs and read outputs with a rated accuracy at the point of measurement at least three times greater than the component under test.
    2. Provide a calibration sticker on test instruments showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required. Include certified calibration reports traceable to the National Institute of Standards and Technology with the final test report.

3. Provide a documenting calibration system to conduct process instrumentation calibration activities that consist of a documenting process calibrator and an instrumentation data management software system that captures the calibration results and electronically document instrument data, date of calibration, calibration procedures, and as-found and as-left instrument calibration data.
4. Provide an instrument calibration system such as Fluke 743B with Fluke DPC/Track Instrumentation Management software or similar system. Submit calibration files with the final test report in hard-copy and electronic formats that does not require specialized equipment or software to read and print the files.
5. Provide buffer solutions and reference fluids for tests of analytical equipment.
6. Provide a communications and software package to record final configuration parameters and settings for variable-frequency drives with the parameters acquired by connection to the network that record the configuration settings without manual data entry or transcription of values.
7. Vendor software tools may document the systems where a licensed copy of the identical software including connectors, cables, keys, interface cards, and devices required for operation is submitted with the final documentation files.

C. Performance Deviation Tolerances:
1. Tolerances are specified in individual sections. Where tolerances are not specified, refer to the manufacturer's published performance specifications.
2. Calculate overall accuracy requirements for loops consisting of two or more components, by the root-summation-square (RSS) of the component accuracy specifications. Calculate and record tolerances for each required calibration point on the associated test report form.

D. Witnessing:
1. The Construction Manager reserves the right to observe factory and field instrumentation testing and calibration procedures. Notify the Construction Manager prior to testing, as specified herein.

3.02 TESTING SEQUENCE

A. Perform tests for each area or system in the following sequence:
1. Phase 1 Commissioning – Component testing
2. Phase 2 Commissioning – Functional testing
3. Phase 3 Commissioning – Operational testing
4. Phase 4 Commissioning – Acceptance testing

B. Group equipment and IO based on the relationship of the equipment to operate safely as specified, including full automatic and manual control and monitoring through the control system. Equipment and IO in a given area or system shall pass testing prior to proceeding to the next set of tests in the sequence above.

3.03 PHASE 1 COMMISSIONING – COMPONENT TESTING

A. Perform tests in the order below.

B. Wiring Tests:
   1. Verify that electrical power and signal cable ring-out and resistance testing has been performed as specified in Sections 26 05 00 and 26 08 00. Conduct wiring tests after cables have been properly terminated, tagged, and inspected.
      a. Power and Control: Section 26 08 00.
      b. Signal: Section 40 61 13-Form A.

C. Network and Bus Cable Inspection and Testing:
   1. Inspected and tested by independent industrial network testing firms.
   2. Test proprietary bus systems by the manufacturer's qualified field services technician. Manufacturer's sales personnel are not considered to be qualified technicians unless qualifications are documented and certified by the manufacturer.
   3. Have a qualified independent network testing service test standardized networks and buses. The following types of cabling and networks shall be tested and certified by the independent industrial network testing firm:
      a. Ethernet system cabling (inclusive of Profinet).
      b. Other networks provided as a part of a packaged monitoring or control system.
   4. Test and verify control and instrumentation bus cabling using the standards that apply to the specific cable and bus type as follows:
      a. Ethernet Category 5E and Category 6: per TIA/EIA-568B standards.
   5. Pre-Active Testing: Inspect and test cables prior to energizing to verify the following:
      a. Media type and specifications.
      b. Physical routing and project-specific cable identification tagging.
      c. Correct termination installation and connection of conductors to pins at terminations.
      d. Record cable run length and compare to the manufacturer or industry standards to verify that lengths are within specifications.
      e. Locations and values of network termination resistance.
      f. Integrity and grounding of cable shields.
      g. Values of transient protection (surge) elements.
      h. Firmware revision level of network devices available prior to energization.
      i. Settings of dip switches and configuration parameters.
   6. Active System Testing: After the cable or network system has been activated for testing, provide diagnostic monitoring and signal analysis for the bus network system to evaluate network and bus integrity and data transfer quality. Measure, verify, and record the following parameters:
      a. Node addressing.
      b. Signal attenuation before and after a repeater device and at the farthest point in the network.
      c. Total network trunk voltage and current loading as applicable.
      d. Baud rate, message traffic rate, percent bandwidth used, error rate, and lost packet count.
      e. Firmware revision level of the network devices.
      f. Pre-active and active testing: within the specified range of values established by the referenced standards.

g. Correct the functionality of networks and devices connected to the network.

D. Piping Tests:
   1. Piping Systems: Tested for leaks in compliance with Section 40 05 01.

E. Instrument and Component Inspection:
   1. PICS components inspection activities include the following:
      a. Compare and validate instrument type and nameplate data with the drawings, specifications, and data sheet.
      b. Validate instrument identification tag.
      c. Confirm that instrument installation conforms to drawings, specifications, and manufacturer's instructions.
      d. Verify proper conductor termination and tagging.
      e. Visually check for physical damage, dirt accumulation, and corrosion.
      f. Verify that isolation amplifiers, surge protection, and safety barriers are properly installed.
      g. Report deficiencies identified within 24 hours of discovery. No instrument or system component shall be tested until deficiencies are addressed.

F. Instrumentation Calibration:
   1. Calibrate instruments and final elements in accordance with the manufacturer's recommended procedures and tested in accordance with the Contractor's test procedure.
   2. Complete and document instruments and component inspections to the satisfaction of the Construction Manager prior to individual component calibration and testing.
   3. Calibrate analog instrument at 0, 10, 50, 90, and 100 percent of the specified full-scale range. Adjust each signal sensing trip and process sensing switch to the required setting. Verify instrument readout matches loop signal. Test data recorded on test forms as specified herein.
   4. Test and adjust final element alignment to verify that each final element operates smoothly over the full range in response to the specified process control signals.
   5. Enter test data on the applicable test forms at the time of testing: set alarm trips, control trips, and switches to initial values specified in Section 40 06 70 Instrument Index at this time. Check final elements for range, deadband, and speed of response.
   6. Have any component repaired or replaced by the manufacturer where the component fails to meet the required tolerances. Repeat the specified tests until the component is within tolerance.
   7. Install a calibration sticker on each instrument following successful calibration that indicates the date of calibration, the name of the testing company, and personnel who calibrated the instrument.
   8. Test forms Section 40 61 13-Form C through I.

9. Certified Test Reports: Field test and inspection activities include verification of instrument parameter setup, verification of instrument zero, and performance at three operating points within the instrument range. Return each instrument that fails to demonstrate proper performance for recalibration or replaced as agreed depending on the impact to the project as determined by the Construction Manager.
    a. Where instrument field calibration is not feasible, certified factory calibration reports may be submitted that include the name and address of the laboratory that conducts the calibration testing.

G. Pre-Loop Testing:
    1. Test every IO point from the field device to the termination on the IO card in the panel.
    2. Perform tests with loop wiring complete and terminated for each point being tested between initial field device and IO termination point.
    3. For each discrete IO point, verify and document contact status value for both the opened and closed positions of the contact.
    4. For analog points, verify analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.

H. Loop Testing
    1. Provide a request to perform loop testing at least 2 weeks prior to the requested loop test date. Include the following with the request:
        a. Area/system for which request is being made.
        b. Written certification that performance testing has been completed, documented, and passed for the area/system for which loop testing is being requested.
        c. Submittal numbers that define the tests and data points for the IO to be tested. Provide updates to the IO list or instrument calibration as an outcome of the performance testing.
    2. Commence loop testing after the performance testing has been completed and documented to the satisfaction of the Construction Manager.
    3. Test each instrument loop as an integrated system. Check operation from field instruments to transmitter to receiving components to the vendor panel or the Plant Control System Operator Interface Station. Inject test signals at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.
    4. For each discrete IO point, verify and document field contact status value for both the opened and closed position of the contact.
    5. For analog points, verify that analog value matches local display. Confirm calibration at 0, 25, 75, and 100 percent of value.
    6. Where loops are interfaced to a controller, verify the controller IO assignment and operation of the input/output system and processor. Inspect the data table or register in the PLC memory to verify proper operation.
    7. If the output control or monitoring device fails to indicate properly, make corrections to the loop circuitry or device. Repeat the test until devices and instruments operate as required.
    8. Correct loop circuitry and repeat the test until the instruments operate properly.
    9. Test Section 40 61 13-Form J.

3.04 PHASE 2 COMMISSIONING - FUNCTIONAL TESTING

A. Process Control Strategy/Functional Testing:
   1. Commence control strategy testing after loop testing has been completed and documented to the satisfaction of the Construction Manager.
   2. Control strategy testing consists of installing and debugging the Owner's PLC control logic program, verifying the interface points between the controller IO cards and field devices and equipment, and exercising the control strategies.
   3. Provide qualified personnel to immediately correct deficiencies in the work that may be encountered during control strategy testing. Failure of the Contractor to provide such personnel in a timely manner may prolong the time allotted to complete control strategy testing.

B. Control System Closed-Loop Testing:
   1. Commence closed-loop commissioning after the control strategy testing has been successfully completed and documented to the satisfaction of the Construction Manager.
   2. Demonstrate stable operation of each loop under operating conditions. Adjust loop tuning parameters as part of the test.
   3. Tuning parameters: gain (or proportional band), integral time constant, and derivative time constant for each control loop, adjusted to provide 1/4-amplitude damping, unless otherwise specified.
   4. Provide the loop response to a step disturbance for each loop. Provide two graphs for cascaded control loops, one showing the secondary loop response with its set point in manual, and the second showing overall loop response.
   5. Adjust control loops with "batch" features to provide optimum response following startup from an integral action saturation condition.
   6. Provide graph recording showing the response and made at sufficient speed and amplitude to show 1/4 amplitude damping. Label to show loop number and title, and settings of parameters and set point.
   7. Where a loop is controlled under the direction of a PLC, the Owner will perform the necessary adjustment of loop tuning parameters and set points, record the loop response, adjusting final elements, and ensuring total integrated loop performance as specified.

C. Functional Checkout:
   1. Conduct to verify the operation of discrete and hardwired control devices, refer to Section 01 45 00. Exercise the operable devices and energize the control circuit. Operate control element, alarm device, and interlocks to verify that the specified action occurs.

3.05 PHASE 3 COMMISSIONING - OPERATIONAL TESTING

A. Perform the Operational Tests after component and subsystem tests have been completed. Perform the test of the completed system in full operation and demonstrate that functional requirements of this specification have been met. Demonstrate the following:
   1. Each component of the system operates correctly with other components of the system.

2. Analog control loops operate in a stable manner.
3. Hard-wired and software equipment interlocks perform correctly.
4. Process control sequences perform correctly.
5. Application program performs monitoring and control functions correctly.
6. Operator interface graphics represent the monitoring and control functions correctly.

3.06 PHASE 4 COMMISSIONING - ACCEPTANCE TEST

A. Per Section 01 91 00.

3.07 OPTIMIZATION COMMISSIONING

A. Per Section 01 91 00.

END OF SECTION

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SECTION 40 61 93

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Input/output (IO) list showing the following types of points that interface with the process control system (PCS):
      a. Points that are hardwired into the PCS's programmable logic controller (PLC) or remote IO (RIO).
      b. Points that are interfaced to the PCS's PLC over communications link.
   2. The IO list does not include internal software points generated by the PCS's PLC and used solely within the PCS.

B. IO list:
   1. The PCS IO list (schedule) is located at the end of this Section as Attachment A.

1.02 RELATED SECTIONS:

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 40 61 13 – Process Control System General Provisions.
   2. Section 40 61 21 – Process Control System Testing.
   3. Section 40 67 00 – Control System Equipment Panels and Racks.

1.03 DEFINITIONS

A. Abbreviations: Section 40 61 13.

B. PCS IO List Column Headings:

Field or Heading	Description
IO Tag	A unique IO identifier which includes Facility Code, Area Code, ISA Prefix, Number, Suffix.
Description	Explanation of IO function.
P&ID	Piping & instrument diagram where IO is shown.
Panel	Panel where the IO module is located.
PLC / RIO	Processor or remote IO location.
Rack	Physical rack where IO is located.
Slot or Segment	Physical slot in the rack where IO is located.
Channel	Physical point in the slot where the IO is located.
IO Type	AI, DI, DO, AO, NW
Module/ Device Type	4-20 mA, Ethernet, 24 Vdc, etc.
Signal Type or Calibration Range	Performance data for IO action /scale of IO signal.
Wiring Diagram	Wiring diagram where IO is shown.
Control Strategy Number	Specification section where IO control function is provided.
Application Notes or Comments	Optional, as required for clarification.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the PCS IO list with the PCS's application programming for supervisory control and data acquisition (SCADA) and ensure all PCS IO is tested as specified in Section 40 61 21.

1.05 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Requirements: Sections 40 61 13 and 40 67 00.

B. Action Submittals:
   1. Submit PCS IO list under Section 40 67 00.

C. Informational Submittals:
   1. Provide a copy of the latest electronic version of the complete PCS IO list, at least monthly, when requested.

D. Closeout Submittals:
   1. Submit record PCS IO list (schedule) under Section 40 61 13.

1.06 QUALITY ASSURANCE

A. Maintain a copy of the complete PCS IO list with modifications during construction in Excel format that has heading filters to allow user to select different sorts.

PART 2 NOT USED

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Refer to Section 40 61 21.

3.02 NAVIGATION

A. The PCS IO list is organized based on the PLC/RIO, rack, slot, and channel.

END OF SECTION

SECTION 40 61 93_ PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

ATTACHMENT A

INPUT/OUTPUT LIST

Item	IO Tag	Description	P&ID	Panel	PLC / RIO	Rack	Slot or Segment	Channel	IO Type	Module/ Device Type	Signal Type or Calibration Range	Wiring Diagram	Control Strategy Number	Application Notes or Comments
1	2167-U05-YA-100	Grinder Pump Station General Alarm Pump 1	I-U05-101	2167-W01-SCA002	2167-W01-PLC002	0	3	0	DI1	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 7	See Section 33 32 16
2	2167-U05-YA-200	Grinder Pump Station General Alarm Pump 2	I-U05-101	2167-W01-SCA002	2167-W01-PLC002	0	3	1	DI1	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 7	See Section 33 32 16
3	2167-B02-YA-1101	Heat Trace Control Panel Remote Trouble Alarm	--	2167-W01-SCA002	2167-W01-PLC002	0	3	2	DI1	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 7	See Section 40 41 13.13
4	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	3	DI1	24 VDC	Dry Contact	I-W01-802	--	
5	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	4	DI1	24 VDC	Dry Contact	I-W01-802	--	
6	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	5	DI1	24 VDC	Dry Contact	I-W01-802	--	
7	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	6	DI1	24 VDC	Dry Contact	I-W01-802	--	
8	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	7	DI1	24 VDC	Dry Contact	I-W01-802	--	
9	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	8	DI1	24 VDC	Dry Contact	I-W01-802	--	
10	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	9	DI1	24 VDC	Dry Contact	I-W01-802	--	
11	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	10	DI1	24 VDC	Dry Contact	I-W01-802	--	
12	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	11	DI1	24 VDC	Dry Contact	I-W01-802	--	
13	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	12	DI1	24 VDC	Dry Contact	I-W01-802	--	
14	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	13	DI1	24 VDC	Dry Contact	I-W01-802	--	
15	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	14	DI1	24 VDC	Dry Contact	I-W01-802	--	
16	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	3	15	DI1	24 VDC	Dry Contact	I-W01-802	--	
17	2167-U04-YA101A	Rinse Water Pump Overload Alarm	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	4	0	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - PCD 202	
18	2167-U04-YL101A	Rinse Water Pump Auto Indication	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	4	1	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - PCD 202	
19	2167-U04-YL101A	Rinse Water Pump Running Status Indication	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	4	2	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - PCD 202	
20	2167-B02-ZS-131	Rest Room Door Open Status Indication	--	2167-W01-SCA002	2167-W01-PLC002	0	4	3	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
21	2167-B02-ZS-132	Maintenance Room Door Open Status Indication	--	2167-W01-SCA002	2167-W01-PLC002	0	4	4	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
22	2167-B02-ZS-133	Storage Room Door Open Status Indication	--	2167-W01-SCA002	2167-W01-PLC002	0	4	5	DI2	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	There are double doors which each have a intrusion switch.
23	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	6	DI2	24 VDC	Dry Contact	I-W01-802	--	
24	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	7	DI2	24 VDC	Dry Contact	I-W01-802	--	
25	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	8	DI2	24 VDC	Dry Contact	I-W01-802	--	
26	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	9	DI2	24 VDC	Dry Contact	I-W01-802	--	
27	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	10	DI2	24 VDC	Dry Contact	I-W01-802	--	
28	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	11	DI2	24 VDC	Dry Contact	I-W01-802	--	

Item	IO Tag	Description	P&ID	Panel	PLC / RIO	Rack	Slot or Segment	Channel	IO Type	Module/ Device Type	Signal Type or Calibration Range	Wiring Diagram	Control Strategy Number	Application Notes or Comments
29	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	12	DI2	24 VDC	Dry Contact	I-W01-802	--	
30	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	13	DI2	24 VDC	Dry Contact	I-W01-802	--	
31	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	14	DI2	24 VDC	Dry Contact	I-W01-802	--	
32	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	4	15	DI2	24 VDC	Dry Contact	I-W01-802	--	
33	2167-W01--	PLC Panel 120 Vac Power Available	--	2167-W01-SCA002	2167-W01-PLC002	0	5	0	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
34	2167-W01--	PLC Panel Intrusion	--	2167-W01-SCA002	2167-W01-PLC002	0	5	1	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
35	2167-W01--	PLC Panel 24 Vdc Power Available	--	2167-W01-SCA002	2167-W01-PLC002	0	5	2	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
36	2167-W01--	UPS on Battery (Buffering)	--	2167-W01-SCA002	2167-W01-PLC002	0	5	3	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
37	2167-W01--	UPS Alarm	--	2167-W01-SCA002	2167-W01-PLC002	0	5	4	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
38	2167-W01--	UPS Battery Low	--	2167-W01-SCA002	2167-W01-PLC002	0	5	5	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
39	2167-W01--	Network Switch Alarm	--	2167-W01-SCA002	2167-W01-PLC002	0	5	6	DI3	24 VDC	Dry Contact	I-W01-802	40 61 96 - Common Function 1, 7	
40	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	7	DI3	24 VDC	Dry Contact	I-W01-802	--	
41	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	8	DI3	24 VDC	Dry Contact	I-W01-802	--	
42	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	9	DI3	24 VDC	Dry Contact	I-W01-802	--	
43	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	10	DI3	24 VDC	Dry Contact	I-W01-802	--	
44	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	11	DI3	24 VDC	Dry Contact	I-W01-802	--	
45	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	12	DI3	24 VDC	Dry Contact	I-W01-802	--	
46	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	13	DI3	24 VDC	Dry Contact	I-W01-802	--	
47	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	14	DI3	24 VDC	Dry Contact	I-W01-802	--	
48	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	5	15	DI3	24 VDC	Dry Contact	I-W01-802	--	
49	2167-U04-HS-101	Rinse Water Pump Call Run Command	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	6	0	DO1	24 VDC	SPDT Relay	I-W01-802	40 61 96 - PCD 202	
50	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	1	DO1	24 VDC	SPDT Relay	I-W01-802	--	
51	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	2	DO1	24 VDC	SPDT Relay	I-W01-802	--	
52	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	3	DO1	24 VDC	SPDT Relay	I-W01-802	--	
53	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	4	DO1	24 VDC	SPDT Relay	I-W01-802	--	
54	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	5	DO1	24 VDC	SPDT Relay	I-W01-802	--	
55	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	6	DO1	24 VDC	SPDT Relay	I-W01-802	--	
56	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	6	7	DO1	24 VDC	SPDT Relay	I-W01-802	--	

Item	IO Tag	Description	P&ID	Panel	PLC / RIO	Rack	Slot or Segment	Channel	IO Type	Module/ Device Type	Signal Type or Calibration Range	Wiring Diagram	Control Strategy Number	Application Notes or Comments
57	2167-P01-FI0103	Pressure Vessels F0100 and F0200 Inlet Flow Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	7	0	AI1	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
58	2167-P01-PI0101	Pressure Vessel 0100 Pressure Indication	I-P01-102	2167-W01-SCA002	2167-W01-PLC002	0	7	1	AI1	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
59	2167-P01-PDI0102	Pressure Vessel 0100 Differential Pressure Indication	I-P01-102	2167-W01-SCA002	2167-W01-PLC002	0	7	2	AI1	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
60	2167-P01-PI0201	Pressure Vessel 0200 Pressure Indication	I-P01-102	2167-W01-SCA002	2167-W01-PLC002	0	7	3	AI1	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
61	2167-P01-PDI0202	Pressure Vessel 0200 Differential Pressure Indication	I-P01-102	2167-W01-SCA002	2167-W01-PLC002	0	7	4	AI1	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
62	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	7	5	AI1	4-20 mA	--	I-W01-803	--	
63	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	7	6	AI1	4-20 mA	--	I-W01-803	--	
64	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	7	7	AI1	4-20 mA	--	I-W01-803	--	
65	2167-P01-FI0303	Pressure Vessels F0300 and F0400 Inlet Flow Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	8	0	AI2	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
66	2167-P01-PI0301	Pressure Vessel 0300 Pressure Indication	I-P01-103	2167-W01-SCA002	2167-W01-PLC002	0	8	1	AI2	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
67	2167-P01-PDI0302	Pressure Vessel 0300 Differential Pressure Indication	I-P01-103	2167-W01-SCA002	2167-W01-PLC002	0	8	2	AI2	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
68	2167-P01-PI0401	Pressure Vessel 0400 Pressure Indication	I-P01-103	2167-W01-SCA002	2167-W01-PLC002	0	8	3	AI2	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
69	2167-P01-PDI0402	Pressure Vessel 0400 Differential Pressure Indication	I-P01-103	2167-W01-SCA002	2167-W01-PLC002	0	8	4	AI2	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
70	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	8	5	AI2	4-20 mA	--	I-W01-803	--	
71	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	8	6	AI2	4-20 mA	--	I-W01-803	--	
72	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	8	7	AI2	4-20 mA	--	I-W01-803	--	
73	2167-P01-FI0503	Pressure Vessels F0500 and F0600 Inlet Flow Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	9	0	AI3	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
74	2167-P01-PI0501	Pressure Vessel 0500 Pressure Indication	I-P01-104	2167-W01-SCA002	2167-W01-PLC002	0	9	1	AI3	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
75	2167-P01-PDI0502	Pressure Vessel 0500 Differential Pressure Indication	I-P01-104	2167-W01-SCA002	2167-W01-PLC002	0	9	2	AI3	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
76	2167-P01-PI0601	Pressure Vessel 0600 Pressure Indication	I-P01-104	2167-W01-SCA002	2167-W01-PLC002	0	9	3	AI3	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
77	2167-P01-PDI0602	Pressure Vessel 0600 Differential Pressure Indication	I-P01-104	2167-W01-SCA002	2167-W01-PLC002	0	9	4	AI3	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
78	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	9	5	AI3	4-20 mA	--	I-W01-803	--	
79	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	9	6	AI3	4-20 mA	--	I-W01-803	--	
80	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	9	7	AI3	4-20 mA	--	I-W01-803	--	
81	2167-P01-PI0002	PFAS Treatment Inlet Pressure Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	10	0	AI4	4-20mA		I-W01-803	40 61 96 - Common Function 2, 6	
82	2167-U04-FI102	Rinse Tank Discharge Flow Indication	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	10	1	AI4	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
83	2167-U05-FI-100	Grinder Pump Discharge Flow Indication	I-U05-101	2167-W01-SCA002	2167-W01-PLC002	0	10	2	AI4	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6	
84	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	10	3	AI4	4-20 mA	--	I-W01-803	--	

Item	IO Tag	Description	P&ID	Panel	PLC / RIO	Rack	Slot or Segment	Channel	IO Type	Module/ Device Type	Signal Type or Calibration Range	Wiring Diagram	Control Strategy Number	Application Notes or Comments
85	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	10	4	AI4	4-20 mA	--	I-W01-803	--	
86	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	10	5	AI4	4-20 mA	--	I-W01-803	--	
87	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	10	6	AI4	4-20 mA	--	I-W01-803	--	
88	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	10	7	AI4	4-20 mA	--	I-W01-803	--	
89	2167-P01-FI0012	Pressure Vessels Rinse Water Supply Flow Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	11	0	AI5	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
90	2167-P01-PI0011	Pressure Vessels Rinse Water Supply Pressure Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	0	11	1	AI5	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 201	
91	2167-P02-LI101	Rinse Water Tank Level Indication	I-P02-101	2167-W01-SCA002	2167-W01-PLC002	0	11	2	AI5	4-20 mA		I-W01-803	40 61 96 - Common Function 2, 6, PCD 202	
92	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	11	3	AI5	4-20 mA	--	I-W01-803	--	
93	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	11	4	AI5	4-20 mA	--	I-W01-803	--	
94	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	11	5	AI5	4-20 mA	--	I-W01-803	--	
95	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	11	6	AI5	4-20 mA	--	I-W01-803	--	
96	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	11	7	AI5	4-20 mA	--	I-W01-803	--	
97	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	12	0	AO1	4-20 mA	--	I-W01-803	--	
98	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	12	1	AO1	4-20 mA	--	I-W01-803	--	
99	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	12	2	AO1	4-20 mA	--	I-W01-803	--	
100	---	Spare	--	2167-W01-SCA002	2167-W01-PLC002	0	12	3	AO1	4-20 mA	--	I-W01-803	--	
101	2167-P01-NI0102	Pressure Vessels F0100 and F0200 Inlet Valve Remote Status Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
102	2167-P01-YA0102	Pressure Vessels F0100 and F0200 Inlet Valve Fault Alarm	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
103	2167-P01-ZIC0102	Pressure Vessels F0100 and F0200 Inlet Valve Closed Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
104	2167-P01-ZIO0102	Pressure Vessels F0100 and F0200 Inlet Valve Open Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
105	2167-P01-ZI102	Pressure Vessels F0100 and F0200 Inlet Valve Position Feedback Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
106	2167-P01-ZC0102	Pressure Vessels F0100 and F0200 Inlet Valve Position Command	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN1	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
107	2167-P01-NI0302	Pressure Vessels F0300 and F0400 Inlet Valve Remote Status Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
108	2167-P01-YA0302	Pressure Vessels F0300 and F0400 Inlet Valve Fault Alarm	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
109	2167-P01-ZIC0302	Pressure Vessels F0300 and F0400 Inlet Valve Closed Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
110	2167-P01-ZIO0302	Pressure Vessels F0300 and F0400 Inlet Valve Open Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
111	2167-P01-ZI0302	Pressure Vessels F0300 and F0400 Inlet Valve Position Feedback Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
112	2167-P01-ZC0302	Pressure Vessels F0300 and F0400 Inlet Valve Position Command	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN2	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	

Item	IO Tag	Description	P&ID	Panel	PLC / RIO	Rack	Slot or Segment	Channel	IO Type	Module/ Device Type	Signal Type or Calibration Range	Wiring Diagram	Control Strategy Number	Application Notes or Comments
113	2167-P01-NI0502	Pressure Vessels F0500 and F0600 Inlet Valve Remote Status Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
114	2167-P01-YA0502	Pressure Vessels F0500 and F0600 Inlet Valve Fault Alarm	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
115	2167-P01-ZIC0502	Pressure Vessels F0500 and F0600 Inlet Valve Closed Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
116	2167-P01-ZIO0502	Pressure Vessels F0500 and F0600 Inlet Valve Open Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
117	2167-P01-ZI0502	Pressure Vessels F0500 and F0600 Inlet Valve Position Feedback Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
118	2167-P01-ZC0502	Pressure Vessels F0500 and F0600 Inlet Valve Position Command	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN3	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
119	2167-P01-NI0010	Pressure Vessels Rinse Water Supply Valve Remote Status Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
120	2167-P01-YA0010	Pressure Vessels Rinse Water Supply Valve Fault Alarm	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
121	2167-P01-ZIC0010	Pressure Vessels Rinse Water Supply Valve Closed Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
122	2167-P01-ZIO0010	Pressure Vessels Rinse Water Supply Valve Open Position Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Bit	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
123	2167-P01-ZI0010	Pressure Vessels Rinse Water Supply Valve Position Feedback Indication	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	
124	2167-P01-ZC0010	Pressure Vessels Rinse Water Supply Valve Position Command	I-P01-101	2167-W01-SCA002	2167-W01-PLC002	--	--	--	Integer	PN4	Data Link	I-000-301	40 61 96 - PCD 101, PCD 201	

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the process control descriptions for automation through PLC, OIT and SCADA HMI. The automation includes sequential steps, interlock control functions, discrete control functions, analog control functions, alarms and event logging with control functions programmed in the PLC with the OIT and SCADA HMI performing the supervisory functions.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Programming: Refer to Section 40 61 13.

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this section prevail.
   1. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/ISA 5.06.01	Functional Requirements Documentation for Control Software
ANSI/ISA 101.01	Human Machine Interfaces for Process Automation

1.04 DEFINITIONS

A. Per ANSI/ISA 5.06.01:
   1. Analog Input (AI): A modulated signal received by the control system from an external device, such as a 4-20 mA or fieldbus signal from a pressure transmitter.
   2. Analog Output (AO): A modulated signal sent by the control system to an external control device, such as a 4-20 mA or fieldbus signal to a flow control valve.
   3. Discrete Input (DI): A binary signal received by the control system from an external switch, such as a 24-Vdc or fieldbus signal from a block valve's closed limit switch.

4. Discrete Output (DO): A binary signal sent by the control system to an external on/off device, such as a 120-Vac or fieldbus signal to start a pump.
5. Operation: A major programmed processing action or set of related actions normally consisting of one or more phases.
6. Piping and Instrumentation Diagram (P&ID): A diagram showing the interconnection of process equipment and instrumentation used to control a process,
7. Process Flow Diagram (PFD): A diagram showing outlines of one or more pieces of equipment and the expected flow paths for materials and utilities.
8. Phase: The smallest element of procedural control that can accomplish a process-oriented task. A phase may be comprised of steps.
9. Step: Sequential action of control devices within a phase.

B. Per ANSI/ISA 101.01:
1. Control System: A system that responds to input signals from the equipment under control and/or from an operator and generates output signals that cause the equipment under control to operate in the desired manner.
2. Operator Interface Terminal (OIT): The collection of hardware and software used by the operator or other users to monitor and interact with the control system and with the process via the control system.
3. Supervisory Control and Data Acquisition (SCADA): A system for monitoring and control of process which are geographically widespread. This includes all equipment and functions for acquiring, processing, transmitting, and displaying the necessary process information.
4. For the purposes of this section, "Existing" refers to those structures, devices, or items of equipment which were a part of the process system prior to the work done under this Contract.

1.05 ADMINISTRATIVE REQUIREMENTS

A. The process control descriptions are not intended to apportion work or responsibility for work among subcontractors, suppliers and manufacturers, but are offered as a guide for testing programming, startup, and checkout. The process control descriptions describe how the system is to operate, and do not necessarily include every component required to make the system function.

B. Coordinate with the Owner as specified in Section 40 61 13 for PLC, OIT and SCADA HMI testing and commissioning.

1.06 SUBMITTALS

A. Procedures:
1. Section 01 33 00.

B. Action Submittals:
1. Conformance with specification per Section 40 61 13.

C. Closeout Submittals:
1. Provide process control descriptions as record included in testing per Section 01 91 00.

PART 2 NOT USED

PART 3 EXECUTION

3.01 GENERAL

A. Common function descriptions associated with process control IO and shall be included in Section 40 61 21 testing requirements:

Common Function Number	Title
1	Discrete Point Status
2	Analog Point Status
3	General Ready, Running and Failure Status
4	SCADA Inputs and Outputs Distribution and Control Requirements
5	General Process Control Function (Analog) System
6	Trend Plots
7	Discrete Alarm System
8	Discrete Status System

B. System functional and operational descriptions associated with process control IO and shall be included in Section 40 61 21 testing requirements:

Process Control Description Number	Title
PCD 101	Process Control Description 101 – Booster Pumps
PCD 102	Process Control Description 102 - Motor Operated Valves (Open/Close)
PCD 103	Process Control Description 103 – Motor Operated Valves (Modulating)
PCD 201	Process Control Description 201 – Pressure Vessels
PCD 202	Process Control Description 202 – Rinse Water Tank

3.02 COMMON FUNCTIONS

A. Common Function 1 – Discrete Point Status:
   1. Description:
      a. The status of each discrete input point shall be maintained in the SCADA system database. The status of each logical discrete point shall also be maintained in the SCADA system database. Logical points are points which depend upon the status of one or several discrete input points.
      b. For example, an equipment-ready logical status shall result from an AUTO status and no associated alarms.
   2. SCADA:
      a. Calculate and maintain the status of all discrete and logical discrete status points in the SCADA system database.

B. Common Function 2 – Analog Point Status:
   1. Analog input points shall be checked for the following status conditions:
      a. Failed: Point value is less than or greater than the specified value range, typically less than 3.6 mA and greater than 21.6 mA.

b. Low Low Aalrm: Point value is equal to or less than a predetermined alarm value.
c. Low Alarm: Point value is equal to or less than a predetermined alarm value.
d. High Alarm: Point value is equal to or greater than a predetermined alarm value.
e. High High Alarm: Point value is equal to or greater than a predetermined alarm value.
f. Normal: Point value is within the predetermined low and high alarm values.

2. An analog point which is in alarm status shall not be changed to normal status until the point value changes by the predetermined deadband value for the point.
3. SCADA:
   a. Failed, high high alarm, high alarm, low alarm, low low alarm, deadband, and time delay values shall be maintained in the SCADA system database. These limits may be changed and shall be determined during commissioning.
   b. Point status shall be maintained in the SCADA system database. Discrete alarm outputs shall be driven from the point status.

C. Common Function 3 – General Ready, Running and Failure Status:
1. Each motor-driven piece of equipment shall have a ON/OFF OR OPEN/CLOSE/TRAVEL status input to the SCADA system. If the equipment is equipped with one or more HAND-OFF-AUTO switches, the equipment shall have an input for AUTO status. If a "RUNNING" input status occurs and the "AUTO" status does not occur, the SCADA system shall identify that the motor is operating in the HAND mode.
2. The run time shall be calculated and stored for all equipment being monitored. This function shall be equivalent to a conventional elapsed time meter to include the tenth of an hour digit and shall include: Today's Total and Yesterday's total and Cumulative Total.
3. The failure of driven equipment shall be monitored by the SCADA system. Equipment shall be considered failed under the following conditions:
   a. The equipment is in AUTO and the SCADA system attempts to operate the equipment and it does not respond within a defined time period.
   b. The equipment is in AUTO and running and for whatever reason other than the SCADA system requesting the equipment to "STOP," the equipment stops.
4. In addition, specific equipment is required to provide "Trouble", "Fault", or other specific alarm inputs to the SCADA system. This input shall be added to the internal logic described in items a and b above so that any one of these events shall trigger a "FAIL" alarm.
5. The SCADA system shall be used to the extent that it shall facilitate sequencing of the equipment. The plant operator shall be able to bypass the sequencing and START/STOP the equipment and OPEN/CLOSE valves and gates on a "SCADA MANUAL" procedure. Interface to the SCADA system shall be through IO points or network connections or operator interface stations.

D. Common Function 4 - SCADA Inputs and Outputs Distribution and Control Requirements:
1. IO assignment shall be per Section 40 61 93.
2. Upon failure of a process equipment unit, the SCADA system shall start the next available unit, as described in the applicable process control description.

3. Upon failure of a PLC input/output module, SCADA system shall skip equipment controlled by PLC input/output module and go to next process unit in the lead-lag sequence.
4. For example, two pumps' input/outputs shall be equally distributed to two different IO modules. If three pumps are required and only two input modules and two output modules are available, then as a minimum, two pumps shall be assigned to one set of input/output modules while the third pump shall be assigned to the second set of input/output modules.
5. Note that "pumps" are used to describe the IO distribution requirements. The concept shall be extended to all process equipment including, valves, gates, instruments for level, flow, pressure, etc.
6. Failures shall be tested during commissioning to validate the above process equipment operation.

E. Common Function 5 - General Process Control Function (Analog) System:
1. All analog control functions shall be provided as required and shall include but not be limited to the following:
    a. Proportional-Integral-Derivative (PID) Control--Standard controller functions with balance less, bumpless transfer from manual to automatic, manual overrides, external reset and output summing capabilities. Provision for cascade, rationing gain, bias, lead-lag, dead-time, feed forward, and feedback control shall be available.
    b. OIT/SCADA HMI display system shall have a common PID controller operator interface for all equipment utilizing PID control. Controller operator interface shall include alphanumeric and graphic indication of the following features as a minimum:
        1) ID of controlled equipment
        2) ID of process variable input
        3) Controller setpoint value
        4) Process variable value
        5) Controller output value
        6) Setpoint adjustment interface
        7) Indication if setpoint is under local or remote control
        8) Local/Manual control output adjustment interface
        9) Indication if control output is under local/manual control or under control of process controller
2. Computational Functions: On-line mathematical functions shall be available to provide real-time computational capability of control variables for use in feed forward and other advanced control functions.
3. All setpoints for alarm and control shall be adjustable from OIT/SCADA HMI Computer screens. PID tuning shall occur during testing and commissioning.

F. Common Function 6 - Trend Plots:
   1. OITs/SCADA HMI shall graphically plot trends of process variables (pressure, flow, temperature, level and analytical), controller setpoints and outputs, and equipment status (speed and motor current) in real-time and from historical data. The operator shall be able to select the plotting interval, within the limits of the actual data collection.
   2. In addition to the plotted data, a trend shall include:
      a. Time
      b. Date
      c. Tag number
      d. Plotting interval
      e. Time at start
      f. Time at latest value
   3. Trend plots shall be used throughout commissioning to monitor control performance.

G. Common Function 7 - Discrete Alarm System:
   1. All discrete input alarms shall be displayed on OIT/SCADA HMI screens as required by the drawings and specifications regardless of whether or not specific process control descriptions are provided. Discrete input alarms can be from field instruments (level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and vendor packaged systems. A manual reset from SCADA is acceptable. Time delays shall be provided to avoid a nuisance alarm; default at 5 seconds and adjust during field testing.
   2. On a power failure, equipment shall return to the ready state when power is returned. Given the process condition, the lead piece of equipment shall start if called for. The lag and lag-lag, etc., starting sequence shall be staggered at 15-second intervals (adjustable) depending on the process. Time values shall be determined time during commissioning.

H. Common Function 8 - Discrete Status System:
   1. All discrete input status shall be displayed on OIT/SCADA HMI screens as required by the drawings and specifications regardless of whether or not specific process control descriptions are provided. Each discrete input shall be shown in its appropriate process screen and/or equipment status screen. Discrete inputs can be originated from field instruments (motorized actuators, HVAC related air handling units, power management related contact inputs, level switches, pressure switches, etc.), local control panels (relay outputs, alarm module outputs, switches), and vendor packaged systems.
   2. All equipment HOA selector switch Auto mode status contact is to be monitored by the PLC. When the HOA switch is not in the Auto mode the SCADA system shall display “Local” for that respective piece of equipment.

3.03 PROCESS CONTROL DESCRIPTION 101 – BOOSTER PUMPS

A. Description: The two existing booster VFD driven pumps shall undergo bowl assembly replacements in accordance with Section 43 23 62. An interlock is being added to the booster pump operation so that both pumps cannot operate if a pair of GAC vessels is offline.

B. Basic process control is provided as a reference, and additional features may also be present which are not documented herein.

C. SCADA Annunciation:
   1. The SCADA system shall annunciate the following alarm conditions for each pump as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
      a. VFD Fault
      b. Motor Winding Temperature High
      c. Start and Stop Fail
         1) If the pump running status is not equal to the Call to Run Command, within adjustable fail timers, the pump alarms "Failed."

D. Field Control and SCADA Control:
   1. Local Manual Control:
      a. The Hand-Off-Auto (HOA) switch and speed potentiometer (SC) for the booster pump is located on a variable frequency drive (VFD) near the booster pump where it is easily accessible by operations.
         1) When in Hand, pump starts, and percent speed is set with speed potentiometer.
   2. Local Auto Control:
      a. Not applicable
   3. SCADA Manual Control:
      a. When the HOA switch for the pump is in Auto and the pump operation mode is set to Manual on OIT/SCADA HMI screens, the pump is controlled by SCADA.
      b. The percent speed is set by Operations on OIT/SCADA HMI screens.
   4. SCADA Auto Control:
      a. When the HOA switch for the pump is in Auto and the pump operation mode is set to Auto on OIT/SCADA HMI screens, the pump is controlled by SCADA.
      b. Pumps operate in lead/lag sequence, starting and stopping based on clearwell level set points and speed percent set points.

E. Monitoring and Control:
   1. The SCADA system shall provide monitoring and/or control of the following conditions for each pump as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
      a. Booster Pump Field HOA – Monitoring
      b. Booster Pump Running – Monitoring
      c. Booster Pump HMI Auto/Manual Selection – Control and Monitoring
      d. Booster Pump Lead Selection – Control and Monitoring
      e. Booster Pump Speed - Control and Monitoring
      f. Booster Pump Amps - Monitoring
      g. Lead Auto Alternate Enable/Disable Selection– Control and Monitoring

h. Booster Sequence
    1) Start/Stop Level Set Points - Control and Monitoring
    2) Maximum/Minimum Speed Level - Control and Monitoring
    3) Maximum/Minimum Speed - Control and Monitoring
2. Each pump is controlled and monitored with the following hardwired signals:
    a. Call to Run Command
    b. Speed Command
    c. Running Status
    d. Speed Feedback
    e. HOA Field In Auto
    f. VFD Fault
    g. Motor Winding Temperature High

F. Interlocks and Permissives:
1. VFD Fault shuts down pump when activated under both Local and SCADA control.
2. Motor Winding Temperature High shuts down pump when activated under both Local and SCADA control.
3. If FCV0102, FCV0302, or FCV0502 are CLOSED, only one booster pump may operate.

3.04 PROCESS CONTROL DESCRIPTION 102 - MOTOR OPERATED VALVES (OPEN/CLOSE)

A. Not used.

3.05 PROCESS CONTROL DESCRIPTION 103 - MOTOR OPERATED VALVES (MODULATING)

A. Description:
1. A number of valves on the project are modulating control valves with Profinet data links to the PLC/OIT/SCADA HMI. These valves throttle between a valve of 0% (fully closed) and 100% (fully open).

B. SCADA Annunciation:
1. The SCADA system shall annunciate the following alarm conditions for each valve as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
    a. Fault – Read via Profinet data link along with the fault code description.
    b. Position Failed
        1) If the valve Position Feedback is not equal to the Position Command, with a 1% dead band and 10 second debounce time, the valve alarms “Position Failed.”
    c. Profinet data link loss.

C. Field Control and SCADA Control:
   1. Local Manual Control:
      a. The Local-Off-Remote (LOR) switch for the valve is integral or located on a hand station (HK) near the valve where it is easily accessible by operations.
      b. When in Local, the position of the valve can be changed using the Open/Stop/Close (OSC) switch, which is also either integral or located on the HK
   2. Local Auto Control:
      a. Not applicable
   3. SCADA Manual Control:
      a. When the LOR switch for the valve is in Remote and the valve operation mode is set to Manual on OIT/SCADA HMI screens, the valve is controlled by SCADA.
      b. The percent open is set by Operations on OIT/SCADA HMI screens.
   4. SCADA Auto Control:
      a. When the LOR switch for the valve is in Remote and the valve operation mode is set to Auto on OIT/SCADA HMI screens, the valve is controlled by SCADA.
      b. A control loop or valve sequence program controls the valve percent open as described in Process Control Description 201.

D. Monitoring and Control:
   1. Each control valve is controlled and monitored with the following Profinet data read/wrote signals between valve and PLC on OIT/SCADA HMI screens:
      a. Position Command – Monitoring and control
      b. Position Feedback – Monitoring
      c. LOR In Remote – Monitoring

E. Interlocks and Permissives:
   1. On power loss, the motor operated valve stays in last position until on normal power or standby power from the generator is present. Allow SCADA control to handle the transfer time for the power to return back to positioning the motor operated valve.
   2. Additionally, interlocks and permissives are described in Process Control Description 201 for operation associated with the pressure vessels' motor operated valves.

3.06 PROCESS CONTROL DESCRIPTION 201 - PRESSURE VESSELS

A. Vessels and Instrument List:

Equipment Number	Description
P01-F0100	Pressure Vessel 0100 (Train 1)
P01-F0200	Pressure Vessel 0200 (Train 1)
P01-F0300	Pressure Vessel 0300 (Train 2)
P01-F0400	Pressure Vessel 0400 (Train 2)
P01-F0500	Pressure Vessel 0500 (Train 3)
P01-F0600	Pressure Vessel 0600 (Train 3)
P01-FE/FIT0012	Rinse Water Supply Flow Meter and Indicating Transmitter
P01-FE/FIT0103	F0100 and F0200 Flow Meter and Indicating Transmitter (Train 1 Raw Water Inlet Flow)
P01-FE/FIT0303	F0300 and F0400 Flow Meter and Indicating Transmitter (Train 2 Raw Water Inlet Flow))
P01-FE/FIT0503	F0500 and F0600 Flow Meter and Indicating Transmitter (Train 3 Raw Water Inlet Flow)

Equipment Number	Description
P01-PIT0101	F0100 Pressure Indicating Transmitter
P01-PDIT0102	F0100 Pressure Differential Indicating Transmitter
P01-PIT0201	F0200 Pressure Indicating Transmitter
P01-PDIT0202	F0200 Pressure Differential Indicating Transmitter
P01-PIT0301	F0300 Pressure Indicating Transmitter
P01-PDIT0302	F0300 Pressure Differential Indicating Transmitter
P01-PIT0401	F0400 Pressure Indicating Transmitter
P01-PDIT0402	F0400 Pressure Differential Indicating Transmitter
P01-PIT0501	F0500 Pressure Indicating Transmitter
P01-PDIT0502	F0500 Pressure Differential Indicating Transmitter
P01-PIT0601	F0600 Pressure Indicating Transmitter
P01-PDIT0602	F0600 Pressure Differential Indicating Transmitter

B. Automated Valve List:

Valve Number	Description
P01-FCV0102	F0100 and F0200 Flow Control Valve (Train 1 Raw Water Inlet)
P01-FCV0302	F0300 and F0400 Flow Control Valve (Train 2 Raw Water Inlet)
P01-FCV0502	F0500 and F0600 Flow Control Valve (Train 3 Raw Water Inlet)
P01-FCV0010	Rinse Water Supply Flow Control Valve

C. Description:
   1. The water treatment plant includes three trains of media vessels, with two pressure vessels per train with pressure and differential pressure instruments used for PFAS treatment.
   2. The train's two pressure vessels have four operating modes selectable for each train:
      a. Filter-to-Distribution
      b. Full Media Backwash
      c. Media Fluff
      d. Filter-to-Waste
   3. The level of automation for each train operating mode varies in the PLC logic and each operating mode does require operator intervention to physically open and close non-motorized hand valves located at the pressure vessels' manifold.

D. SCADA Annunciation:
   1. The SCADA system shall annunciate the following alarm conditions as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
      a. Train's Vessel Differential Pressure Alarms per common function 2:
         1) Failed
         2) High Alarm at 8 psi.
         3) High-High Alarm at 10 psi. Alert at OIT/SCADA HMI for operator to backwash.
      b. Automated Flow Control Valves – See Process Control Description 103 for SCADA annunciation.

E. Field Control and SCADA Control:
    1. Local Manual Control:
        a. Automated Flow Control Valves – See Process Control Description 103 for local manual control.
    2. Local Auto Control:
        a. Not applicable
    3. SCADA Manual Control:
        a. Automated Flow Control Valves – See Process Control Description 103 for SCADA manual control. Normally the flow control valves are operated under SCADA Auto Control.
    4. SCADA Auto Control:
        a. Operator can enter for each train's pressure vessels, IN Service (InS) or OUT of Service (OoS) on OIT/SCADA HMI screen. For a train with at least one pressure vessel not OoS, the operator selects a train operating mode on OIT/SCADA HMI screen.
            1) Filter-to-Distribution
            2) Full Media Backwash
            3) Media Fluff
            4) Filter-to-Waste
        b. A train can only be assigned to one operating mode, and each train can have different operating modes.
        c. The trains' raw water inlet flow control valves are initially set to closed position. The train's raw water inlet flow control valve remains in closed position if both of the train's pressure vessels are OoS. The train's valve control is enabled to move when the train has at least one pressure vessel not OoS and has an assigned operating mode. Refer to the operating modes for information on auto positioning of these valves.
        d. The trains' backwash flow control valve (P01-FCV0010) is set to closed position. The trains' backwash flow control valve is enabled to move when the train has at least one pressure vessel not OoS and has an assigned operating mode of "Full Media Backwash" or "Media Fluff". Refer to the operating modes for information on auto positioning of this valve.
        e. Filter-to-Distribution:
            1) General: Filter-to-Distribution is the normal operating mode for trains 1, 2, and 3 where raw water flows through the train's two pressure vessels in a downward flow pattern with a lead-lag flow path.
            2) For a train with both vessels not OoS, the operator selects a lead and lag vessel assignment on OIT/SCADA HMI screen. Or the operator can also use only one IN Service vessel for this operating mode if the train has the other pressure vessel OoS.
            3) The hand valves required positions are displayed on OIT/SCADA HMI screen for the filter-to-distribution mode. Operator shall confirm hand valve positions match on OIT/SCADA HMI screen. See Table 3.06A for the hand valve positions required that the operator would verify/set in the field.

Table 3.06A: Filter-to-Distribution (F-T-D) Hand Valve Positions

Vessel ID	Vessel Valve ID	Vessel A = Lead Vessel B = Lag	Vessel A = InS Vessel B = OoS (1)	Vessel A = Lag Vessel B = Lead	Vessel A = OoS (1) Vessel B = InS
Vessel A P01-F0X00	P01-BFV0X01	Closed	Closed	Closed	Closed
	P01-BFV0X02	Closed	Open	Open	Closed
	P01-BFV0X03	Open	Closed	Closed	Closed
	P01-BFV0X04	Open	Open	Closed	Closed
	P01-BFV0X05	Closed	Closed	Closed	Closed
	P01-BFV0X06	Open	Open	Open	Closed
Vessel B P01-F0Y00	P01-BFV0Y01	Closed	Closed	Closed	Closed
	P01-BFV0Y02	Open	Closed	Closed	Open
	P01-BFV0Y03	Closed	Closed	Open	Closed
	P01-BFV0Y04	Closed	Closed	Open	Open
	P01-BFV0Y05	Closed	Closed	Closed	Closed
	P01-BFV0Y06	Open	Closed	Open	Open

		Train 1	Train 2	Train 3
Where	X is based on Train's Vessel A	1	3	5
	Y is based on Train's Vessel B	2	4	6
	InS = In Service and OoS = Out of Service (1) Can be set OoS for Pressure Vessel Carbon Transfer			

4) When Filter-to-Distribution mode arrangement is confirmed on OIT/SCADA HMI screens, the PLC logic equally splits the flow measured by P01-FE/FIT0103, 0303, and 0503 by modulating the OPEN flow control valves P01-FCV0102, 0302, and 0502 as appropriate when the train's flow control valve is set in SCADA Auto control. If a FCV is CLOSED for Backwash, then FCV remains closed and other two FCVs modulate.

f. Full Media Backwash:

1) General: When backwashing, the distribution water is sent in an upward direction from the bottom to the top of the pressure vessel for the following reasons:

a) New media is placed. Backwash serves to remove media fines for proper Filter-to-Distribution operation.

b) Differential pressure in the lead vessel hits 10 psi (operator adjustable value).

c) Differential pressure in the lag vessel hits 5 psi (operator adjustable value).

2) Backwash operation is anticipated to be very infrequent. New media replacement is estimated at 4 to 5 years. Backwash for headloss accumulation is anticipated to occur after multiple months to several years.

3) The operator selects which train to Backwash at SCADA. SCADA displays the position of the hand valves required for the selected train to backwash. The operator will have to manually reposition all valves in the manifold between the train's two vessels. Operator shall confirm hand valve positions match at SCADA. See Table 3.06B for the hand valve positions required.
   a) SCADA calculates volume available in rinse water tank based on the geometry of the rinse water tank cylinder with sloped bottom and the current level measurement from P02-LIT101.
   b) SCADA calculates the backwash volume required based on tables 3.06C or 3.06D for backwash stage flow in gpm and stage time duration in minutes.
   c) If the backwash volume exceeds the rinse water tank volume available, then alert at OIT/SCADA HMI screens and do not initiate Backwash mode. Until the backwash volume is less than or equal to the rinse water tank volume available.

Table 3.06B: Backwash Hand Valve Positions

Vessel ID	Vessel Valve ID	Vessel A = Backwash Vessel B = OoS	Vessel A = OoS Vessel B = Backwash	Vessel A = InS Vessel B = Backwash	Vessel A = Backwash Vessel B = InS
Vessel A P01-F0X00	P01-BFV0X01	Open	Closed	Closed	Open
	P01-BFV0X02	Closed	Closed	Open	Closed
	P01-BFV0X03	Closed	Closed	Closed	Closed
	P01-BFV0X04	Closed	Closed	Open	Closed
	P01-BFV0X05	Open	Closed	Closed	Open
	P01-BFV0X06	Open	Closed	Open	Open
Vessel B P01-F0Y00	P01-BFV0Y01	Closed	Open	Open	Closed
	P01-BFV0Y02	Closed	Closed	Closed	Open
	P01-BFV0Y03	Closed	Closed	Closed	Closed
	P01-BFV0Y04	Closed	Closed	Closed	Open
	P01-BFV0Y05	Closed	Open	Open	Closed
	P01-BFV0Y06	Closed	Open	Open	Open

		Train 1	Train 2	Train 3
Where	X is based on Train's Vessel A	1	3	5
	Y is based on Train's Vessel B	2	4	6
	InS = In Service (i.e. Vessel in F-T-D) and OoS = Out of Service			

4) When the Backwash valve arrangement is confirmed, the PLC logic:
   a) Allows only one train to be backwashed at a time, so only one raw water inlet flow control valve can be CLOSED at a time. Only one pressure vessel to backwash at a time.

b) Operator initiates the selected train to Backwash.

c) All three existing well pumps cannot operate when backwash is initiated.

(1) If Well Pumps 1, 2, and 3 (W01-PMP100, W02-PMP100, and W03-PMP100) are all operating, Well Pump of lowest priority is shut down. Window to pop-up for operator confirmation.

d) Corresponding P01-FCV0102, P01-FCV0302, or P01-FCV0502 CLOSES based on the train to BACKWASH.

e) Once a backwash is initiated, the backwash sequence shall be carried out automatically through the PLC. Rinse water supply valve FCV0010 opens. The valve continues to open until the target flow rate is measured through the rinse water supply flow meter P01-FE/FIT0012. Table 3.06C below details default backwash sequence based on 12-foot diameter vessels. The programmed flow rates can be changed by an operator at SCADA and the operator can view the backwash stages as the sequence progresses at SCADA.

f) Once a backwash sequence is completed, the operator can select a new operating mode at SCADA.

Table 3.06C: Full Media Backwash Stages

Backwash Stage	Backwash Rate (gpm/ft^2)	Rinse Water Supply Flow (gpm)	Duration (min)
1	5	565	2
2	6.5	735	2
3	7.5	847	2
4	10	1,130	30
5	7.5	847	2
6	6.5	735	2
7	5	565	2

g. Media Fluff:

1) General: When performing a media fluff, the distribution water is sent in an upward direction from the bottom to the top of the pressure vessel for the following reasons:

a) Differential pressure in the lead vessel hits 5 psi (operator adjustable value).

b) A period of three to six months of vessel operation has passed without a fluff (operator adjustable value).

2) Media fluffing is anticipated to be infrequent. This mode of operation is an operator tool that can be tested and tried out.

3) The operator selects which train to fluff at SCADA. SCADA displays the position of the hand valves required for the selected train to fluff. The operator will have to manually reposition all valves in the manifold between the train's two vessels. Operator shall confirm hand valve positions match at SCADA. See Table 3.06B for the hand valve positions required.

4) When the Media fluff valve arrangement is confirmed, the PLC logic:

a) Allows only one train to be fluffed at a time, so only one flow control valve can be CLOSED at a time. Allow only one vessel to fluff at a time.

b) Operator initiates the selected train to fluff.

c) All three existing well pumps cannot operate when media fluff is initiated.

(1) If Well Pumps 1, 2, and 3 (W01-PMP100, W02-PMP100, and W03-PMP100) are all operating, Well Pump of lowest priority is shut down. Window to pop-up for operator confirmation.

d) Corresponding P01-FCV0102, P01-FCV0302, or P01-FCV0502 CLOSES based on the train to fluff.

e) Once a media fluff is initiated, the fluff sequence shall be carried out automatically through the PLC. Rinse water supply valve P01-FCV0010 opens. The valve continues to open until the target flow rate is measured through the rinse water supply flow meter P01-FE/FIT0012. Table 3.06D details the default media fluff sequence based on 12-foot diameter vessels. The programmed flow rates can be changed by an operator at SCADA and the operator can view the media fluff stages as the sequence progresses at SCADA.

Table 3.06D: Media Fluff Stages

Fluff Stage	Backwash Rate (gpm/ft^2)	Rinse Water Supply Flow (gpm)	Duration (min)
1	5	565	2
2	6.5	735	2
3	5	565	2

h. Filter-to-Waste:

1) Operators shall place vessels into filter-to-waste mode. First, the influent control valve to the pertinent filter train shall be manually closed. Then, the hand valves on the vessel manifold shall be adjusted such that water pumped from the booster pumps can flow downward through the vessel and proceed to the rinse water tank. Once the hand valves are placed in the correct positions, the vessel can be placed into filter-to-waste mode via the OIT/SCADA HMI screen. Similar to a train in Filter-to-Distribution mode, flow from the booster pumps will be split amongst P01-FE/FIT0103, 0303, and 0503 by modulating the OPEN flow control valves P01-FCV0102, 0302, and 0502 when the train's flow control valve is set in SCADA Auto control. Operator may set desired flow value for P01-FCV0102, 0302, and 0502. Doing so will open the influent control valve to the train and route water to the rinse water tank. Valve positions to place each vessel into filter-to-waste mode are summarized in the Table 3.06E below.

Table 3.06E: Filter-to-Waste (F-T-W) Hand Valve Positions

Vessel ID	Vessel Valve ID	Vessel A = F-T-W Vessel B = OoS	Vessel A = OoS Vessel B = F-T-W
Vessel A P01-F0X00	P01-BFV0X01	Closed	Closed
	P01-BFV0X02	Closed	Closed
	P01-BFV0X03	Open	Closed
	P01-BFV0X04	Open	Closed
	P01-BFV0X05	Closed	Open
	P01-BFV0X06	Open	Closed
Vessel B P01-F0Y00	P01-BFV0Y01	Closed	Closed
	P01-BFV0Y02	Closed	Closed
	P01-BFV0Y03	Closed	Open
	P01-BFV0Y04	Closed	Open
	P01-BFV0Y05	Open	Closed
	P01-BFV0Y06	Closed	Open

		Train 1	Train 2	Train 3
Where	X is based on Train's Vessel A	1	3	5
	Y is based on Train's Vessel B	2	4	6
	InS = In Service and OoS = Out of Service			

5. Operator selects when filter-to-waste ends and what the next mode of operation will be (i.e., Filter-to-Distribution). Next, all hand valves on the filter manifold shall be readjusted to allow water to be pumped from the booster pumps through the vessel before proceeding to distribution. The vessel may then be placed back in service via the OIT/SCADA HMI screen.

F. Monitoring and Control:
   1. The SCADA system shall provide monitoring and/or control of the following conditions as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
      a. Train's in and out of service selection – Control and Monitoring
      b. Train's pressure vessels operating mode selections and associated valve position required - Control and Monitoring
      c. Train's lead – lag arrangement for vessel A and B and associated hand valve position required – Control and Monitoring
      d. Backwash count down based on Train's last backwash initiation – Monitoring
      e. The flow to each train, totalized flow to each train and bed volumes calculated by the PLC system - Monitoring
         1) Bed volume for each vessel is calculated based on:
            a) Bed Volume = totalized flow per vessel pair in gallons (P01-FE/FIT0103, 0303, or 0503)/10,247 gal

2) When media in a vessel is changed, the operator manually reset the total flow value for specific vessel.

G. Interlocks and Permissives:
1. If any of P01-FCV0102, P01-FCV0302, and P01-FCV0502 are CLOSED, booster pump maximum flow cannot exceed 2,200 gpm.
2. Filter-to-waste and Full Backwash or Media Fluff cannot occur at the same time.

3.07 PROCESS CONTROL DESCRIPTION 202 - RINSE WATER TANK

A. Equipment List:

Equipment Number	Description
P02-TNK100	Rinse Water Tank
P02-LIT101	Rinse Water Tank Level Indicating Transmitter
B02-PSL003	Rinse Water Pump Inlet Pressure Switch Low
B02-PMP101	Rinse Water Pump
B02-FE/FIT102	Rinse Water Tank Effluent Flowmeter and Indicating Transmitter

B. Description:
1. The rinse water tank collects spent backwash water (rinse water discharge) and water that flows through the vessels during a filter-to-waste event. A level indicating transmitter is installed to continuously monitor the water level in the tank. An inline pump and flow meter are installed downstream of the tank to discharge the rinse water passing through the floating decanter to the sewer.
2. A Vactor truck connection is installed directly on the bottom of the rinse water tank.

C. SCADA Annunciation:
1. The SCADA system shall annunciate the following alarm conditions as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
   a. Overload
   b. Pump Start Failed and Stop Failed per common function 3.
   c. Rinse Tank Level Alarms per common function 2:
      1) Failed
      2) Low Level at 2.0 feet – used in SCADA Auto to turn off the rinse water pump, B02-PMP100.
      3) Low-Low alarm at 0.75 feet – not used if the rinse water tank is placed OoS.
      4) High Level at 18 feet - used in SCADA Auto to turn on the rinse water pump, B02-PMP100 when filter-to-wasting is active.
      5) High-High Alarm at 22 feet.
   d. Pump running without flow being detected using B02-FIT102.

D. Field Control and SCADA Control:
1. Local Manual Control:
   a. The Hand-Off-Auto (HOA) switch for the pump located on the motor starter panel.
      1) When in Hand, the pump runs. When in Off, the pump stops.

2. Local Auto Control:
    a. Not applicable
3. SCADA Manual Control:
    a. When the HOA switch for the pump is in Auto and the pump operation mode is set to Manual on OIT/SCADA HMI screens, the pump start and stop is controlled by operator at OIT/SCADA HMI screen.
4. SCADA Auto Control:
    a. When the HOA switch for the pump is in Auto and the pump operation mode is set to Auto on OIT/SCADA HMI screens, the pump is controlled by SCADA.
    b. The rinse water pump is controlled based on the pressure vessel operating mode.
        1) Backwash mode: Upon 60 minutes (default, operator adjustable value between 0 and 1440 minutes) after Full Media Backwash complete or Media Fluff is complete, rinse water pump, B02-PMP101 turns ON. Operator can adjust time based on type of full backwash and solids settleability. If second backwash is initiated during rinse water pump operation (P01-FCV0010 opens again), time resets at 60 minutes.
        2) Filter-to-Waste mode: Rinse water pump, B02-PMP101, turns ON when Rinse Water Tank level reaches 13 feet or 60 minutes after Filter-to-Waste mode was initiated, whichever occurs first (default, operator adjustable values).
        3) Rinse water pump, B02-PMP101, turns OFF when Rinse Water Tank level drops to 1.25 feet (default, operator adjustable value).

E. Monitoring and Control:
1. The SCADA system shall provide monitoring and/or control of the following conditions as well as the other conditions described in this strategy on OIT/SCADA HMI screens:
    a. Rinse Water Tank Level – Interlocks and Monitoring
    b. Rinse Water Tank Volume – Calculating per paragraph 3.06.
    c. Pump Running – Monitoring
    d. Pump Field Hand-Off-Auto Switch in Auto – Monitoring
    e. Pump HMI Auto/Manual Selection – Control and Monitoring
    f. Pump Discharge Flow – Monitoring
2. The rinse water tank discharging is controlled and monitored with the following hardwired signals:
    a. Pump Call to Run Command
    b. Pump Running Status Feedback
    c. Pump HOA In Auto
    d. Pump Motor Overload
    e. Pump Discharge Flow
    f. Rinse Water Tank Level

F. Interlocks and Permissives:

1. If high-high alarm is reached in Rinse Water Tank and Backwash mode is turned ON, then P01-FCV0010 CLOSES.
2. If high-high alarm is reached in Rinse Water Tank and Filter-to-Waste mode is turned ON, then P01-FCV0102, 0302, or 0502 CLOSES accordingly.
3. Rinse water tank low-low alarm turns off rinse water pump, B02-PMP101 in SCADA Manual or SCADA Auto.
4. To protect the rinse water pump from running against a blocked downstream path when HOA is in Auto, shutdown pump when no flow is detected at the discharge while the pump is running. Provide delay timers to allow pump to initially start and not shutdown on an erratic signal spike from B02-FIT102.
5. To protect the rinse water pump from running dry when the HOA is in Hand or Auto, there is a pressure switch low located on the pump's inlet to shutdown pump when activated.
6. To protect the rinse water pump from running above the rated amps for the motor when the HOA is in Hand or Auto, there is a motor overload contact located in the pump's starter circuit to shutdown pump when activated.

END OF SECTION

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SECTION 40 63 43

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for programmable logic controllers (PLC) designed to execute discrete and continuous control logic with high reliability in industrial applications. Enclosures and components are specified in Section 40 67 00.

B. PLC Schedule:

Panel No.	Testing	PLC Programmer
2167-W01-SCA002	40 61 21	Owner

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 91 00 - Commissioning, Testing and Start-up
   2. Section 40 61 93 – Process Control System Input/Output List
   3. Section 40 61 21 - Process Control System Testing
   4. Section 40 61 96 – Process Control Descriptions
   5. Section 40 67 00 - Control System Equipment Panels and Racks

1.03 REFERENCES

A. This section contains references to documents listed below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
IEC 61131-3	Programmable Controllers – Part 3: Programming Languages
NEMA IA 2.2	Programmable Controllers – Equipment Requirements and Tests
NEMA IA 2.3	Programmable Controllers – Programming Languages

1.04 DEFINITIONS

A. Abbreviations:
   1. IEC: International Electrotechnical Commission
   2. IO: input/output
   3. NEMA: National Electrical Manufacturer Association
   4. PLC: programmable logic controller

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. See Section 01 12 16 Work Sequence.
   2. PLC source and field quality control testing shall be conducted with Owner when Owner is identified as the programmer.

1.06 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00
   2. Submittal requirements: Section 40 61 13.

B. Action Submittals:
   1. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
      a. Section 40 61 93.
      b. Section 40 67 00.
   2. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Submit shop drawings per the requirements of this section under Section 40 67 00, including:
      a. Submittal requirements per Section 40 67 00 for the equipment specified herein.
      b. PLC Input/Output (IO) interconnection diagram drawings.
      c. Internal power distribution schematic diagram drawings.
      d. PLC power supply loading calculations.
      e. List of spare parts to be provided.
   4. Submit testing information per the requirements of this section under Section 40 61 21, including:
      a. Factory Acceptance Test Schedule And Forms

C. Closeout Submittals:
   1. Operating and maintenance submittals: Section 01 78 23.
   2. Include the following as part of the operating and maintenance submittal:
      a. Manufacturer, Representative, and Supplier contact information.
      b. Manufacturer instruction manuals shall include only the following as applicable to the PLC system:
         1) Safety Precautions.
         2) Environmental Conditions.

3) Troubleshooting guides and diagnostic techniques.
4) Component connection diagrams.
5) Removal and replacement instructions.

c. Warranty information.
d. Final reviewed submittal.
e. As-built drawings with record of switch and jumper settings for all components.

3. Factory Acceptance Test Results:
   a. Submit under Section 40 61 21 and per the requirements of this Section.
4. Spare parts:
   a. Provide the following spare parts:
      1) Programmable Logic Controller:
         a) One of each unique processor card.
         b) One of each unique and communication card.
         c) One for each ten, minimum of one for each unique IO card.
         d) Three of each unique terminal base unit.

1.07 QUALITY ASSURANCE

A. All PLCs provided shall comply with the requirements of this Section. PLCs provided with equipment specified in Divisions 23, 41, 43, 44, and 46 are provided by the Equipment Manufacturer (identified as vendor packages). Other PLCs are provided by the Systems Integrator per Section 40 61 13 with Section 40 61 93 – Process Control System Input/Output List.

B. Qualifications for the Systems Integrator: See Section 40 61 13.

C. Source Quality Control:
   1. Factory acceptance testing required for all PLCs.
      a. System Integrator provided PLCs per Section 40 67 00.

1.08 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00

1.09 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.

PART 2 PRODUCTS

2.01 GENERAL

A. Manufacturer:
   1. PLC: Siemens ET200SP.
      a. Processor (Controller): Siemens 1512SP-1 PN.
         1) Memory: 12MB storage, 6ES7954-8LE03-0AA0.
         2) Bus Adapter – 2 RJ 45 ports: 6ES7193-6AR00-0AA0.

b. Communication:
    1) Profibus DP Module: 6ES7545-5DA00-0AB0
        a) Bus Adapter: 6ES7972-0BB70-0XA0.
c. IO Module:
    1) Analog Input Module: 6ES7134-6GF00-0AA1.
    2) Analog Output Module: 6ES7135-6HD00-0BA1.
    3) Discrete Input Module: 6ES7131-6BH01-0BA0.
    4) Discrete Output Module: 6ES7132-6BF01-0BA0.
    5) Separated Base Unit: 6ES7193-6BP00-0DA0.
    6) Separated Base Unit with Auxiliary Terminals: 6ES7193-6BP20-0DA0
    7) Jumpered Base Unit: 6ES7193-6BP00-0BA0.

B. Materials
    1. All products shall be new and unused at the time of system assembly.

2.02 PROCESSOR/CENTRAL PROCESSING UNIT

A. Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.
    1. RFI/EMI Susceptibility: MIL STD 461B CS02.
    2. Showering Arc Test: NEMA Pub No ICS2-230.42.
    3. Surge Withstand: ANSI C37.90a.
    4. RFI Immunity: IEC 801-3.
    5. Ground Continuity: IEC 801-5.
    6. Electrostatic Discharge: IEC 801-2.
    7. Electromagnetic Field: IEC 61000-4-3.
    8. Fast transients: IEC 61000-4-4.

B. NEMA IA 2.3 and IEC 61131-3 compliant program editor.

C. With Ethernet port and serial port dedicated solely for programming use, minimum 200k bytes (8 bit) for IEC 1131 control programs, and 24k words (16 bit) for storage of data in battery-backed RAM memory. Provide additional serial communications adapters required for other serial interfacing. Include real-time clock.

2.03 COMMUNICATION

A. Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete operating network as shown.

2.04 POWER MODULE

A. External UPS 24 Vdc with battery: Refer to Section 40 67 00.

2.05 INPUT AND OUTPUT MODULE

A. Discrete Inputs: 24 Vdc, 16 channel.

B. Discrete Outputs: 24 Vdc, 8 channel, 0.5 A.

C. Analog Inputs: 4-20 mAdc, 8 channel.

D. Analog Outputs: 4-20 mAdc, 4 channel.

E. Spare Input/Outputs:
   1. Greater of a minimum one channel or 20 percent of each type of IO provided as spares for future use.

2.06 MISCELLANEOUS:

A. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.

2.07 PROGRAMMING SOFTWARE

A. PLC software licensing will be purchased by the Owner.

2.08 CONTROL PANEL FABRICATION

A. Refer to Section 40 67 00.

B. Detail shop drawings showing field connections and any terminal block jumpering required.

C. Terminate all used and spare IO wiring to terminal blocks.

D. Create wire markers with “to-from” component name, PLC slot/base, or terminal column number and terminal number information identical at each end.

E. Provide terminal blocks for connections to PLC Discrete Inputs:
   1. One fused terminal with LED and one pass through terminal for each PLC discrete input channel on the module.
   2. Surge protecting device (SPD) for each outdoor field mounted instrument or equipment connecting with PLC discrete input channel, grounded per SPD product requirements.

F. Provide terminal blocks for connections to PLC Discrete Outputs:
   1. One terminal block style SPDT contact relay for each PLC discrete output channel on the module.
   2. Surge protecting device (SPD) for each outdoor load connecting with PLC discrete output channel, grounded per SPD product requirements.

G. Provide terminal blocks for connections to PLC Analog Inputs:
   1. One fused terminal with LED, one pass through terminal and one ground terminal for each PLC analog input channel on the module.
   2. Surge protecting device (SPD) for each outdoor field mounted instrument or equipment connecting with PLC analog input channel, grounded per SPD product requirements.

3. Signal isolator as required for connecting with PLC analog input channel as single-ended circuit.

H. Provide terminal blocks for field connections to PLC Analog Outputs:
   1. One fused terminal with LED, and two pass through terminals for each PLC analog output channel on the module. Or one fused terminal with LED, one pass through terminal and one ground terminal if the analog output signal is not grounded at the load.
   2. Surge protecting device (SPD) for each outdoor field load connecting with PLC analog output channel, grounded per SPD product requirements.
   3. Signal isolator as required for connecting with PLC analog output channel as differential-ended circuit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Confirm and field verify equipment locations, and available space prior to fabrication.

B. See Section 40 67 00 for requirements.

3.02 INSTALLATION

A. Refer to Section 40 67 00.

B. Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

3.03 REPAIR/RESTORATION

A. Defective or damaged components shall be removed and replaced.

B. Equipment shall be clean prior to acceptance.

3.04 FIELD QUALITY CONTROL

A. Equipment Manufacturer for vendor package and Systems Integrator: The supplier of each PLC system shall provide a qualified service representative to perform the following:
   1. Inspect the PLC installation including IO and network systems, hardware configuration switch and jumper settings.
   2. Monitor all PLC system diagnostic indicators, both hardware and software, and certify that the PLC system performance meets or exceeds the Manufacturer's published specifications.
   3. Assist in all testing. The Systems Integrator [and Equipment Manufacturers for vendor package] shall provide on-site staff for the duration of the testing and start-up period to assist in all testing efforts.
   4. Certify in writing to the Construction Manager that the PLC system has been installed and configured in accordance with the Manufacturer's published guidelines. Equipment Manufacturer certification requirements are per the associated equipment Specification.

B. Contractor

1. Fault or trouble conditions shall be investigated and resolved by the Contractor to the satisfaction of the PLC supplier and the PLC programmer.

3.05 SYSTEMS START UP

A. Procedures: Section 01 45 20

B. Operational testing and commissioning shall be performed and documented as specified and required by Section 01 91 00 and 01 99 90.

3.06 TRAINING

A. Training shall conform to the requirements of Section 01 79 00.

B. In addition to Section 40 61 13 requirements, training shall be provided on the product components/hardware and include:

1. Power-up and power down of hardware.
2. Description of status and trouble indication lights.
3. Definition and identification of fault and trouble codes.
4. Installation, removal and replacement of components/hardware parts.
5. Ensure component is properly networked and the network is active.

END OF SECTION

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SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Requirements for panels, cabinets, and termination cabinets for instrument, control, and communication equipment per the Panel Schedule herein.
2. Requirements for power supply, surge protection devices, and conditioning equipment required to support the instrumentation and communication systems specified.

B. Control Panel Schedule:

Panel No.	Spec / P&ID	Features *	Enclosure Type	Dimensions (W x H x D in)	SCCR kA	Panel Title	Layout Dwgs / Notes
2167-W01-SCA002	40 67 00/ Varies	C, 1, 2, 5, 6, 7	NEMA 12	36 x 60 x 16	10	PFAS TREATMENT PLC PANEL	I-W01-201
2167-B02-PNL011	40 67 00/ Not Applicable		NEMA 12	20 x 12 x 8	5	SECURITY NETWORK PANEL	I-000-302

*FEATURES Legend

V - Vendor / Manufacture Panel per equipment specification requirements

C - Contractor Custom Panel as shown

1. *Programmable Logic Controller (PLC) or Remote I/O devices
2. *Panel mounted Operator Interface Terminal (OIT)
3. *Hardwired control logic required
4. *Windowed outer door and inner door for displays or devices.
5. *UPS
6. *Fans
7. *Heating
8. *Air Conditioning
9. *Sun/Rain Hood
10. *NEMA 4X OIT Cover

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 26 05 00.01 - Common Work Results for Electrical.
2. Section 40 13 61 - Process Control System General Provisions.
3. Section 40 61 21 – Process Control System Testing.
4. Section 40 61 93 - Process Control System Input/Output List.
5. Section 40 63 43 – Programmable Logic Controllers.
6. Section 40 61 96 – Process Control Descriptions.

1.03 DEFINITIONS

A. Abbreviations: Section 40 61 13.

1.04 REFERENCES

A. Standards:
   1. This section contains references to the following documents that are part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids).
   3. If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.
   4. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
EIA RS-310C	Racks, Panels, and Associated Equipment
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations
NFPA 79	Electrical Standard for Industrial Machinery
NFPA 70	National Electrical Code (NEC)
NEMA ICS 6	Industrial Control and Systems: Enclosures
ANSI/UL 497-1995	Standard for Protectors for Paired Conductor Communications Circuits
UL 1012	Power Supplies
EIA RS-310C	Racks, Panels, and Associated Equipment
UL 1449	UL Standard for Safety for Surge Protective Devices

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Vendor and Manufacturer panels specification Sections are referenced in the Panel Schedule and specify specific requirement for these panel. Contractor custom panels are specified herein and shown on the drawings.
   2. The Vendor / Manufacturer package equipment and Contractor custom field panels shall adhere to the requirements in specifications Section 26 05 00.01 for motor starters, controllers, and devices and the circuits shall be arranged for Fail-Safe wiring and electrical operation, as defined hereinafter.

1.06 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Submittal requirements: Section 40 61 13; and Section 40 63 43 when panel fabrication includes a PLC.

B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Check “marked” copy of specification Section 40 61 13.
   3. Check “marked” copy of specification Section 40 61 21.
   4. Check “marked” copy of specification Section 40 61 96.
   5. Check “marked” copy of specification Section 26 05 00.01.
   6. A copy of the contract documents relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing(s) “no changes required” on the drawing index. Drawings marked “no changes required” on the drawing index do not need to be included in the submittal. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   7. Marked product literature of all the enclosure electrical devices and components mounted on or within the control panel.
   8. List of miscellaneous items, cables, spare and replenishment parts, and chemicals to be provided, including MSDS information.
   9. Dimensioned drawings:
      a. Exterior panel and layout
      b. Interior devices and layout
      c. Door-in-door construction devices, where required
   10. Panel assembly drawings including sections showing clearances between face and rear mounted equipment.
   11. Nameplate engraving schedule:
      a. Indicate engraving by line
      b. Character size
      c. Nameplate size
      d. Panel and equipment tag number and description
   12. Heat load calculations for each cabinet based on the highest ambient temperature listed in Section 40 61 13 for the area in which the subject panel will be located.
   13. UPS and UPS battery sizing calculations demonstrating the UPS is sufficient to supply total connected loads plus an additional 50 percent for future expansion and can meet battery backup time requirements.
   14. Wiring drawings:
      a. Schematic diagrams
      b. Internal wiring diagrams
      c. Connection diagrams

d. Power and control single line diagrams to comply with NEC Article 409.
e. Panel power distribution drawings
    1) Provide each circuit breaker and fuse with a unique ID number and identify an amp rating.

15. Network block diagrams
16. Section 40 61 93 I/O List, updated to reflect any necessary modifications during construction.

C. Informational Submittals:
1. Special requirements for delivery of the information such as time, manner, place, or quantity.
2. Installation and training forms specified in Part 3.
3. Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.

D. Closeout Submittals:
1. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal and separate record of all final configuration, jumper, and switch settings.
2. As-built record drawings incorporating all modifications to the originally submitted panel drawings must be provided in both AutoCAD and Portable Document Format (PDF) format.
3. Test results as specified in Section 40 61 21-2.02.
4. List of spare parts provided.

1.07 QUALITY ASSURANCE

A. Provide the instrument, control, and monitoring features indicated on the P&ID and drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring, in accordance with NEC Article 409. Panels shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels shall be labeled in accordance with Article 409 of the National Electrical Code.

B. Interconnect transmitters, analyzers, signal conditioning modules and other equipment or devices as specified in other Division 40 sections.

C. Panels that contain programmable logic controllers (PLC) and operator interface terminals (OIT) units shall be as indicated in the Panel Schedule. PLCs shall comply with Section 40 63 43 and OIT shall comply with this section.

D. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier’s facility for corrections, testing, relabeling and inspection.

E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.

F. Listed Products:
   1. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
   2. The control panels shall have factory applied UL 508A labels.
   3. All panels shall be labeled in accordance with NEC Article 409.

G. Factory Testing:
   1. Prior to shipment, the manufacturer shall test the functional operation of the control panel as described in the process control description in Section 40 61 96.

1.08 ENVIRONMENTAL CONDITIONS

A. Refer to Section 40 61 13.

1.09 SHIPMENT, PROTECTION AND STORAGE:

A. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 60 00.

PART 2 PRODUCTS

2.01 FABRICATION

A. General:
   1. Panels shall be designed for the seismic requirements of Section 40 61 13. Structures, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
   2. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
   3. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel shall be supported underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
   4. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall mounted.
   5. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.

B. Panel Layout:
   1. Provide 20 percent spare contiguous sub-panel area for future expansion.

2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.
4. Separation between the power components (over 120Vac) and the control / instrument components (120Vac and less) by locating the power components and the control / instrument components in separate sections of the cabinet enclosure.
5. Power cabinet section and the control / instrument cabinet section with separate door handles.
6. Separation between the power components and the control / instrument components using barriers.
7. External lockable circuit breaker handle for the main panel disconnect.
8. Individual power and control components with internal circuit breakers, as required.
9. Motor controllers, as required by the equipment specifications.
10. Displays with door-in-door construction accessible by opening the cabinet outer door.
11. Face-mounted equipment flush or semi-flush with flat-black escutcheons.
12. Panel tops of wall-mounted panels: mounted at the same elevation.
13. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
14. Panel inner door contains a drawing holder.
15. Panel drawings enclosed in a transparent, protective jacket.
16. Panel functions as specified.
17. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.
18. Wall mounting of panel weighs less than 100 pounds, where wall space is available,

C. Control Power Distribution:
   1. Panel containing 120-volt powered equipment shall use the din-rail power distribution method with miniature circuit breakers, and fuses with blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.
   2. Panels containing voltages greater than 480 Vac shall be separated from the control section by physical barrier.
   3. Power Supplies:
      a. Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments shall contain direct current power supply system as specified herein.

D. Enclosures:
   1. Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.

2. General Services: cabinet shall be a NEMA 250, Type 12 enclosure fabricated from 1/8-inch minimum thickness sheet steel. Face-mounted instruments and devices shall be mounted in the door a minimum of 36 inches above the finished grade. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Doors shall be hung on concealed hinges with removable pins and quipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Where cabinet width exceeds 36 inches, multiple doors no wider than 34 inchesshall be provided. The enclosure sub-panel shall be painted white.
3. Process Areas and/or Outdoors: Cabinet shall be similar to those specified in paragraph above, except it shall be fabricated from Type 316 stainless steel, provided with suitable door clamps and gaskets as required for NEMA 250, Type 4X requirements. Outdoor enclosures exposed to direct sunlight shall be painted white (powder-coated) by the manufacturer.
4. Manufacturer:
    a. Hoffmann Enclosures, Inc.
    b. Saginaw
    c. Rittal
    d. Approved equal.

2.02 ENVIRONMENTAL CONTROL

A. Environmental controls shall be provided as required to maintain the environmental ratings of the enclosed components and shall maintain the NEMA enclosure rating as required by its location.

B. Heating: Panels located in unconditioned areas or outdoors shall be provided with thermostatically controlled space heaters as required to maintain the panel temperature 10 degrees F above ambient to prevent condensation within the panel. Space heaters with surface temperatures that exceed 120 degrees F require an expanded metal guard. Thermostats shall be Honeywell T631 series, Johnson Controls A28AA-4, or equal.

C. Ventilation: Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.

D. Air Conditioning: Systems shall not exchange cabinet interior air with ambient air.
    1. The cooling system shall be either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for heat load and ambient temperature conditions.
    2. Panel air conditioner coils shall be Heresite, or equal coated and protected from corrosion.

E. All external tapping shall be self-sealing screws of the same metal of the enclosure to maintain the NEMA rating of the enclosure.

2.03 PROTECTION COATING AND FINISH

A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.04 NAMEPLATES

A. External door-mounted components and the panel description shall be identified with plastic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

B. The machine engraved laminated white phenolic nameplates with black lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

D. The nameplates shall be attached to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide NEMA-4X sealing washers for nameplates for NEMA-4X panels.

E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.05 PANEL FEATURES

A. Interconnection Wiring: Panel Interconnecting Wiring:
   1. Panel control wiring: Single conductor stranded copper NEC rated Type MTW No. 16 AWG minimum(rated 10 A per NFPA 79, Table 12.5.1), with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
   2. Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
   3. Panel power wiring: Conductors specified in Division 26 and meet the NEC requirements for power including phase, grounded, and grounding conductors.
   4. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.
   5. Wiring channels shall comply with UL 94, Type V.
   6. Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50% maximum fill.
   7. Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.

B. Conductor Identification:
   1. Wiring shall be tagged at every termination with machine printed plastic sleeves or pre-printed self-sticking labels as manufactured by W.H. Brady, 3M, or approved equal. No hand-written labels are permitted.
   2. Three-part wire numbers for instrument and control panel internal conductors:
      a. Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
      b. Part-2: Code letter and wire colors per the following tables.
      c. Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120 Vac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24 Vdc Power	Blue
CS	24 Vdc Control	Violet
IS	24 Vdc Intrinsically Safe Control	Light Blue
S+	Signal (+)	Black
SG	Signal Ground	White
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

C. Conductor Installation And Protection:
   1. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. If practical, a general barrier may be provided between AC control devices and the electronic equipment.
   2. Terminal blocks shall be strap screw type rated for 300 or 600 volts. Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
   3. No more than two connections shall be made to one terminal. In the case of two connections, a twin-wire insulated ferrule shall be used.
   4. Wire connectors shall be insulated ferrule crimp type terminals. Systems Integrator shall prepare wires and wire labels for interconnections between field and control panels.
   5. Terminal blocks shall be DIN rail mounted, screw type, rated for 500 volts or 300 volts, and have a width between 6 and 7 mm. Knife disconnect terminal blocks shall be provided for electrical circuit isolation where foreign voltage enters control panel. Fuse terminal blocks shall be tip-out or draw-out type with LED blown fuse indicators and shall be provided with fuse sized per circuit requirements. For each PLC input and output interconnection specified in Section 40 63 43 can use a tier terminal block style as panel space optimization. Terminal blocks candidate manufacturers:
      a. Phoenix Contact UT 4 series (current rating as required).
      b. Or approved equal.

D. Field Wiring:
   1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.

E. Fuse And Fuse Holders:
   1. Fuses for 120 Vac circuits shall have a minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

2. Fuses for 24 Vdc circuits shall be fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
3. Fuses for 24 Vdc circuits shall be 1/2 amp for the power supply to individual instruments.
4. Fuse holders shall be tip-out or draw-out type.
5. Provide Phoenix Contact or or approved equal.

F. Panel Power:
1. 120 Vac control power source: Single power source for all control and DC power.
a. Provide control power transformers, as required for the load.
b. Provide direct current power supplies, as required for the load.
c. Provide UPS for PLC and derived loop power as defined above, as required for the load.
2. Provide a 120 Vac circuit for the panel light, receptacle, heating, fan, or heat exchanger as required.
3. Receptacle shall comply with Section 26 05 00.01.

G. Circuit Breakers:
1. Provide circuit breaker for branch circuit protection. Circuit breaker UL rated, 10kA interrupting capacity, DIN rail mounted, and trip current rating to be determined based on the circuit load by Contractor.
2. Eaton FAZ-NA series, or approved equal.

H. Accessories:
1. Panels greater than 24" high x 24" wide shall include GFCI convenience receptacles and LED utility lights.
2. Receptacles and utility lights shall not be powered by the UPS, where included.
3. Print pocket.
4. Fold-up shelf of sufficient size, sufficient weight capacity, and the proper angle for supporting a laptop computer mounted to the inside.

I. Corrosion Inhibitors:
1. All control panels shall be provided with vapor-emitting corrosion inhibitors to protect the control panel electrical components against corrosion. Corrosion inhibitors shall provide a minimum of 24 months of protection before replacement is required. Each inhibitor shall provide protection for a minimum of 11 cubic feet of panel volume. Manufacturer/model: Cortec Corporation VpCI-111 or approved equal.

J. Fail-Safe Wiring:
1. Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.

2.06 CONTROL DEVICES

A. Pushbuttons, selector switches, and indicator lights shall comply with Section 26 05 00.01.

B. Control Relays:
   1. Provide:
      a. DIN rail-mounted, terminal block style.
      b. Coil rating: 24 VDC/VAC or 120 VAC/VDC, as required by application.
      c. Contact rating (120 VAC): 30 A (break) and 3 A (make).
      d. Contact rating (24 VDC): 1 A (break/make).
      e. Contact type: gold-plated SPDT or DPDT, as required by application.
      f. Built-in reverse DC polarity protection and surge protection.
      g. LED indicator light to show when coil is energized.
   2. Manufacturer/model: Allen-Bradley 700-HL Series or approved equal.

C. Control Timers:
   1. Provide:
      a. DIN rail-mounted, terminal block style.
      b. Contact rating (24 VDC): 1 A.
      c. Contact type: gold-plated SPDT pr DPDT, as required by application.
      d. LED indicator light to show when timer is energized.
      e. Rated for Class I, Division 2 hazardous locations, as required by application.
      f. Adjustable time range from 0.3 – 30 minutes
   2. Manufacturer/model: Phoenix Contact ETD-BL-1T Series or approved equal.

D. INDICATING LIGHTS
   1. Indicating lights shall be equipped with colored lenses as specified in Section 26 05 00.01.

2.07 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application.

B. All power supply equipment shall be provided in redundant configurations, where shown on the drawings, such that failure of a single unit will not disable all or any part of the instrumentation and communication systems.

C. Direct-Current Power Supplies:
   1. Nominal 24-volt direct-current instrumentation and control power supply:
      a. DIN rail-mounted with integral input fuse.
      b. Capable of withstanding six times nominal current for 12 milliseconds (ms) to allow for coordination with downstream circuit protection devices.
      c. Nominal input voltage range: 100 to 240 Vac.
      d. Input voltage range: 85 to 264 Vac.
      e. Frequency range: 45 to 63 Hz.
      f. Mains buffering: ≥ 20 ms.
      g. Nominal output voltage: 24 Vdc ± 3 percent.

h. Output voltage setting range: 22.8 to 28 Vdc.
i. Nominal output current: per 24 Vdc power supply sizing calculations.
j. Output ripple voltage: < 150 millivolts (mV) peak-to-peak.
k. Load regulation (dynamic, 10 to 90 percent): < 2 percent.
l. DC OK indication: visual LED indication and SPST contact rated for at least 0.3 A at 60 Vdc.
m. Operating temperature: -13 to 158 degrees F.
n. Maximum operating temperature before derating: 140 degrees F.
o. Relative humidity range: 5 to 95 percent.
p. MTBF: ≥ 520,000 hours.
q. FM Approved or UL Listed for Class I, Division 2 hazardous locations, as required.
r. The panel supplier shall calculate the required VA rating at 120 percent of connected load. Submit load calculations, schematic diagrams, and wiring connection diagrams.
s. Provide dry contact for failure alarm. Dry contact to be wired as an input to the nearest PLC/RIO.
t. Manufacturer:
    1) Puls QS5.DNET, or approved equal.

D. Uninterruptible Power System (UPS) – 24 Vdc:
1. Provide industrial-grade UPS with electrical isolation. UPS shall consist of direct current power supply, charge controller, and sealed backup battery pack:
    a. Nominal input voltage: 24 Vdc
    b. Nominal output voltage: 24 Vdc
2. Provide rechargeable battery backup system with sealed no maintenance batteries. Batteries shall be two 12V batteries in series.
3. Allowed battery size shall be 10 -150 Ah.
4. DIN rail mount UPS.
5. Mount UPS battery to panel according to contract drawings.
6. Provide relay output contacts for remote monitoring of UPS on battery, UPS alarm, and UPS low battery. Provide visual LED indication and SPST contact rated for at least 0.1 A at 30 Vdc.
7. Size UPS system for 15 minutes of backup time on batteries at 100% load + 50% of load for future growth. Submit load calculations, schematic diagrams, and wiring connection diagrams.
8. Manufacturer:
    a. Puls UB Series with two 12 V battery modules.
    b. Or approved equal.

2.08 DC TO DC CONVERTERS

A. DC/DC Converter shall provide NEC Class 2 output with 24 VDC input and 24VDC output.
1. DIN rail mounted.
2. Efficiency: 90.5%.

3. Manufacturer:
    a. PULS CD5.241-L1.
    b. Or approved equal.

2.09 SURGE PROTECTION

A. General: Surge protection shall be provided to protect the electronic instrumentation systems from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, be maintenance free, and self restoring. Signals originating from instruments mounted outside the building where the control panel is located shall include surge protection at the panel and at the transmitter, for two-wire and four-wire instruments.
    1. Provide lightning and surge protection devices at all antennas, as well as signal lines, communication networks, and power feeds for all lines that originate or are routed outside a building on any part of the existing or proposed circuits.
    2. Lightning and surge protection devices shall provide full protection from line to line and from line to ground. Units shall be DIN-rail mounted, rated for a minimum of 10kA maximum surge current and voltage suitable for the type of circuit being protected. Reaction time shall be on the order of nanoseconds.

B. Surge protectors shall be listed per. Surge protectors shall be removable without changing the impedance of the circuit. Surge protectors product manufactures shall be:
    1. AC power lines shall comply with all requirements of UL1449 3rd edition with listed devices having a minimum 18kA surge protection and RFI filtering.
        a. Phoenix Contact
        b. Or approved equal.
    2. For analog signal lines use ANSI/UL497 listed device with minimum 10kA protection surge protection device, as manufactured by Phoenix Contact, Eaton MTL, or approved equal.
    3. For Ethernet BaseT communications use UL497A & UL497B listed ZoneBarrier Model ZB24540IE, Category 6 Universal LAN Protector as manufactured by Eaton MTL, or approved equal.

2.10 PANEL GROUNDING

A. Each panel shall be provided with two copper ground bars.
    1. One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
    2. Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.
    3. Provide additional ground bar(s) if indicated on drawings.

B. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.

C. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.

D. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.

E. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

2.11 PANEL DRAWING PROTECTION

A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel-wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.12 OPERATOR INTERFACE TERMINAL (OIT)

A. Manufacturer: Siemens, TP1200

B. Requirements:
   1. Display: 12” analog resistive multi-touch display, TFT color
   2. Memory: Flash, RAM, 12 Mbyte for user data
   3. Power: 24 VDC, 0.85 A
   4. Communications:
      a. Number of industrial Ethernet interfaces: 2 ports
      b. Number of RS 485 interfaces: 1
      c. Number of SD card slots: 2
      d. Protocols:
         1) Profinet
         2) Profibus
         3) EtherNet/IP
         4) TCP/IP
         5) SNMP
         6) HTTP
         7) Modbus
      e. Diagnostic information readable: via S7 controller
   5. Rating: Provide OIT with NEMA rating to maintain the NEMA rating of enclosure
   6. Operating temperature: Suitable for 0 to 40 degree C
   7. Approvals/Certificates: cULus
   8. Software:
      a. Operating system: Windows CE, pre-installed
      b. Configuration: WinCC

2.13 NETWORK SWITCH

A. Manufacturer: Siemens Scalance (model as shown on drawings

B. Requirements:
   1. Transfer rate: Managed 10 Mbit/s, 100 Mbit/s, 1000 Mbit/s

2. Power: 24 VDC with consumed current 2A
    a. Provide external fuse protection on power input per manufacturer's requirements.
3. Number of ports: 16 RJ45, Profinet compliant, SFP for either multi-mode or single mode fiber optic cable with LC connectors
4. Operating temperature: Suitable for -40 to 70 degree C
5. Mounting: 35 mm DIN rail
6. Approvals/Certificates: UL
7. Warranty: 5 years

2.14 INTRUSION DOOR SWITCHES

A. Magnetic reed switch, hermetically sealed, for installation on enclosure doors for intrusion alarm detection.

B. Contacts rated for switching currents from 20 to 100 mA at 24 volts DC, Form C, DPDT.

C. Manufacturer:
    1. Hoffman
    2. Or approved equal

2.15 SPARE PARTS

A. The following spare parts shall be provided:
    1. Ten each of each type of light bulb used in the panels.
    2. Five each of each type and rating of fuse used in the panels.
    3. Five each of each type of primary protector surge suppressor used in the panels.
    4. Two each of each type of surge protective device used in the panels.
    5. Two of each type of intrinsic safety isolator used.
    6. One 24 Vdc power supply.
    7. One UPS.
    8. Three UPS batteries.
    9. Five of each type of control relay used.
    10. One network switch.
    11. One DC to DC converter.

PART 3 EXECUTION

3.01 GENERAL

A. Floor mounted cabinets shall be mounted and shimmed to precise alignment, so doors operate without binding. Sealant shall be provided for conduit entering the panels.

B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with Section 40 61 13.

C. Terminals and terminal blocks shall be sprayed after all terminations have been completed with a silicone resin conformal coating, Fine-L-Coat Type SR, Dow Corning, or equal. Spray coating only required for control panels in corrosive or classified installation environments.

D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind plexiglass holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.

E. Vacuum clean control panels and cabinets in accordance with Sections 01 74 23 and 40 61 13.

F. Verify that all panels have been labeled with Arc Flash warning labels per NEC 110.16. Provide labels, with Arc Flash protection boundary and PPE levels, in accordance with Section 26 05 00.01.

3.02 MOUNTING

A. Control panels supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Sills shall be leveled so panel structures will not be distorted. Panels shall be shimmed to precise alignment so doors operate without binding and mounted where shock or vibration will impair its operation.

B. Support systems shall not be attached to handrails, process piping or mechanical equipment. Control panels supported directly by concrete or concrete block walls shall be spaced out from the wall to provide for air circulation around the panels.

C. Steel used for support of equipment shall be 316 stainless steel. Support systems including panels shall be designed to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.

D. Floor-mounted cabinets, except in dry control rooms or electrical equipment rooms, shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified.

E. Panels shall be shimmed to precise alignment, so doors operate without binding. Sealant shall be provided under panels not located in dry control or electrical equipment rooms.

F. Centerline of wall-mounted panels shall be 48 inches above the floor.

G. Panel tops of wall-mounted panels shall be mounted at the same elevation.

3.03 PANEL POWER SUPPLY

A. Power supply and conditioning equipment shall be mounted and connected in compliance with the manufacturer's instructions.

B. Line side disconnect switches shall be provided for power supply and conditioning equipment. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Disconnect switches shall comply with Section 26 05 00.01.

C. Small power supply and conditioning equipment may be mounted in the panel served. Larger units shall be mounted adjacent to the equipment served. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel.

D. Power supply and conditioning equipment larger than 5 kVA load capacity supported from surfaces other than concrete shall be provided with sound isolators.

E. Final raceway connections shall be a flexible conduit in compliance with Division 26.

3.04 SOURCE QUALITY CONTROL

A. The control panel shall be assembled, interconnected, and functionally tested at the assembly shop prior to shipment. The Owner/Engineer shall have the option of witnessing the functional shop test. The Contractor shall notify the Owner/Engineer at least two (2) weeks in advance prior of the scheduled functional shop test.

3.05 FIELD QUALITY CONTROL

A. Field verify the following for Instrument and Control Panels:
   1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.
   2. Control contacts installed in the ungrounded side of the circuit.
   3. Panel signal and control wiring separated and installed in separate wireways with barriers between the power wiring and the signal and control wiring.
   4. Barriers between the power wiring and the signal and control wiring.
   5. Connected to the plant grounding system, as specified.
   6. Inner door contains a copy of the Record elementary and wiring diagrams, in a protected drawing holder. Drawings shall be enclosed in a transparent, protective jacket.
   7. Panel Functions as specified.
   8. Mounted with stainless steel unistrut, fittings, and fasteners.
   9. Tested in accordance with Section 40 61 21.

3.06 TRAINING

A. Equipment Manufacturer training is per the associated equipment Specification.

B. System integrator training to include requirements specified in Section 01 79 00 for each fabricated control system equipment panel and rack in one training session.

END OF SECTION

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SECTION 40 71 00

FLOW MEASUREMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.
   2. Requirements for process flow measurement instruments including meters, transmitters, switches, associated indication devices, and accessories.
   3. Requirements for instrumentation elements which form a part of the process control systems are specified in Section 40 61 13 and Section 40 06 70. Application requirements are specified in the instrument schedule, Section 40 06 70.

B. Instrument list: Instruments are scheduled in Section 40 06 70.

1.02 RELATED SECTIONS

A. This section contains specific references to related sections listed below. Additional related sections may apply that are not specifically listed below.
   1. Section 40 05 01 Piping systems
   2. Section 40 06 70 Schedules for Instrumentation of Process Systems
   3. Section 40 61 13 Process Control System General Provisions
   4. Section 40 61 21 Process Control System Testing
   5. Section 40 79 00 Miscellaneous Instruments, Calibration Equipment, Instrument Valves, and Fittings

1.03 REFERENCES

A. This section contains references to documents listed below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NSF 61	Drinking Water System Components – Health Effects
API RP 551	American Petroleum Institute Recommended Practice Process Measurement
NEMA 250	National Electrical Manufacturers Association Enclosures for Electrical Equipment (1000 Volts Maximum)

1.04 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Submittal requirements: Section 40 61 13.

B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Check “marked” copy of Section 40 06 70 – Schedules for Instrumentation of Process Systems.
   3. Check “marked” copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment.
   4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   5. Manufacturer’s product information for all instrumentation and accessories items.
      a. Marked to only show products intended to be ordered, and salient features meeting specification requirements along with:
         1) Installation details and mounting accessories.
         2) Electrical and signal connection details.
         3) Surge protectors.
   6. Instrument Schedule as defined in Section 40 06 70.
   7. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
   8. Loop Diagrams as defined in Section 40 61 13.

C. Informational Submittals:
   1. Factory calibration certificates:
      a. Instruspec FM
   2. Instrument manufacturer certifications and compliance documentation included in the shipped package.
   3. Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.
   4. Safety Data Sheets (SDS) for chemicals such as an instrument fill fluid per OSHA requirements.

D. Closeout Submittals:
   1. Completed test forms: Section 01 99 90.
   2. Calibration reports manufacturer certification and PCS Integrator’s final calibration provided in the field.
   3. Head versus flow charts (required for open channel flow meters).
   4. Differential pressure versus flow charts (required for differential pressure flowmeters like orifice plate, venturi tube, pitot tube, annubar).
   5. Operating and maintenance submittals: Section 01 78 23.
      a. Final reviewed submittals.
      b. Manufacturer’s operation and maintenance instruction, edited for this project.
      c. Record of menu configurations, jumpers, settings (range, set point, deadband) and other configurable parameters for each instrument in electronic form using Microsoft Excel or Word.

d. Hardcopy and electronic copy of final configuration files used for configuration and communication set up of programmable electronic based instruments (or smart instruments. If instrument uses HART programmer, provide the most current HART configuration files.

1.05 QUALITY ASSURANCE

A. Manufacturer: Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Identification of Listed Products: Provide instrumentation listed for the purpose for which they are to be used, by an independent nationally recognized testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent nationally recognized testing laboratory acceptable to the inspection authority having jurisdiction and is recognized by OSHA.

C. Approval/Certification: ANSI/NSF 61 for process instruments used on potable (drinking) water.

D. Installer: Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the INSTRUSPEC sheets in Part 4 of this section. Candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements.

2.02 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. INSTRUSPEC sheets in Part 4 of this section represent different types of flow measurement instruments. The flow measurement instruments are listed in the instrument schedule, Section 40 06 70 with required INSTRUSPEC symbol specified.

2.03 SYSTEM EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.

2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
7. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
1. Measured parameter output indicators complying with paragraph 2.04 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
4. Transmitter output shall increase with increasing measurement.
5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
8. Transmitters located outdoors shall be provided with surge protectors:
   a. Signal: Surgelogic SSP030SSE10HC, or approved equal.
   b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. ASCO 252 or approved equal.
9. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.06 connected in the output signal circuit.

2.04 PROCESS PARAMETER OUTPUT INDICATOR

A. Analog output process indicators shall be 0.5-inch digit height display enclosed in a NEMA 4/4X rated meter case. Provide indicators with accuracy within one percent of span. Provide a diode to maintain loop continuity for indicator removal. Displays shall be scaled in engineering units, over the calibrated range of the associated instrument. Calibrate the indicator scale in process units.

B. Manufacturers:
   1. Siemens Sitrans RD200
   2. Or approved equal.

2.05 INTRINSIC SAFETY BARRIERS

A. Not used.

2.06 SIGNAL CURRENT ISOLATOR

A. Per Section 40 67 00.

2.07 MISCELLANEOUS INSTRUMENTS, CALIBRATION EQUIPMENT, INSTRUMENT VALVES, AND FITTINGS

A. Per Section 40 79 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
   2. Installation requirements are specified in Section 40 61 13.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 01 and 40 79 00. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
      c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Safety Instruments: No valves shall be installed at process taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
   3. Flushing/Calibration Connection: Provide a tee and isolation valve between the root or gauge valve and the instrument or diaphragm seal.

C. Tubing:
   1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
   2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
   3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

E. Outdoor Transmitters:
   1. Transmitters mounted outdoors shall be provided with rain/sun hood per Drawing Details.
   2. Provide instruments and impulse lines with insulation and heat trace when specified for cold climates reaching temperature below freezing.

3.02 FIELD QUALITY CONTROL

A. Testing requirements are specified in Section 40 61 21.

3.03 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

3.04 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with one-half hour for each type of flow measurement instrument.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
FM	Magnetic Flow Transmitter	Flow Measurement

4.02 INSTRUMENT IDENTIFICATION: FM

A. Instrument Function: Flow Measurement

B. Instrument Description: Magnetic Flow Metering System

C. Manufacturer:
   1. Siemens Sitrans
      a. Water Applications- flow sensor/transmitter: FMS500 / FMT020
      b. Water/Wastewater Applications – flow sensor/transmitter: F M MAG 5100 W
   2. Approved equal.

D. Features:
   1. Power: 24 volts DC
   2. Signal Input: Process
   3. Signal Output:
      a. Analog signal as specified in paragraph 2.03 and scaled pulse frequency
      b. HART
   4. Process Connection:
      a. Carbon steel flanges, corrosion resistent coating, ANSI B16.5, Class 150.
   5. Product Requirements: Magnetic flow meter provided as a system consisting of a flow sensor (or tube) with separate indicating transmitter, unless otherwise specified in the instrument schedule, Section 40 06 70, complete with interconnecting cables of sufficient length between the flow tube and the transmitter.
      a. Indicating transmitter for full-scale flow rates from 1.0 to 30 feet per second. System error shall not exceed the greater of 0.5 percent of flowrate or 0.1 foot per second from 3 to 30 feet per second. Separate mounting shall be NEMA 4X. Integral mounting shall be NEMA 6.
      b. Flow Tube/Flow Meter: Shall be rated NEMA 6P for continuous submergence up to 20 feet.
      c. Grounding Rings: Provide up-stream and downstream 316L stainless steel grounding rings shall be fabricated from the same metal as for the electrodes below.

d. Electrodes: Shall have conical shaped probes that are cleaned by the velocity of the flow stream. Probes shall be manufactured of Hastolloy C or 316L stainless steel unless otherwise specified in Section 40 06 70.

e. Liner: EPDM or as applicable for the process fluid being measured applications. Do not provide liner material with per- and polyfluoroalkyl substances.

f. Transmitter: Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4X, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.

1) Means to calibrate the metering system without use of external calibration units. Transmitter self-diagnostics. Traceability certificate of actual flow lab certification provided with each flow tube.

2) Integral 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.

3) Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

E. Execution:

1. Factory calibration required at Zero-point, 25%, 90% ascending and descending.
2. Installation: Install in accordance with manufacturer's instructions and the recommendations of API RP551 to the specified requirements.
3. Orientation of meter shall be such that the pipeline is full and shall comply with manufacturer’s requirements based on flow direction and straight run.

END OF SECTION

SECTION 40 72 00

LEVEL MEASUREMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.
   2. Requirements for process level measurement instruments including meters, transmitters, switches, associated indication devices, and accessories.
   3. Requirements for instrumentation elements which form a part of the process control systems specified in Section 40 61 13 and Section 40 06 70. Application requirements are specified in the instrument schedule, Section 40 06 70.

B. Instrument list: instruments are scheduled in Section 40 06 70.

1.02 RELATED SECTIONS

A. This section contains specific references to related sections listed below. Additional related sections may apply that are not specifically listed below.
   1. Section 40 06 70 Schedules for Instrumentation of Process Systems
   2. Section 40 61 13 Process Control System General Provisions
   3. Section 40 61 21 Process Control System Testing
   4. Section 40 79 00 Miscellaneous Instruments, Calibration Equipment, Instrument Valves and Fittings

1.03 REFERENCES

A. This section contains references to documents listed below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
API RP 551	American Petroleum Institute Recommended Practice Process Measurement
NEC	National Electric Code (NFPA 70)
NEMA 250	National Electrical Manufacturers Association Enclosures for Electrical Equipment (1000 Volts Maximum)

1.04 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00
   2. Submittal requirements: Section 40 61 13.

B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Check “marked” copy of Section 40 06 70 – Schedules for Instrumentation of Process Systems.
   3. Check “marked” copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment.
   4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   5. Marked product literature of all equipment and features to be provided.
      a. Installation drawings for only the transmitters, sensors, and mounting accessories to be provided.
      b. Electrical and signal connection drawings for only the transmitters and sensors to be provided.
   6. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
   7. Marked product literature for surge protectors.

C. Closeout Submittals:
   1. Procedures: Section 01 33 00.
   2. Completed test forms: Section 01 99 90
   3. Factory calibration certificates.
   4. Operating and maintenance submittals: Section 01 78 23.
      a. Final reviewed submittals.
      b. Manufacturer’s operation and maintenance instruction, edited for this project.
      c. Record of menu configurations, jumpers, settings (range, set point, deadband) and other configurable parameters for each instrument in electronic form using Microsoft Excel or Word.
      d. Hardcopy and electronic copy of final configuration files used for configuration and communication set up of programmable electronic based instruments (or smart instruments. If instrument uses HART programmer, provide the most current HART configuration files.

1.05 QUALITY ASSURANCE

A. Manufacturer: Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Identification of Listed Products: Provide instrumentation listed for the purpose for which they are to be used, by an independent nationally recognized testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent nationally recognized testing laboratory acceptable to the inspection authority having jurisdiction and is recognized by OSHA.

C. Approval/Certification: ANSI/NSF 61 for process instruments used on potable (drinking) water.

D. Installer: Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the INSTRUSPEC sheets in Part 4 of this section. Candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements.

2.02 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. INSTRUSPEC sheets in Part 4 of this section represent different types of level measurement instruments. The level measurement instruments are listed in the instrument schedule, Section 40 06 70 with required INSTRUSPEC symbol specified.

2.03 SYSTEM EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
   7. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.04 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for level measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
   8. Transmitters located outdoors shall be provided with surge protectors:
      a. Signal: Surgelogic SSP030SSE10HC or approved equal.
      b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. ASCO 252 or accepted equal.
   9. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.06 connected in the output signal circuit.

2.04 PROCESS PARAMETER OUTPUT INDICATOR

A. Analog output process indicators shall be 0.5-inch digit height display enclosed in a NEMA 4/4X rated meter case. Provide indicators with accuracy within one percent of span. Provide a diode to maintain loop continuity for indicator removal. Displays shall be scaled in engineering units, over the calibrated range of the associated instrument. Calibrate the indicator scale in process units.

B. Manufacturers:
   1. Siemens Sitrans RD200
   2. Or approved equal.

2.05 INTRINSIC SAFETY BARRIERS

A. Not Used.

2.06 SIGNAL CURRENT ISOLATOR

A. Per Section 40 67 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
   2. Installation requirements are specified in Section 40 61 13.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 01. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.
      c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.
   2. Safety Instruments: No valves shall be installed at taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
   3. Gauge Valves: Gauge valves shall be provided for each gauge tap except where chemical seals are used.
   4. Flushing/Calibration Connection: Provide a tee and isolation valve between the root or gauge valve and the instrument or diaphragm seal.

C. Tubing:
   1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
   2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
   3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
   1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

E. Outdoor Transmitters:
   1. Transmitters mounted outdoors shall be provided with rain/sun hood per Drawing Details.
   2. Provide instruments and impulse lines with insulation and heat trace when specified for cold climates reaching temperature below freezing.

3.02 FIELD QUALITY CONTROL

A. Testing requirements are specified in Section 40 61 21.

3.03 PROCESS CONNECTIONS

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

3.04 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with one-half hour for each type of level transmitter.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
LDFS	Liquid Displacer Float Switch	Level Measurement
LFT	Flange Mounted Diaphragm Level Transmitter	Level Measurement

4.02 INSTRUMENT IDENTIFICATION: LDFS

A. Instrument Function: Level Measurement

B. Instrument Description: Level Displacer Float Switch

C. Manufacturer:
   1. Madison, M8800.
   2. Or approved equal.

D. Features:
   1. Power Supply: None. Mechanical float based system.
   2. Signal Input: Process
   3. Signal Output: Normally close contact, in accordance with paragraph 2.03 of this section.
   4. Process Connection: Threaded connection for vertical installation.

5. Product Requirements:
    a. Accuracy: Level detection in sump
    b. Operating Temperature: 0 to 160 degree Fahrenheit
    c. Float/Stem Material: Polypropylene
    d. Float Specific Gravity: less than 0.9
    e. Float Cable(s): Potted seal to Float/Stem
    f. Max Pressure: 100 psi

E. Execution:
    1. Installation: Install in accordance with the manufacturer's instructions as specified on the drawings.

4.03 INSTRUMENT IDENTIFICATION: LFT

A. Instrument Function: Level Measurement

B. Instrument Description: Flange Mounted Diaphragm Level Transmitter

C. Manufacturer:
    1. Siemens SITRANS P320
    2. Rosemount 3051L
    3. Yokogawa EJA210A or EJA220A
    4. Approved equal.

D. Features:
    1. Power Supply: As specified in paragraph 2.03
    2. Signal Input: Process
    3. Signal Output: As specified in paragraph 2.03
    4. Process Connection: 2-inch flange, ANSI B16.5, Class 150, raised face
    5. Product Requirements:
        a. Differential Pressure Transmitter: Capacitance or piezoresistive.
        b. Diaphragm and Wetted Parts: Type 316 stainless steel unless otherwise specified in Section 40 06 70.
        c. Range: 100:1.
        d. Accuracy: 0.075 percent of calibrated span.
        e. Static pressure rating: 275 psi.
        f. Operating Temperature: 0 to 200 deg. F
        g. Indicator: LCD display.
        h. HART data communication protocol

E. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.
   2. Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer, and components factory-assembled prior to shipping.
   3. Calibration:
      a. Install the diaphragm seal integral to the transmitter at the proper elevations.
      b. Zero the transmitter on an empty tank open to the atmosphere.

END OF SECTION

SECTION 40 73 00

PRESSURE, STRAIN AND FORCE MEASUREMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for instrumentation elements that quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.
   2. Requirements for process pressure, strain and force measurement instruments including meters, transmitters, switches, associated indication devices, and accessories.
   3. Requirements for instrumentation elements which form a part of the process control systems specified in Section 40 61 13 and Section 40 06 70. Application requirements are specified in the instrument schedule, Section 40 06 70.

B. Instrument list: Instruments are scheduled in Section 40 06 70.

1.02 RELATED SECTIONS

A. This section contains specific references to related sections listed below. Additional related sections may apply that are not specifically listed below.
   1. Section 40 05 02 Piping System Schedules including Sections numbered from 40 05 02.00 through 40 05 02.99
   2. Section 40 06 70 Schedules for Instrumentation of Process Systems
   3. Section 40 61 13 Process Control System General Provisions
   4. Section 40 61 21 Process Control System Testing
   5. Section 40 79 00 Miscellaneous Instruments, Calibration Equipment, Instrument Valves, and Fittings

1.03 REFERENCES

A. This section contains references to documents listed below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NSF 61	Drinking Water System Components – Health Effects
API RP 551	American Petroleum Institute Recommended Practice Process Measurement
NEC	National Electric Code (NFPA 70)
NEMA 250	National Electrical Manufacturers Association Enclosures for Electrical Equipment (1000 Volts Maximum)
OSHA	Occupational Safety and Health Administration

1.04 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Submittal requirements: Section 40 61 13.

B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Check “marked” copy of Section 40 06 70 – Schedules for Instrumentation of Process Systems.
   3. Check “marked” copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment.
   4. Marked Contract Document Mechanical and/or Electrical Plan drawings, sections, and details showing sensor installation locations and details. Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   5. Manufacturer’s product information for all instrumentation and accessories items.
      a. Marked to only show products intended to be ordered, and salient features meeting specification requirements along with:
         1) Installation details and mounting accessories.
         2) Electrical and signal connection details.
   6. Instrument Schedule as defined in Section 40 06 70.
   7. List of miscellaneous items, cables, spare parts, that will be provided in accordance with INSTRUSPEC sheet requirements.
   8. Loop Diagrams as defined in Section 40 61 13.

C. Informational Submittals:
   1. Factory calibration certificates:
      a. Instruspec PGDT
      b. Instruspec PGT
   2. Instrument manufacturer certifications and compliance documentation included in the shipped package.
   3. Manufacturer's certification for the performance of features of the specified equipment that cannot be readily inspected.
   4. Safety Data Sheets (SDS) for chemicals such as an instrument fill fluid per OSHA requirements.

D. Closeout Submittals:
   1. Completed test forms: Section 01 99 90.
   2. Calibration reports manufacturer certification and PCS Integrator’s final calibration provided in the field.
   3. Operating and maintenance submittals: Section 01 78 23.
      a. Final reviewed submittals.
      b. Manufacturer’s operation and maintenance instruction, edited for this project.

c. Record of menu configurations, jumpers, settings (range, set point, deadband) and other configurable parameters for each instrument in electronic form using Microsoft Excel or Word.

d. Hardcopy and electronic copy of final configuration files used for configuration and communication set up of programmable electronic based instruments (or smart instruments. If instrument uses HART programmer, provide the most current HART configuration files.

1.05 QUALITY ASSURANCE

A. Manufacturer: Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

B. Identification of Listed Products: Provide instrumentation listed for the purpose for which they are to be used, by an independent nationally recognized testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent nationally recognized testing laboratory acceptable to the inspection authority having jurisdiction and is recognized by OSHA.

C. Approval/Certification: ANSI/NSF 61 for process instruments used on potable (drinking) water.

D. Installer: Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled, Certified Technicians specified in Section 40 61 13, who are regularly engaged in such activities involving systems of similar complexity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the INSTRUSPEC sheets in Part 4 of this section. Candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements.

2.02 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

A. INSTRUSPEC sheets in Part 4 of this section represent different types of pressure, strain and force measurement instruments. The pressure, strain and force measurement instruments are listed in the instrument schedule, Section 40 06 70 with required INSTRUSPEC symbol specified.

2.03 SYSTEM EQUIPMENT

A. General:
   1. In accordance with Section 01 33 00, the General Conditions of the Contract Documents, drawings, information, and technical data for all equipment as, required in Section 40 61 13 and this section shall be provided. All required product data for this section shall be included in one complete package.

B. Process switches and devices shall comply with the following requirements:
   1. Contact outputs used for alarm actuation shall be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
   2. Contact outputs used to control equipment shall be normally-opened and shall close to start the equipment.
   3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
   4. Contacts, monitored by electromagnetic devices such as mechanical relays, shall be rated as NEMA ICS 2, designation B300.
   5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
   6. Switch electrical enclosures rated as NEMA 250, Type 4 minimum.
   7. Switch range shall be selected so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

C. Measuring elements and transmitters shall comply with the following requirements:
   1. Measured parameter output indicators complying with paragraph 2.04 shall be provided with any transmitter that does not include an integral indicator. Indicators, whether integral or separate, shall be calibrated in process units, and engraved on the indicator scale plate.
   2. The two-wire type transmitters shall have operating power derived from the signal transmission circuit.
   3. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% linearly corresponding to 4 to 20 mAdc.
   4. Transmitter output shall increase with increasing measurement.
   5. Time constant shall be adjustable from 0.5 to 5.0 seconds for transmitters used for pressure measurement.
   6. Transmitter output shall be galvanically isolated via electro-mechanical or optical technology.
   7. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
   8. Transmitters located outdoors shall be provided with surge protectors:
      a. Signal: Surgelogic SSP030SSE10HC or approved equal.
      b. AC Power: UL 1449, LED indicator, screw terminal connections, NEMA 4X. ASCO 252 or approved equal.

9. Four-wire transmitters shall be isolated from the process and power or provided with a loop-powered signal current isolator as specified in paragraph 2.06 connected in the output signal circuit.

2.04 PROCESS PARAMETER OUTPUT INDICATOR

A. Analog output process indicators shall be 0.5-inch digit height display enclosed in a NEMA 4/4X rated meter case. Provide indicators with accuracy within one percent of span. Provide a diode to maintain loop continuity for indicator removal. Displays shall be scaled in engineering units, over the calibrated range of the associated instrument. Calibrate the indicator scale in process units.

B. Manufacturers:
   1. Siemens Sitrans RD200
   2. Or approved equal.

2.05 INTRINSIC SAFETY BARRIERS

A. Not Used.

2.06 SIGNAL CURRENT ISOLATOR

A. Per Section 40 67 00.

2.07 MISCELLANEOUS INSTRUMENTS, CALIBRATION EQUIPMENT, INSTRUMENT VALVES, AND FITTINGS

A. Per Section 40 79 00.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets.
   2. Installation requirements are specified in Section 40 61 13.

B. Process Connections:
   1. General: Unless otherwise specified, process taps shall comply with Section 40 05 02 Piping System Schedules, including sections numbered in the range from 40 05 02.00 through 40 05 02.99. Process connections shall be arranged such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment.
      a. Where process taps are not readily accessible from instrument locations, an isolation valve shall be provided at the instrument.
      b. Isolation valves shall be provided for each instrument where multiple instruments are connected to one process tap.

c. Pipe between the process connection and instruments shall be 1/2-inch stainless steel with treatment material for easy removal, as specified herein.

2. Safety Instruments: No valves shall be installed at taps for safety instruments. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording except when annular chemical seals are used.
3. Root Valves: Root valves shall be provided at all process taps, except as follows:
   a. Temperature taps, where valves are unnecessary.
   b. Pump discharge pressure taps where no instrument is permanently installed. Isolation valves shall be provided.
   c. Process taps for safety instruments.
   d. Where gauge valves are provided.
   e. Where chemical seals are used.
4. Gauge Valves: Gauge valves shall be provided for each pressure gauge tap except where chemical seals are used.
5. Flushing/Calibration Connection: Provide a tee and isolation valve with quick-connect fitting between the root or gauge valve and the instrument or diaphragm seal.

C. Tubing:
1. Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit.
2. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least 1/8 inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening.
3. Ends of tubing shall be square-cut and de-burred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Electrical Connections:
1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of 2 feet.

A. Outdoor Transmitters:
1. Transmitters mounted outdoors shall be provided with rain/sun hood per Drawing Details.
2. Provide instruments and impulse lines with insulation and heat trace when specified for cold climates reaching temperature below freezing.

3.02 FIELD QUALITY CONTROL

A. Testing requirements are specified in Section 40 61 21.

3.03 PROCESS CONNECTIONS:

A. Process connection piping and tubing shall be tested in accordance with Section 40 05 01.

3.04 TRAINING

A. Training requirements are specified in Section 01 79 00. Provide two training sessions, each with one-half hour for each type of pressure instrument.

PART 4 APPENDIX - INSTRUSPECS

4.01 INSTRUSPECS

A. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets herein. Application requirements are specified in the Instrument Index, and/or on the drawings.

Table A

INSTRUSPEC Symbol	Instrument description	Instrument function
PDT	Pressure differential transmitter	Pressure differential measurement
PG	Pressure gage	Pressure measurement
PGT	Gage pressure transmitter	Pressure measurement
PS	Pressure switch	Pressure measurement

4.02 INSTRUMENT IDENTIFICATION: PDT

A. Instrument Function: Pressure Differential Measurement

B. Instrument Description: Pressure Differential Transmitter

C. Manufacturer:
   1. Siemens, Sitrans P320
   2. Approved equal.

D. Features:
   1. Power Supply: As specified in paragraph 2.03 for two-wire type transmitters
   2. Signal Input: Process
   3. Signal Output: Analog transmission signal as specified in paragraph 2.03
   4. Process Connection: Five valve manifold
   5. Product Data:
      a. Pressure Transmitter: Capacitance or piezoresistive type.
      b. Wetted Parts: As required for ANSI/NSF 61 approval with no PFAS containing materials.
      c. Range: 100:1.
      d. Accuracy: 0.075 percent of calibrated span.
      e. Maximum Permissible Operating Pressure: 2,000 psi.
      f. Operating Temperature: 0 to 200 deg. F

g. Indicator: LCD display.
h. HART standard data communication protocol.

E. Execution:
1. Factory calibration required at Zero-point, 25%, 90% ascending and descending.
2. Installation: Install in accordance with manufacturer's instructions and installation details.
3. Provide root valves at all process pressure taps.
4. Provide five valve manifold at the instrument.
5. Locate pressure instruments as close as practical to the process tap and position to permit observation and maintenance.
6. Do not support pressure instruments from process piping.

4.03 INSTRUMENT IDENTIFICATION: PG

A. Instrument Function: Pressure measurement

B. Instrument Description: Pressure gage

C. Manufacturer:
1. WIKA, Type 111.25DW
2. Approved equal.

D. Features:
1. Signal Input: Process pressure
2. Process Connection: ¼ or ½ -inch male NPT
3. Product Requirements:
a. Size: 4-1/2-inch
b. Type: bourdon tube element
c. Movement: 270-degree milled stainless steel
d. Accuracy: +/- 1 percent of span or better.
e. Wetted Parts: As required for ANSI/NSF 61 approval with no PFAS containing materials.

E. Execution:
1. Installation: Install in accordance with manufacturer's instructions and installation details.
2. Provide gauge valves at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
3. Locate pressure instruments as close as practical to the process tap and position to permit observation and maintenance.
4. Install pressure instruments in such a manner that blowout discs are not obstructed.

4.04 INSTRUMENT IDENTIFICATION: PGT

A. Instrument Function: Pressure Measurement

B. Instrument Description: Gage Pressure Transmitter

C. Manufacturer:
   1. Siemens, Sitrans P320
   2. Approved equal.

D. Features:
   1. Power Supply: As specified in paragraph 2.03 for two-wire type transmitters
   2. Signal Input: Process
   3. Signal Output: Analog transmission signal as specified in paragraph 2.03
   4. Process Connection: 1/2-inch female NPT flange adapter
   5. Product Data:
      a. Pressure Transmitter: Capacitance or piezoresistive type.
      b. Wetted Parts: As required for ANSI/NSF 61 approval with no PFAS containing materials.
      c. Range: 100:1.
      d. Accuracy: 0.075 percent of calibrated span.
      e. Maximum Permissible Operating Pressure: 2.5x upper measurement span
      f. Operating Temperature: 0 to 200 deg. F
      g. Indicator: LCD display.
      h. HART standard data communication protocol.

E. Execution:
   1. Factory calibration required at Zero-point, 25%, 90% ascending and descending.
   2. Installation: Install in accordance with manufacturer's instructions and installation details.
   3. Provide root valves at all process pressure taps.
   4. Provide gauge valves at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
   5. Locate pressure instruments as close as practical to the process tap and position to permit observation and maintenance.
   6. Do not support pressure instruments from process piping.

4.05 INSTRUMENT IDENTIFICATION: PS

A. Instrument Function: Pressure Measurement

B. Instrument Description: Pressure Switch

C. Manufacturer:
   1. Ashcroft B Series
   2. SOR Inc. Static-O-Ring
   3. United Electric 100 Series
   4. Approved equal.

D. Features:
   1. Signal Input: Process
   2. Signal Output: As specified in paragraph 2.03, with DPDT contact outputs rated for 10A, 120 Vac
   3. Process Connection: 1/2-inch female NPT
   4. Product Data:
      a. Pressure switch shall consist of a pressure transducer and a precision switch. Pressure transducer shall be the diaphragm piston type with 316SS wetted materials unless otherwise specified. Piston backed by a cylinder disc to permit 10 times over-range pressure without affecting calibration.
      b. Range spring and piston shall be isolated from process fluids by the diaphragm. Switch provided with two 3/4-inch conduit connections. Switch assembly housing shall be type 4, and 4X per NEMA ICS6.
      c. Approximate set point and, if applicable, reset point indicated on calibrated scales. Repeatability and sensitivity shall be 1.0 percent of operating range. Unless otherwise specified, pressure switch shall be an adjustable deadband type.

E. Execution:
   1. Installation: Install in accordance with manufacturer's instructions and installation details.
   2. Application/Calibration: Application, calibration, and set points as specified in Section 40 06 70.

END OF SECTION

SECTION 40 79 00

MISCELLANEOUS INSTRUMENTS, CALIBRATION EQUIPMENT, INSTRUMENT VALVES, AND FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. This section includes requirements for miscellaneous instruments, instrument valves, process fluid signal transmission systems, and accessories used in association with instrumentation of process systems.

1.02 RELATED SECTIONS

A. This section contains specific references to related sections listed below. Additional related sections may apply that are not specifically listed below.
   1. Section 40 05 01 Piping Systems
   2. Section 40 05 02 Piping System Schedules including Sections numbered from 40 05 02.00 through 40 05 02.99
   3. Section 40 61 13 Process Control System General Provisions

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI/NSF 61	Drinking Water System Components – Health Effects
ASTM A269	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM B68	Seamless Copper Tube, Bright Annealed
ASTM D883	Definition of Terms Relating to Plastics
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics

1.04 SUBMITTALS

A. General:
   1. Procedures: Section 01 33 00.
   2. Submittal requirements: Section 40 61 13.

B. Action Submittals:
   1. Check “marked” copy of this specification section.
   2. Marked product literature of all equipment and features to be provided.

C. Closeout Submittals:
   1. Procedures: Section 01 33 00.
   2. Operating and maintenance submittals: Section 01 78 23.
      a. Final reviewed submittals.
      b. Manufacturer's operation and maintenance instruction, edited for this project.

1.05 QUALITY ASSURANCE

A. Approval/Certification: ANSI/NSF 61 used on potable (drinking) water for product.

PART 2 PRODUCTS

2.01 SIGNAL PIPING AND FITTINGS

A. Copper Tubing:
   1. Signal tubing shall be ASTM B68 DHP soft annealed copper with an ASTM D883 PVC jacket. Tubing shall be 1/4-inch O.D. by 0.03-inch wall or 3/8-inch O.D. by 0.032-inch wall as specified.

B. Stainless Steel Tubing:
   1. Tubing shall be seamless annealed ASTM A269 Type 316 stainless steel 1/2-inch and 3/8-inch tubing shall have a wall thickness of 0.035 inches and 1/4-inch tubing shall have a wall thickness of 0.028 inches.

C. Plastic Tubing:
   1. Tubing shall be extruded from high molecular weight, low density polyethylene compound. Tubing shall be 1/4-inch outside diameter and shall be black, unless otherwise specified or shown. Tubing shall meet the standard ASTM D1693 test for stress cracking of base materials. Wall thickness shall be 0.040 inches plus or minus 0.005 inches. Maximum working pressure shall be 80 psig, at 100 degrees F, or higher.
   2. Tubing manufacturers: Dekoron "P", Parker Hannifin "E", or approved equal.

D. Plastic Tubing:
   1. Plastic tubing shall be high molecular weight virgin polyethylene in accordance with ASTM D1248, Type III, Class C, Grade 3 with 0.04 inch minimum wall thickness.

E. Tubing Fittings:
   1. Tubing fittings shall be Type 316 stainless steel and shall be the double-ferrule swage type. Flare, ball sleeve compression or single-ferrule swage type are not acceptable.
   2. Fitting manufactures: Crawford "Swagelok", Hoke "Gyrolok", or approved equal.

F. Fittings:
   1. Fittings shall be Type 316 stainless steel. Fittings shall be of the swage ferrule design and shall have components (nut, body and ferrule system) interchangeable with those of at least one other manufacturer. Flare and ball sleeve compression type fittings are not acceptable. Fittings shall be Parker CPI, Crawford Swagelok, Hoke Gyrolok, or approved equal.

2.02 VALVES

A. Isolation Valves:
   1. Valves shall be full port ball valves with ASTM A276, Type 316 stainless steel trim and body and with UHMWPE seats and packing. Valves shall be Parker CPI, Whitey, Hoke, or approved equal.

B. Gage Valves:
   1. Gage valves shall be machined from ASTM A276, Type 316 stainless steel bar stock and shall be provided with 1/2-inch NPT connections and integral bleed plug. Valves shall be Anderson, Greenwood & Company M9 VIS-44, Hoke 6801L8Y, or approved equal.

C. Root Valves:
   1. Root valves shall be ASTM A276, Type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, Type 316 stainless steel bleed valve. ASTM A276, Type 316 stainless steel plugs shall be provided for unused ports.
   2. Lagging type units shall be provided for insulated vessels and pipes.
   3. Root valve manufactures: Anderson, Greenwood & Company M5 VIS-44, Hoke 6802L8Y, or approved equal.

D. Manifolds:
   1. Manifolds shall be three-valve and five-valve bar-stock type. Manifold body shall be machined from ASTM Type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and UHMWPE stem packing.
   2. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified.
   3. Manifold manufacturers: Anderson Greenwood AX3T VIS-4, Hoke GP831211F8YL, or approved equal.

2.03 INSTRUMENT SEALS – DIAPHRAGM AND ANNULAR

A. Diaphragm Seals:
   1. Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Wetted materials shall be submitted with proof of compatibility with the process fluid.
   2. Provide ½" process and instrument connections. Provide 316 stainless steel reducer for instrument connection if required.
   3. Provide seal flushing connection Type 316 stainless steel interconnecting fitting, and flush valve.
   4. Diaphragm seal manufactures: Ametek U.S. Gauge/Mansfield and Green Type SG, Ashcroft Type 101, or approved equal.

B. Annular Seals:
   1. Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be Type 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seal shall be over-proof rated to match the instrument side over-proof rating or better.
   2. Annular seal manufactures: OPW Engineered Systems/Ronningen-Petter Iso-Ring, Red Valve series 40, or approved equal.

C. Fill Fluid:
   1. Seals and associated instruments shall be factory filled as follows:
      a. Instrument side of seal, capillary tubing, and instrument shall be evacuated to an absolute pressure of 1.0 Torr or less; filled; and sealed. Provide silicone oil fill fluid, halocarbon fill fluid for chlorine applications, unless otherwise recommended by the seal or isolator manufacturer.
      b. Fill fluid manufacture: Dow Corning DC200, Syltherm 800, or approved equal.

2.04 PURGE ASSEMBLIES

A. Not used.

2.05 CALIBRATION EQUIPMENT

A. HART communicator and process calibration tool.
   1. Complete pressure, temperature, and mA loop calibrator
      a. Includes duplicate a transmitter basic information to a different transmitter
   2. Troubleshoot and calibrate HART smart digital transmitters
   3. Create calibration procedures and automatically document results
   4. Product Manufactor: Fluke 754 w/HART or approved equal.

PART 3 EXECUTION

3.01 SIGNAL PIPING

A. Signal tubing shall be 1/4-inch through ½-inch diameter and shall mate to the instrumentation for process systems. Tubing shall be supported at intervals not to exceed 3 feet. Plastic tubing shall be used only where specifically specified and shall be continuously supported in trays or conduits provided as specified in Division 26. Tubing shall be run parallel or perpendicular to walls and structural members. Signal tubing shall follow building surfaces closely unless carried in trays or conduit. Tubing supported directly from concrete or concrete block surfaces shall be spaced at least 1/8 inch from said surface by the use of suitable clamp backs.

B. Bends shall be formed to uniform radii without flattening or kinking the tube. Ends of tubing shall be square-cut and cleaned before being inserted into fittings. Compression fittings shall be used for splices, turns, and connections near instruments. Bulkhead assemblies shall be provided for termination of field tubing on panels.

C. Signal tubing testing shall be in accordance with Section 40 05 01 with test pressures and durations as specified in the Piping System Schedules.

3.02 VALVES

A. Valve type and arrangement shall be as specified on drawings.

B. Valves shall be pressure and temperature rated as specified in the Piping System Schedules.

END OF SECTION

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SECTION 41 22 33

BOOM LIFT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section provides specifications for a boom lift complete with base structure, boom, working platform, and hydraulic lift system.
2. Equipment List

Item	Equipment Number
Boom Lift	LFT-101

B. Type:

1. Boom lift shall utilize a diesel or dual fuel engine and include a 355 degree non-continuous swing articulating jib, and a 180 degree hydraulic platform rotator. Boom lift shall be of corrosion resistant construction.

C. Performance and Design Requirements:

1. Boom lift shall be the standard product of a manufacturer regularly engaged in the manufacture of boom lifts.

D. Operating Conditions:

1. Operating requirements and equipment characteristics shall conform to the following:

Item	Requirement
Platform Vertical Reach	33 ft. 10.5 in.
Horizontal Outreach	19 ft. 11 in.
Up and Over Height	17 ft.
Swing	355 Degrees Non-Continuous
Platform Capacity	500 lb.
Platform Size	30 x 60 in.
Platform Rotator	180 Degrees Hydraulic
Jib	4 ft
Range of Articulation	144 degrees (+84 -60)
Weight	9,700 lb.
Max Ground Bearing Pressure	64 psi
Drive Speed, 4WD	3.2 mph
Tilt Cut Out	3 Degrees
Gradeability, 4WD	45%
Turning Radius, Inside	5 ft.
Turning Radius, Outside	13 ft.

1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A92	Performance Standard for Mobile Elevated Work Platforms (MEWPs)

B. Factory Testing:

1. Boom lift manufacturer shall test the equipment in accordance with industry standards and federal regulations prior to shipment of the equipment. Test certifications shall be provided.

C. Shipment, Protection, and Storage

1. Equipment shipment, protection, and storage shall conform to the requirements specified in Section 01 66 00.

D. Environmental Conditions

1. Boom lift shall operate at an outdoor water treatment facility in Vancouver, Washington. Environmental conditions are specified in Section 01 11 80.

1.03 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01 33 00 and shall include the following information:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations form specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Design Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Manufacturer's catalog data confirming rated capacity, equipment speeds, horsepower and electrical requirements.
   3. Dimensional drawings and other construction details including materials of construction, component sizes and dimensions, equipment weights and required clearances.

1.04 WARRANTY

A. The equipment shall be warranted for two years on the entire machine, 2 years or 2,000 hours on the drivetrain, and five years on all specified major structural components. Warranty repairs or replacement shall be performed on site by the equipment manufacturer at no cost to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements:
   1. JLG
   2. Genie
   3. Approved equal

2.02 PRODUCT DATA

A. The following information shall be provided:
   1. Manufacturer's recommended storage, installation, and start-up procedures prior to shipment.
   2. Applicable operating and maintenance information in accordance with Section 01 78 23.
   3. Copy of fabricator's warranty.

PART 3 EXECUTION

3.01 FIELD TESTING

A. After delivery, the boom lift shall be completely tested to ensure compliance with the performance requirements as specified. As a minimum, testing shall be operating the equipment through a complete lift and lowering cycle, operation of the drivetrain to move the boom, and through a complete side-to-side rotation of the working platform, to determine that the equipment performs smoothly and safely without failure. Such tests shall be carried out with the hoisting equipment loaded as near to the specified capacity as possible. Any defects shall be corrected or replaced immediately by the Contractor and at no expense to the Owner. All testing and the costs of all required certification shall be at the Contractor's expense.

B. Testing shall be conducted by an OSHA certified hoist testing service company. A copy of the hoist testing service company certification shall be provided.

3.02 USE BY CONTRACTOR

A. Any boom lift system used by the Contractor shall be repaired, repainted and otherwise refurbished to like-new condition prior to its acceptance. In addition, the boom lift system shall be completely retested to demonstrate compliance with the specified performance requirements. The results of the retesting and recertification shall be submitted for review and be acceptable prior to acceptance of the boom lift. The Contractor assumes all responsibility for operation and maintenance until the boom lift system has been accepted.

3.03 TRAINING

A. During the commissioning period specified in Section 01 91 00, the boom lift manufacturer shall provide a factory-trained person experienced in boom lift system operation and maintenance for a period of at least 4 hours to train the plant operators. Training shall conform to Section 01 79 00.

END OF SECTION

SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. Equipment Lists:
   1. Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not listed below.
   1. Section 01 99 90: Reference Forms

1.03 QUALITY ASSURANCE

A. Arrangement:
   1. The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:
   1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ISO 1940-1	Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State: Part 1: Specification and Verification of Balance Tolerances

C. Unit Responsibility:

1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

D. The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

E. Balance:

1. Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015 \frac{GW}{N}$$

a. Where:

1) U_{per} = permissible imbalance, ounce-inches, maximum
2) G = Balance quality grade, millimeters per second
3) W = Weight of the balanced assembly, pounds mass
4) N = Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be *G* 2.5 (*G* = 2.5 mm/sec) or better in accordance with ANSI S2.19.

PART 2 PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.02 BEARINGS

A. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

D. All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

2.03 V-BELT ASSEMBLIES

A. Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

C. Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

2.04 PUMP SHAFT SEALS

A. General:

1. Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

B. Mechanical Seals:

1. Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self-aligning, and self-centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.
2. Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.
3. Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.
4. Candidate seals include:
    a. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
    b. AESSEAL RDSX seals with restriction bushing.
    c. John Crane 3740 seals with Type 24SL bushing.
5. Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.
6. Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start-up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

C. Shaft Packing:

1. Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 2.04 Mechanical Seals for the applicable pump and operating conditions.
2. Unless otherwise specified, lantern rings shall be bronze or UHMWPE, packing shall be die-molded packing rings of non-asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two-piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC-20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.
3. The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.05 COUPLINGS

A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.06 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.07 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "Caution Automatic Equipment May Start At Any Time". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.08 GAGE TAPS, TEST PLUGS AND GAGES

A. Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Division 40.

2.09 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment (Section 01 45 23), the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05 05 20.

2.12 SPARE PARTS

A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 EXECUTION

3.01 GENERAL

1. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 43 05 13

RIGID EQUIPMENT MOUNTS

PART 1 GENERAL

1.01 SUMMARY

1. Section includes: This Section specifies requirements for rigid equipment mounts. Rigid equipment mounts consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.
2. Conform to the requirements specified in the Equipment Mounting Schedule (Part 4 of this Section) or equipment mounting configuration requirements specified in individual equipment specifications. Where equipment mounting requirements are not specifically identified, the default mounting configuration for equipment consists of Pad Anchored Equipment Pads per Standard Detail D01007 with adhesive dowels anchoring the equipment pad to the foundation, equipment and driver mounted on a common mounting plate, mounting plate leveled within 0.005 inch/foot, equipment anchored to the equipment pad with cast-in-place equipment anchors per Standard Detail D01002, equipment anchor sleeve length is 10 times the bolt diameter, and the mounting plate is grouted in position using non-shrink grout.
3. If a conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.
4. Requirements for non-rigid equipment mounts (vibration isolation systems) are specified in the associated equipment specification. Furnish rigid equipment mounts conforming to the requirements of this Section for the equipment pad and other equipment mounting components supporting the vibration isolation system.

1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 99 90 - Reference Forms
   4. Section 03 60 00 – Grouting
   5. Section 05 05 20 – Anchor Bolts
   6. Section 43 05 13 – Rigid Equipment Mounts
   7. Section 43 23 62 – Variable Speed Vertical Turbine
   8. Section 43 31 13.13 – Vertical Liquid Pressure Vessel

1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

Reference	Title
ACI 318, Appendix D	Building Code and Commentary, Anchorage to Concrete
HI 14.3	Rotodynamic Pumps –for Design and Application
HI 14.4	Rotodynamic Pumps –for Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASCE 7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F1554	Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	International Building Code (including local amendments)

1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

1. Baseplate: A mounting plate configured with a top plate and a perimeter edge of the mounting plate that is below the top plate. Baseplates have a cavity between the top plate and a horizontal plane at the bottom edge of the perimeter of the mounting plate.
2. Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside of the mounting plate, excepting shear lugs/keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.). Soleplates have a top plate but lack the perimeter bottom edge that extends below the underside of the top plate that is a defining feature of baseplates.
3. Fabricated Steel Frame: An equipment mounting plate constructed of rolled steel shapes and plates welded into a frame. Fabricated steel frames do not have top plates.
4. Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.
5. Mounting Pads: Milled/machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.
6. Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or fabricated steel frames prior to grouting.
7. Shims: Thin stainless steel plates of uniform thickness used for fine adjustment of level. Shims are used on top of leveling blocks for mounting plate leveling or used between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.

8. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or fabricated steel frames for the purpose of leveling mounting plates.
9. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or fabricated steel frames for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or fabricated steel frames.
10. Reinforcement Dowels or Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
11. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and fabricated steel frames prior to grouting.
12. Grout Manufacturer: Refers to the manufacturer of the grout product used for installation of rigid equipment mounts.
13. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer. The Grout Manufacturer's Technical Representative shall not be an employee of the Contractor.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:
   1. Conduct a pre-installation meeting with the Construction Manager's representative prior to installation of equipment mounts.
   2. Schedule a pre-installation meeting for the equipment mounts associated with each system or group of identical equipment items.
   3. Where equipment anchors are cast in the floor slab or foundation, schedule the pre-installation meeting prior to pouring the floor slab or foundation.

1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, including addendum updates, (referenced sections need not be included for this Section) with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check marks denote full compliance with a paragraph as a whole. Underline each deviation and denote with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. Mark copies of this Section with the specification number and equipment number for inclusion (filing) with submittal materials furnished for individual equipment specifications.
   3. Name, employer, and a copy of the employee's Qualified Millwright card or other equivalent certificate of journeyman qualifications for millwrights who will install rigid equipment mounts, as specified in paragraph 3.02, Leveling.

4. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 1.07 Quality Control by Contractor.
5. List of Contractor's equipment installation staff that have completed epoxy grout manufacturer's grout installation training specified in paragraph 3.03, Manufacturer's Services.
6. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; grout formwork; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or fabricated steel frames to be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

B. Informational Submittals:
1. Procedures: Section 01 33 00
2. Submit equipment anchor calculations demonstrating compliance with paragraph 2.04, Equipment Anchor Design. Submit equipment anchor calculations with submittal information specified in the associated equipment specification.
3. Results of grout strength tests, as specified in paragraph 3.02, Grouting.
4. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in paragraph 3.03, Manufacturer's Services.

1.07 QUALITY ASSURANCE

A. Quality Control By Contractor:
1. Except where union rules require installation by another trade, all machinery to be mounted and leveled by journeyman millwrights.
2. Epoxy grout installation performed by employees that have completed the epoxy grout manufacturer's grout installation training specified in this Section.
3. Provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. Testing laboratory to sample and test materials installed as part of rigid equipment mounts specified in this Section. Testing laboratory services costs borne by the Contractor.
4. Where epoxy grout is specified for bedding mounting plates, furnish the services of a grout manufacturer's technical representative who has been factory trained by the grout manufacturer. The grout manufacturer's technical representative performs training and quality control for epoxy grout installation for rigid equipment mounts as specified in paragraph 3.03, Manufacturer's Services.

B. Special Inspection for Equipment Anchors:
1. Equipment anchors shall comply with special inspection requirements specified in Section 05 05 20.

PART 2 PRODUCTS

2.01 GENERAL

A. Configure rigid equipment mounts as specified in the Equipment Mounting Schedule (See Part 4 of this specification) or as specified in individual equipment specifications. Equipment mounting configuration requirements in individual equipment specifications govern over configuration requirements specified in the Equipment Mounting Schedule. In the absence of equipment mounting configuration requirements in either of these locations, mount equipment per the default requirements specified in paragraph 1.01.

B. Pumps installed in accordance with this Section, HI 14.3, and HI 14.4.

2.02 MATERIALS FOR EQUIPMENT MOUNTING

A. Equipment pads: Reinforced concrete as specified in Standard Details D01006, D01007, D01008, and D01009.

B. Mounting Plates: Cast iron, cast steel, plate steel, fabricated steel frame, polymer concrete, or FRP as specified in the equipment specification.

C. Grout type for equipment mounting as specified in the Equipment Mounting Schedule or in individual equipment specification.

1. Epoxy Grout for Equipment Mounting: Where epoxy grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, provide Epoxy Grout for Equipment Mounting as specified in Section 03 60 00. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it means Epoxy Grout for Equipment Mounting as specified in Section 03 60 00.
2. Cementitious Nonshrink Grout: Where non-shrink grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, Cementitious Non-shrink Grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it means Cementitious Non-shrink Grout as specified in Section 03 60 00.

D. Equipment anchors: Materials per the following table and per the area exposure condition where the equipment is installed. Section 01 61 45 specifies area exposure conditions.

Area Exposure	Equipment Anchor Materials
Indoor, Dry	Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod
Indoor, Wet	Galvanized Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod
Outdoor	304 Stainless, ASTM F593, Cond. CW

E. Anchor sleeves: Flexible polyurethane foam, steel cylinder/tubes, or corrugated/ribbed plastic sleeves.

F. Epoxy Primer: High-strength, lead free, chrome free, rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. Bond strength to sandblasted metal not less than 1500 psi.
    a. ITW Performance Polymer MS-7CZ primer
    b. Approved equal.

G. Anti-seize/Anti-galling compound: Molybdenum disulfide and graphite combination in aluminum complex base grease conforming to MIL-PRF-907E.
    a. Jet Lube 550 by Jet Lube, Inc.
    b. E-Z Break by LA-CO
    c. or approved equal.

2.03 EQUIPMENT PADS

A. Minimum dimensions for equipment pads are shown on structural drawings where a minimum equipment pad mass is required for vibration dampening/control. Contractor shall increase dimensions as necessary to accommodate reinforcement, minimum coverage, and grout installation requirements with provided equipment soleplate and/or baseplates. All changes must be submitted for approval by the Engineer.

B. Equipment Pad Drainage:
    1. Furnish equipment pads with 2-inch drains.
    2. Locate equipment pad drains at drainage outlets from equipment or mounting plates
    3. Route equipment drainage outlets or mounting plate drainage outlets to equipment pad drains
    4. Route equipment pad drains to the floor drainage collection system.
    5. Drainage piping for equipment pads shall be routed below the finished floor elevation.
    6. Exposed drain lines mounted on the floor are not acceptable.

2.04 EQUIPMENT ANCHORS:

A. Equipment Anchors:
    1. All thread rod with heavy hex welded nuts, heavy hex bolts, post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors), or adjustable canister anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.
    2. Bolt length as required for the specified embedment and sleeve length. Reduce equipment anchor sleeve length as necessary to fit within finished height of equipment pad if equipment pad height is insufficient to provide specified equipment anchor sleeve length. Unified Coarse Thread Series per ASME B1.1.
    3. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) conforming to the requirements of Section 05 05 20.
    4. Adjustable canister anchors consist of cast-in-place pre-manufactured adjustable anchor inserts. Provide a minimum of 6 inches of vertical bolt height adjustment and lateral adjustment of the anchor bolt while maintaining the anchor bolt in a true vertical orientation.
        a. Jakebolts as manufactured by Unisorb

b. Heavy Duty Adjustable Anchors as manufactured by Deco
c. Rowan Adjustable Canister Anchor Bolt
d. or approved equal.

B. Equipment Anchor Design:
1. Size (diameter) of anchors for clamping/fastening mounting plates to equipment pads determined by the equipment manufacturer.
2. Comply with 2021 I-Codes with Washington Amendments for equipment anchor size, embedment, and edge distance.
3. Resistance to lateral (horizontal) loads based on the static friction between the mounting plate and its supporting grout pad. Include the clamping force applied by equipment anchors and the weight of the equipment for calculating static friction resistance to lateral loads. Do not include lateral (shear) loading on equipment anchors or adhesion between mounting plates and supporting grout in lateral loading resistance calculations.
4. Furnish equipment anchor calculation submittals for all equipment unless one of the following exceptions is applicable:
a. The importance factor, I_p, for the equipment is equal to 1.0, flexible connections are provided for all electrical and mechanical connections to the equipment, the center of mass of the equipment is less than 48 inches above the floor when it is mounted or attached to the structure, and the equipment weighs less than 400 pounds.
b. The importance factor, I_p, for the equipment is equal to 1.0, flexible connections are provided for all electrical and mechanical connections to the equipment, and the equipment weighs less than 20 pounds.
5. Equipment anchor calculations sealed by a registered structural or civil engineer licensed in the State of Washington.

C. Equipment Anchor Tension:
1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, tighten equipment anchors to provide a final clamping force that produces a tensile stress of 15,000 psi in each equipment anchor. Tighten adjustable canister anchors to the manufacturer's maximum safe working load. Tighten post-installed anchors to manufacturer's recommendations.
2. Bolt torque values required to produce the specified bolt tension based on well lubricated plain finish national coarse thread bolts are presented in the following table. Revise bolt torque values per equipment manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

Bolt Diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Final bolt torque for 15,000 psi bolt stress (ft*lbs)	8	15	30	50	80	125	180	250	400

3. Prior to leveling and grouting mounting plates, pull test grouted equipment anchors (standard detail D01003) to the values specified in the following table.

Anchor Diam. (in)	3/8	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Pull test load (kips)	2.1	3.8	6.1	9.1	13	17	22	28	43

D. Anchor Sleeves:
   1. Provide sleeves for equipment anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.
   2. Adjust equipment anchor length/embedment depth shown in Standard Detail D01002 and Standard Detail D01003 if sleeves are not required.
   3. Sleeves may be installed at the Contractor's option if not specified in the Equipment Mounting Schedule or in individual equipment specifications provided they do not interfere with specified embedment lengths.
   4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room temperature vulcanizing (RTV) sealant prior to embedment/installation.

2.05 MOUNTING PLATES

A. General:
   1. Round edges of surfaces of baseplates, soleplates, and fabricated steel frames that bear on grout to a radius of not less than 0.25 inch.
   2. Round perimeter corners of baseplates, soleplates, or fabricated steel frames to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.
   3. Provide grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) and air release holes in all baseplates and soleplates.
   4. Provide grout relief or vent holes (minimum 1 inch in diameter) in all baseplates and soleplates.
   5. Drill mounting holes for equipment anchors through baseplates, soleplates, and fabricated steel frames. Open slots or burned out holes for equipment anchors are not permitted.
   6. Provide acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease where terminations to baseplates and soleplates are required.
   7. Where fasteners terminate only into the baseplate, soleplate, or fabricated steel frame, threaded lengths (tapped or embedded in mounting plates) shall be not less than the bolt diameter.
   8. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, tap jackscrew threads in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
   9. Mill mounting pads and/or mounting surfaces of baseplates, soleplates, and fabricated steel frames flat and coplanar within 0.0005 inch per foot in all directions after all welding and stress relieving.
   10. Pre-grout baseplates prior to milling.

11. Baseplates, soleplates, and fabricated steel frames provide common support for the equipment and driver (and flywheel, if one is specified).
12. For equipment with drivers 20 horsepower and greater, provide transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates, soleplates, and fabricated steel frames.
13. Provide alignment/positioning jackscrews in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews provided for transverse alignment of the flywheel, if flywheels are specified in the equipment specification.)
14. Where specified in individual equipment specifications; baseplates, soleplates, and fabricated steel frames fitted with RK Fixators as manufactured by Unisorb, or approved equal.
    a. Fixators installed at mounting surfaces for drivers.
    b. Fixators consist of a three-piece wedge leveling adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface for the equipment driver.

B. Fabricated Steel Frames:
1. Fabricated steel frames consist of structural steel shapes welded to form mounting plates.
2. Fabricated steel frames to be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped to accommodate the equipment driver and accessories.
3. Fabricated steel frames for split case pumps include supports for suction and discharge elbows, if required by the specified configuration.
4. Perimeter members consist of I-beams or C-channel with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
5. Fabricated steel frames furnished with thickened steel mounting pads welded to the fabricated steel frame for bolting equipment to the mounting plate.
6. Sandblast surfaces of fabricated steel frames in contact with grout to white metal per SSPC SP-5.
7. Apply a high-strength epoxy primer as specified in paragraph 2.02 within 8 hours of sandblasting the fabricated steel frame.

C. Baseplates:
1. Baseplates may be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.
2. Provide internal stiffeners on all cast and fabricated baseplates. Stiffeners designed to allow free flow of grout from one section of the baseplate to another.
3. Provide a minimum 2 inches high by 6 inches wide opening in cross bracing and stiffeners for grout flow between sections of the baseplate.
4. All welds continuous and free from skips, blowholes, laps and pockets.

5. Pre-grout baseplates at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Pre-grout baseplates in the field if they have not been pre-grouted at the factory. Remove the equipment from the baseplate, invert the baseplate, and pre-grout as specified in this Section.
6. Prior to pre-grouting, sandblast the underside of baseplates to white metal per SSPC SP-5.
7. Complete pre-grouting within 8 hours of sandblasting.
8. Fill the underside of the baseplate to the bottom edges of the baseplate.
9. Seal cast iron baseplates to prevent surface bleeding prior to shipment to the project site.

D. Plate Steel Soleplates:
1. Not less than 1.0 inch thick for equipment with drivers greater than 30 horsepower.
2. Furnished with grout keys/lugs or stiffeners on the underside of the soleplate.
3. Flat uniform horizontal surface on underside of plate steel soleplates, excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.).
4. Prior to milling the mounting pads for equipment or mounting surfaces, scribe the words “THIS SIDE DOWN”, using welding rod material, on the underside of plate steel soleplates , .
5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.
6. Sandblast surfaces of plate steel soleplates in contact with grout to white metal per SSPC-SP-5, prior to shipment to the project site.
7. Apply a high-strength epoxy primer as specified in paragraph 2.02 within 8 hours of sandblasting the underside of plate steel soleplates.
8. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom-suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of mounting on a common equipment pad and soleplate. In such instances, support the equipment at the feet or mounting surfaces on individual plate steel soleplates. Level individual plate steel soleplates and grout into place on the individual piers or equipment pads as specified in this Section. Where multiple soleplates are installed to support one piece of equipment, soleplates shall be coplanar within 0.002 inch/foot.

E. Polymer Concrete Soleplates:
1. Pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.
2. Mounting surfaces shall be coplanar within 0.002 inch/foot.
3. Furnished with a uniform horizontal surface over the entire underside of the mounting plate, excepting grout keys, grout pour holes and vent holes.
    a. PoxyBase as manufactured by Basetek
    b. Chembase as manufactured by Goulds
    c. Approved equal.

F. Corrosion Resistant FRP Baseplates:
   1. Pre-formed fiber reinforced plastic fabrications.
   2. Product of the manufacturer of the equipment that is mounted on the baseplate.

PART 3 EXECUTION

3.01 PREPARATION

A. Concrete Equipment Pad Preparation:
   1. Roughen the top of the equipment pad after the concrete has reached its 28-day compressive strength.
   2. Remove all laitance and defective or weak concrete.
   3. Roughen surface profile to 0.25 inch amplitude, minimum.
   4. Expose broken aggregate without dislodging unbroken aggregate from the cement matrix and without fracturing concrete and aggregate below the concrete surface.
   5. Roughen using a light-duty (15 pounds or less), hand-held chipper with a chisel type tool.
   6. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted are not acceptable.
   7. Demonstrate removal of defective or weak concrete to the Construction Manager prior to leveling.
   8. Chip the surface of the concrete such that the final elevation of the equipment pad provides the grout manufacturer's recommended thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate, or underside of the fabricated steel frame.
   9. Remove all dust, dirt, chips, oil, water, and any other contaminants and protect the surface with plastic sheeting until grout is installed.
   10. Protect concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions. Protect from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Restore leveling positions by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates installed level on the epoxy putty.

B. Grout Form Construction:
   1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout and manufacturer's recommendations for form edge clearance for intended pour scheme, but not less than two inches.
   2. Install grout expansion joints at 4 to 6 foot intervals, perpendicular to the centerline of baseplates. Design expansion joints in accordance with the grout manufacturer's written instructions.
   3. Coat forms with three coats of paste wax on all areas of the forms that will be in contact with the grout.
   4. Wax forms before assembly.
   5. Prevent accidental application of wax to surfaces where the grout is to bond.
   6. Remove any foreign material, such as oil, sand, water, wax, grease, etc., from concrete surfaces that will contact grout before forms are installed.

7. Forms must be liquid tight. Seal any open spaces or cracks in forms, or at the joint between forms and the foundation using sealant, putty, or caulking compound.
8. Chamfer vertical and horizontal edges of the grout with 45-degree chamfers as specified in equipment pad details. Locate 45-degree perimeter chamfer strips at the final elevation of the grout.
9. Match chamfers in concrete portions of the equipment pad.
10. Install block outs at all leveling positions to allow removal of leveling equipment and leveling nuts to be backed off after the grout has cured.
11. Coat jackscrews with a light oil or other acceptable bond-breaking compound prior to grouting.
12. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.
13. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.

C. Mounting Plate Preparation:
1. Roughen the underside of soleplates and fabricated steel frames and wipe with a residue-free solvent as recommended by the epoxy primer manufacturer before placement of the baseplate, soleplate, or fabricated steel frames on the equipment pad for leveling. Roughen surfaces of mounting plates that will be in contact with grout by power tool cleaning. Cleaning performed by power wire brushing, power sanding, power grinding, power tool chipping or power tool descaling. Impart a minimum profile of 1.0 mil.
2. Prior to placement on the equipment pad for leveling, roughen exposed grout surfaces of pre-grouted baseplates and wipe with a residue-free solvent as recommended by the manufacturer of the epoxy grout used for pre-grouting.
3. Prepare the underside of corrosion-resistant FRP baseplates and polymer concrete baseplates per the baseplate manufacturer's recommendations and prior to placement of the baseplate on the equipment pad for leveling.
4. Grouting for installation of mounting plates on equipment pads completed prior to connecting any field piping or electrical and instrumentation systems.
5. Unless the Construction Manager accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames leveled and grouted with the equipment removed.

3.02 INSTALLATION

A. Leveling:
1. Except where union rules require installation by another trade, all equipment and machinery mounted and leveled by a Qualified Millwright.
2. Use precision surveying equipment for leveling.
3. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or fabricated steel frame with a plan dimension greater than 4 feet.
4. Baseplates, soleplates, and fabricated steel frames leveled to the tolerance specified in the Equipment Mounting Schedule, in the individual equipment specification, or as otherwise required by the equipment manufacturer, if more stringent.

5. Apply an anti-seize or anti-galling compound, specified in paragraph 2.02, to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.
6. Level all baseplates, soleplates, and fabricated steel frames against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited.
7. Use stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
8. Leveling nuts may be used for leveling baseplates, soleplates, and fabricated steel frames weighing less than 200 pounds (inclusive of the weight of the equipment if leveled with the equipment on the mounting plate).
9. Leveling blocks shall be stainless steel, 4 inches square and 1.5 inches thick with an open-ended slot terminating in the center for the equipment anchor.
10. Machine leveling blocks flat on all horizontal surfaces and place under the baseplate or soleplate at each equipment anchor.
11. Provide pre-cut stainless steel shims, slotted for removal after grouting. Coat leveling blocks and shims with a light oil just prior to beginning the leveling and grouting work. Place shims so the tabs on the shims are easily accessible.
12. Clamp baseplates, soleplates, or fabricated steel frames in position (after leveling) by installing the equipment anchor nuts and washers.
13. Apply bolt tension to fix the position of mounting plates during grouting (30 to 60 percent of the final clamping force applied to clamp the mounting plate to the equipment pad).
14. Prior to grouting, verify that the correct level and position of the baseplate, soleplate, or fabricated steel frame has been maintained after clamping it to the equipment pad.

B. Grouting:
1. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.
2. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.
3. Place epoxy grout using a method that avoids air entrapment.
4. Place grout at one end of the baseplate or soleplate and work grout toward the opposite end to force the air out from beneath the baseplate or soleplate.
5. Pour grout through a head box into grout pouring holes.
6. When the head box is moved to the next grout hole, place a 6 inch standpipe over the grout hole and fill with grout.
7. Pour grout to the top of the lower flange of the perimeter I-beams or C-channel of fabricated steel frames.
8. Pour grout at least 0.125 inch but not more than 0.5 inch above the bottom or underside of the perimeter edge of a baseplate or soleplate.
9. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
10. Never allow the grout in the head box to fall below the top of the baseplate or soleplate once the grout has made contact with the baseplate or soleplate.

11. Grout placement applied in one continuous pour, until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.
12. Prepare subsequent batches of grout prior to depleting the preceding batch.
13. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.
14. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) remove the standpipes and clean excess grout from all surfaces.
15. Check for leaks throughout grout pours. Repair leaks immediately to prevent formation of voids.
16. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.
17. Cure grout in accordance with the grout manufacturer's written instructions.
18. Collect at least one grout sample from each grout pour. Where specified in the individual equipment specifications, collect a grout sample from the grout pour for each equipment pad.
    a. Place samples in a cylinder of sufficient size to yield three 2-inch cubes as test samples.
    b. Label samples with project name, date, time, the equipment number, and ambient temperature at the time of placement.
    c. Place samples next to the foundation of the equipment being grouted and cure for 48 hours.
    d. Test grout samples in accordance with the grout manufacturer's recommendations.
    e. Grout samples tested by the independent testing laboratory specified in paragraph 1.07 Quality Control by Contractor.
    f. Report test results directly to the Construction Manager.

C. Completion:
    1. Upon acceptance by the Construction Manager and the equipment manufacturer's representative and after the grout has reached sufficient strength, remove grout forms and block outs at leveling positions. Remove leveling blocks and shims or wedges and support plates. Back off leveling nuts and jack screws to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
    2. Tighten equipment anchor nuts using calibrated indicating torque wrenches, to develop the full bolt tension specified in paragraph 2.04 Equipment Anchor Tension.
    3. Tighten equipment anchor nuts in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.

4. After applying additional wax or mastic to exposed portions of equipment anchors and tightening to final torque values, fill and point block outs (pockets) for access to leveling nuts, leveling blocks, shims, or wedges with the grout material installed under baseplates, soleplates, or fabricated steel frames. Remove jackscrews and fill holes in the baseplate, soleplate, or fabricated steel frame with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or fabricated steel frame movement (soft foot) by individually loosening and re-tightening each equipment anchor. Measure and record vertical movement at each equipment anchor during loosening and retightening. Measure vertical movement using a magnetic-based dial indicator on the baseplate, soleplate, or fabricated steel frame referenced to the epoxy grout surface of the equipment pad, or other approved method. Vertical movement exceeding 25 micrometers (0.001 inch) indicates a soft foot condition. Soft foot conditions are sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames.
6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Mark grout voids. A grout void is sufficient cause for removal and reinstallation of grout and baseplate, soleplate, or fabricated steel frame. At the discretion of the Construction Manager, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API RP 686.

D. Piping Connections:
1. Anchor piping connecting to flexible connections and/or expansion joints such that the intended function of these connections/joints is maintained in the piping system without imposing strain on the equipment connections.
2. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, delete any flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
    a. Install equipment pad as shown in the detail specified in the Equipment Mounting Schedule or in the individual equipment specification.
    b. Install the baseplate, soleplate, or fabricated steel frame supporting the equipment and grouted in place as specified in this Section.
    c. Install and align piping between equipment connections and field piping without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints bolted up and pressure-tested.
    d. All piping must be fully supported by supports designed to accept their full weight and thrust forces.
    e. Install the final section of piping. Align the final section of pipe with the equipment and field connections without the use of jacks, chain falls, or other devices to force it into alignment.
    f. Do not weld the final piping joints until after the previous steps have been completed and accepted by the Construction Manager.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Services

1. Epoxy Grout Training: Prior to commencing rigid equipment mount installation work on equipment pads, furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers who will be using epoxy grout for rigid equipment mount installations. Epoxy grout training school duration to be not less than 4 hours duration and covers all aspects of using the products, including form construction for each equipment installation, surface preparation, mixing, application, void prevention/elimination, and clean up. This requirement does not relieve the Contractor of overall responsibility for this portion of the work. Epoxy grout manufacturer to furnish a list of school attendees who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.
2. Epoxy Grout Quality Control: The epoxy grout manufacturer's technical representative provides quality control services for equipment mounted with epoxy grout. The epoxy grout manufacturer's technical representative must be present (on site) to inspect and verify that the installation personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.
3. Epoxy grout manufacturer's technical representative performs the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:
    a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
    b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied. Inspect surface for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.
    c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
    d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
    e. Inspect preparation and application of epoxy grout form work for conformance to the specifications and manufacturer's recommendations for form edge clearance.
    f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
    g. Inspect epoxy grout for cure.
    h. Inspect and record that localized repairs made to grout voids conform to the specification requirements.
    i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.
    j. Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," Form 43 05 13-A in Section 01 99 90.

B. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

3.04 FINAL INSPECTION

A. The Construction Manager will conduct a final inspection with the Contractor for conformance to requirements of this Section.

PART 4 EQUIPMENT MOUNTING SCHEDULE

Equipment Mounting Schedule

Equipment Number	Specification Section	Specification Title	Equipment Pad Detail	Mounting Plate Leveling Tolerance (inch/foot)	Equipment Anchor Type	Equipment Anchor Sleeve Length	Grout Type	Application Notes
Default Config.	*Various*	*Various*	*D01007*	*0.005*	*D01002*	*10D*	*Non-shrink*	*Default equipment mounting configuration for all equipment not otherwise specified in this schedule*
Freestanding floor-mounted electrical panels and equipment	*Various*	*Various*	*D01006*	*Not applicable*	*D01004*	*Not required*	*Not required*	
F0100 F0200 F0300 F0400 F0500 F0600	*43 31 13.13*	*Vertical GAC Liquid Pressure Vessel*	*D01007*	*0.005*	*D01002*	*6D*	*Non-shrink*	
PMP100 PMP200	*43 23 62*	*Variable Speed Vertical Turbine Pumps*	*D01007*	*0.005*	*D01003*	*12D*	*Epoxy*	

END OF SECTION

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SECTION 43 23 03

GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL-FLOW PUMPING EQUIPMENT

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:

1. This section, when referenced in the detailed specification section, provides minimum requirements applicable to centrifugal and axial-flow pumping equipment furnished under this contract. More restrictive requirements and/or specific citation or requirement in conflict with a 43 23 03 provision, where found in individual pump specifications, supersede requirements of this section for each specific instance.
2. "Detailed pump specification," "detailed specification," "individual pump specification," "referencing section," or words of similar import in this section, mean the specification section where the requirements for specific pump performance are presented. "Pumping unit," whenever and wherever used, means the complete pumping assembly, including driver (whether engine, turbine, or motor) and includes accessories such as variable-speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and supports for equipment furnished with the pump.
3. For a subset of pumps, a number of provisions of this section are required. These requirements (refer to paragraphs 1.05 and 1.07 in this section) are in addition to requirements applicable to pumps. The subset of pumps is defined as pumping equipment meeting any of the following criteria:
    a. All pumping unit specifications where the words "custom-engineered" appear in the title of the specification section
    b. Where a particular Section 43 23 03 provision is cited in the detailed section

B. Definitions:

1. The following definitions apply for classifying pumps specified in this and referencing sections:
    a. General: Terminology and definitions in this section follow those established in American National Standards Institute (ANSI)/Hydraulic Institute (HI) 9.1 through 9.5, unless otherwise noted.
    b. Solids-bearing liquids: Liquids to be pumped containing, or assumed to contain, solids that require appropriate pump design considerations and/or materials of construction. Solids-bearing liquids are liquids with settleable solids exceeding 50 milligrams per liter (mg/L) and include wastewater, stormwater, primary effluent, return sludge, return activated sludge (RAS), trickling filter circulation, and similar services.
    c. Clear liquids: Liquids to be pumped mostly free of deleterious solids. Potable water, heat reservoir, raw water, secondary effluent pumping, and similar services are clear liquids.

d. Efficiency: For the purposes of this section and sections referencing this section, efficiency, as related to pumps, is the ratio of the pump output power (water horsepower [hp]) divided by the pump input power (brake horsepower) required to deliver the total head, with meanings as defined in ANSI/HI 14.2.6.6. For column-type pumps, efficiency is computed inclusive of inlet, bowl, column, and discharge head losses.

e. Net positive suction head, 3 percent reduction (NPSH3): For the purposes of this section and sections referencing this section, NPSH3 means the value of net positive suction head (NPSH) resulting in a reduction of 3 percent in the developed pump discharge head when the pump is tested in accordance with procedures established by ANSI/HI. NPSH3 is the successor designation to net positive suction head required (NPSHR). Where NPSHR is used in the contract documents it means NPSH3.

f. NPSH margin: For the purposes of this section and sections referencing this section, "NPSH margin," wherever used, means net positive suction head available (NPSHA) divided by the candidate pump's NPSH3 for the specific operating condition in question.

g. POR: preferred operating region as defined in ANSI/HI 9.6.3.

h. AOR: allowable operating region as defined in ANSI/HI 9.6.3.

1.02 TYPE

A. Provisions and requirements contained in this section apply specifically to centrifugal and axial-flow pumps, both vertical and horizontal, commonly falling into the generic types covered by ANSI/HI 14.1 through 14.3. This section does not apply, except by specific reference, to positive-displacement pumps of any type.

1.03 REFERENCES

A. This section (Section 43 23 03) contains references to the following documents. They are a part of this section and any referencing section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. The following order of precedence prevails in the event of conflict between the requirements of this section or any referencing section and those of the listed documents (in the order of primacy):

1. The referencing section
2. This section
3. The referenced document

B. Unless otherwise specified, references to documents mean the documents in effect at the time of advertisement for bids or invitation to bid (or on the effective date of the agreement if there were no bids). References to documents mean the replacement documents issued or otherwise identified by the organization if referenced documents have been discontinued, or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings
AISC	American Institute of Steel Construction—Manual of Practice
ANSI/API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries (also referenced as ISO 13709-2009)
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay
ANSI/HI 9.1–9.5	Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation
ANSI/HI 9.6.1	Rotodynamic Pumps—Guideline for NPSH Margin
ANSI/HI 9.6.2	Centrifugal and Vertical Pumps for Allowable Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps (Centrifugal and Vertical) Guideline for Allowable Operating Region
ANSI/HI 9.6.4	Rotodynamic Pumps—Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps—Guideline for Dynamics of Pumping Machinery
ANSI/HI 9.8	Pump Intake Design
ANSI/HI 11.6	Submersible Pump Tests
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.4	Rotodynamic Pumps for Installation, Operation, and Maintenance
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests
API 686/PIP REIE 686	Recommended Practices for Machinery Installation and Installation Design
ASME B18.8.2	Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series)
ASME Code	ASME Boiler and Pressure Vessel Code
ASTM A27	Steel Castings, Carbon, for General Application
ASTM A36	Carbon Structural Steel
ASTM A148	Steel Castings, High Strength, for Structural Purposes
ASTM A322	Steel Bars, Alloy, Standard Grades
ASTM A564	Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A571	Austenitic Ductile Iron Castings for Pressure-Containing Parts Suitable for Low-Temperature Service
ASTM A995	Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts, Grades 2A, 3A, or 6A
ASTM B148	Aluminum-Bronze Sand Castings
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
NSF/ANSI 61	Drinking Water System Components – Health Effects
IEC 61298-2	Process Measurement and Control Devices. General Methods and Procedures for Evaluating Performance Tests Under Reference Conditions
ISO 1940-1:2003	Mechanical Vibration—Balance quality requirements for rotors in a constant (rigid) state—Part 1: Specification and verification of balance tolerances
ISO 9001	Quality Management Systems—Requirements, 3rd Edition (2000)
ISO 10816-1	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 1: General Guidelines, Annex B, Table B.1. Class I, II or II, as applicable. For the purposes of this specification, Annex B of ISO 10816, Part 1 forms a part of this specification and ISO 10816, Part 1.

Reference	Title
ISO 10816-3	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ, Annex A, Table A.1 and A.2. For the purposes of this specification, Annex A of ISO 10816, Part 3 forms a part of this specification and ISO 10816, Part 3.
ISO 10816-6	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 6: Reciprocating machines with power ratings above 100 kW, Annex A, Table A.1, machine vibration classification number 3. For the purposes of this specification, Annex A of ISO 10816, Part 6 forms a part of this specification and ISO 10816, Part 6.
ISO 10816-7	Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 7: Rotordynamic Pumps for Industrial Applications, Including Measurements on Rotating Shafts, Annex A, Tables A-1 and A-2 Category II as applicable. For the purposes of this specification, Annex A of ISO 10816, Part 7 forms a part of this specification and ISO 10816, Part 7.

1.04 DESIGN REQUIREMENTS, ALL PUMPS:

A. General:

1. Equipment furnished under sections referencing this section shall meet the longevity objective that the pumping equipment, motor, shafting, couplings and appurtenances are designed for at least a 20-year service life and 3 years of “uninterrupted operation.” Select all components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, that are designed to function without damage or disassembly at reverse rotational speeds up to 130 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump’s entire full-speed operating curve. Furnish pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding 5 seconds with drivers sized to operate continuously at the power requirement for that condition even though the power requirements at the rated condition may be less.
2. Pump selections proposing maximum diameter impellers for the proposed pump model and casing size will not be accepted.
3. With the exception of submersible pumps and the inlet connection for pumps designed to operate in open forebays or wetwells, pump connection nozzles shall be designed for the loads and moments stipulated in ANSI/HI 9.6.2. Where ANSI/HI 9.6.2 does not cover a specific pump type or category, or where that document is silent on allowable nozzle loads or a particular type of nozzle load (e.g., thermal pipe strain), the contractor shall furnish documentation from the manufacturer attesting to the limitations on loads and moment forces that can be tolerated on each connection and recommended connection details to be used.

B. Pump Selection:
   1. Proven designs:
      a. Pumps furnished under sections referencing this section shall be proven designs that have been in similar conditions of service with no objectionable performance characteristics for a period of not less than 5 years. The contractor shall furnish a detailed list of installations with contact information supporting qualification under this requirement with the information required under paragraph 1.08. To satisfy this requirement, the listed pump shall be of the same size volute or bowl, discharge case and nozzle size, and impeller design (including number of vanes) and is operating under similar conditions of pumped fluid, head, capacity, speed, rotation, and NPSHA.
      b. The contractor may propose alternative equipment that cannot meet the requirement for a proven design under this paragraph, subject to additional documentation requirements and under the following conditions:
         1) The proposed design has been in successful operation under similar conditions of volute or bowl, discharge case and nozzle size, impeller design (including number of vanes), pumped fluid, head, capacity, rotation, and NPSHA, but at a higher speed for a period of not less than 3 years.
         2) The proposed design has been in operation in designs where both larger and smaller nozzle size pumps have been in service for a period of not less than 5 years, and impeller design (including number of vanes, plus or minus one vane in pumps with four or more vanes), pumped fluid, head, capacity, speed, and NPSHA are similar to that for the proposed installation and within one synchronous speed higher or lower than that indicated in the detailed specification.
         3) In addition to the installation list required under this paragraph, provide dimensional drawings, bill of materials, and historical (certified) shop test results for candidate pumps documenting performance including, but not limited to head, capacity, speed, and NPSHR, and limit of stable hydraulic operation based on the onset of suction recirculation, if available. Results should match or bracket the specified performance and two or more candidate pump results may be required.
      c. If the proposed pump is not a proven design under either of the above paragraphs, the contractor shall demonstrate, by operation of a test pump in a fully equipped hydraulic test facility, that the proposed pump in the size and at the speed proposed with the proposed impeller design will have acceptable operating characteristics under the conditions specified for the proposed installation. Set up the test pump and perform a witnessed demonstration prior to designing, fabrication, and testing of any of the equipment proposed for the specific installation.
   2. General performance criteria:
      a. Pumps furnished under this section and any referencing section shall operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and are specifically selected for NPSH margin requirements detailed in paragraph 1.04 NPSH margin limitations. Pump selections that do not provide the specified margin will be rejected.

3. General design criteria:
    a. Select pumps furnished under sections referencing this section that are designed in accordance with applicable portions of ANSI/HI 9.6.2, 9.6.3, 9.6.4, 9.6.6, 9.6.8 and 14.1-14.3 and the requirements of this section. Select pumps that are specifically designed to pump the fluid described in the detailed specification and to operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Clogging or fouling conditions may be of any cause, demonstrated by a 5 percent or greater capacity drift within 2 hours of sustained operation.
    b. Unless otherwise noted or specified, slope pump head capacity curves in one continuous curve within the specified operating conditions. Do not permit points of reverse slope inflection capable of causing unstable operation within the specified zone of continuous-duty operation. Pumps with head/capacity curves with a reverse inflection are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.
    c. Column-type (vertical-turbine, vertical-column solids-handling, and axial-flow propeller and mixed-flow) pumps shall have bells selected to provide intake velocity of not less than 3.5 feet per second (ft/s) or more than 4.0 ft/s when operating at the maximum specified flow or the flow resulting from the lowest specified operating head at maximum speed, whichever is greatest (“peak flow”). Pump discharge column sizes shall limit the calculated average velocity at peak flow to no more than 12 ft/s.
    d. Pumps specified to operate at constant-speed shall function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by Condition Points A, B, and C and any other continuous-duty operating condition specified in the detailed specification referencing this section. In addition, constant-speed pumps shall be selected to place Condition Point C in the detailed specification within the POR, or a modified POR if stipulated in the detailed pump specification.
    e. Pumps specified to operate at variable-speed shall function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by Condition Points A, B, and C and any other continuous-duty operating condition specified in the detailed specification referencing this section. Unless otherwise specified in the section referencing this section, acceptance criteria shall include the following:
        1) Operating Condition Point C and any other continuous-duty operating point specifically required in the detailed specification shall reside within the region defined by the POR, or in a modified POR if stipulated in the detailed pump specification.
        2) Unless otherwise noted in the detailed specification referencing this section, Operating Condition Point A may reside in the AOR outside the POR; Condition Point C will be located within the POR, or in a modified POR if stipulated in the detailed pump specification; and Condition B will preferably be located within the POR, or within 5 BEPQ percentage points (in terms of flow) outside the POR so long as Condition Point C resides in the POR or the stipulated modified range.

4. POR:
    a. Unless otherwise specified, the POR for a given pump is as defined in ANSI/HI 9.6.3.
    b. The detailed specifications may stipulate a narrower POR than indicated in ANSI/HI 9.6.3.
    c. The suction-specific speed (S) shall not exceed 8,500, unless otherwise indicated in the detailed specifications.
    d. For high- S pumps (greater than 8,500) and other conditions as determined by the engineer, a narrower stable operating region may be defined in the detailed specifications and then identified in ANSI/HI 9.6.3 for the POR. The detailed specifications take precedence over this section.
    e. The detailed specification sections identify the duty points that must be within a pump's POR and those that may be within the AOR and take precedence over this section.

C. Critical Speeds and Natural Frequencies:
    1. General:
        a. The criteria of this paragraph applies to pumps, provided that the foundation and support details provided at the time of pump design are accurate. Repair or replace pumps exhibiting adverse behavior after installation from resonance, vibration, or fatigue at no cost to the owner. The criteria apply to the equipment in "like-new" condition as well as the "as-worn" condition (i.e., when parts, individually and as a composite, reach the manufacturers' maximum tolerances). Critical speed and natural frequency data submittal requirements depend upon the pump:
            1) For the more critical pumps that are covered under paragraph 1.05, and other pumps covered under paragraph 1.04 Alternate mass elastic design, where specified in the detailed specification section, the contractor is required to submit analytical reports confirming requirements on critical speeds and natural frequencies prior to pump fabrication, as specified
            2) Unless otherwise specified, for constant-speed pumps and variable-speed pumps with suction size less than 6 inches diameter, no critical speed submittal is required
            3) Except as modified in paragraph 1.04 Alternate mass elastic design, the requirements of 1.05 Critical Speed Analysis and System Design apply to other pumps, where specified in the detailed specification section.

    2. Alternate mass elastic design:
        a. Subject the complete pumping unit (including rotating elements, frames, and supports) and related structural elements (including pump, motor, and bearing supports) to structural, lateral, and torsional dynamic analyses, per ANSI/HI 9.6.8 Level 2 and as follows:
            1) Select the complete pumping unit rotating group including pump, motor, intermediate shafting and flywheel rotors (if specified), and other elements in the power train (or powered via the power train) that are designed and manufactured to limit torsional stresses.

2) Additionally, for vertically suspended (VS) and vertically mounted overhung (OH) and between bearing (BB) types provide pump structural natural frequency analysis by modal finite element analysis (FEA)

3) Motors for vertical pumps, subjected to Level 2 analyses shall be subjected to bump test requirements under paragraph 1.04 Motors for custom-engineered pumps.

b. Professional qualifications:

1) The contractor shall require the manufacturer of the pumping equipment to provide the required analyses either with a qualified design professional employed by the manufacturer or a person employed by an independent firm that may have other contract relationships with the pump manufacturer.

2) Aside from allowing the qualified design professional to be employed by the manufacturer or an independent firm that may be contracted to manufacturer, all other qualifications requirements of paragraph 1.05B.2 Professional qualifications apply. Provide a letter, signed by an officer of the manufacturer, describing the role of design professional and relationship to the manufacturer, in lieu of notarized certification.

c. Reports, calculations and recommendations:

1) All documentation shall be provided as specified in paragraph 1.05.

2) A field torsional vibration test is required.

d. Methodology:

1) Conduct analyses in accordance with paragraph 1.05 Lateral rotor and structural dynamic analyses, except as noted:

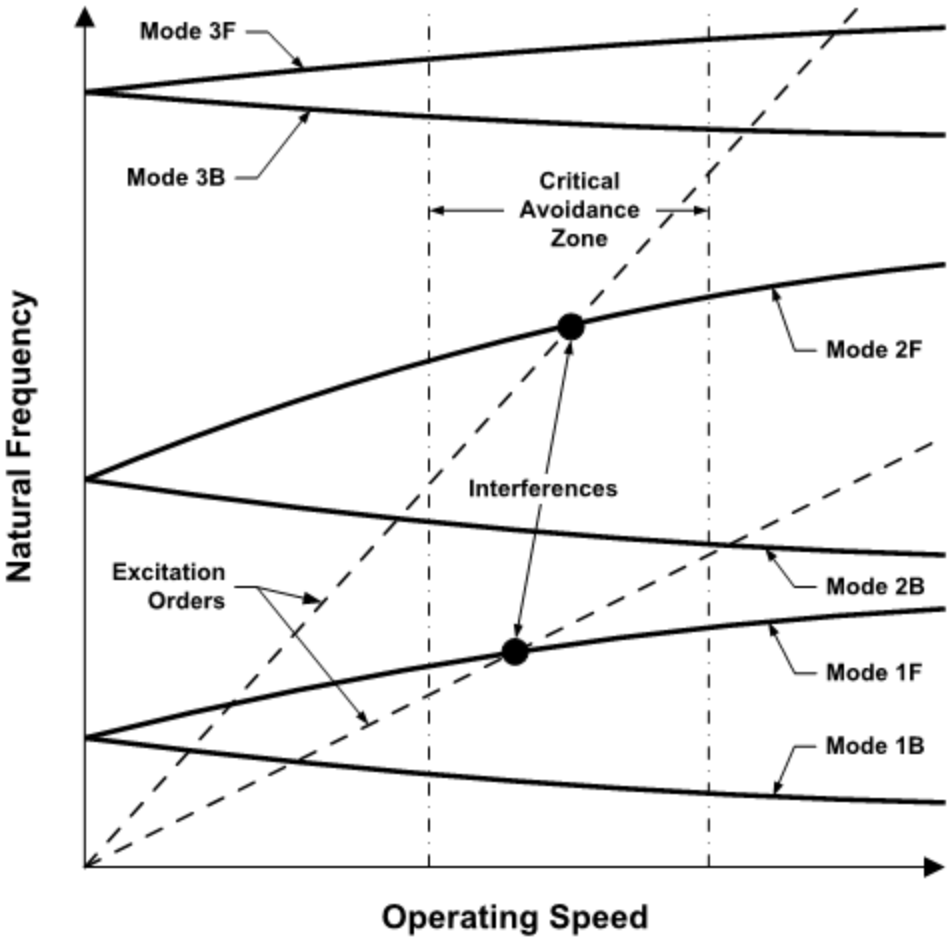
a) Analyses based on a Level 2 analysis prescribed in ANSI/HI 9.6.8:

b) Mathematical calculation tools in compliance with ANSI/HI 9.6.8, as selected by the design professional.

2) In case of conflict between these specifications and ANSI/HI 9.6.8, these specifications shall prevail (e.g., Campbell diagrams shall be provided), unless an exception is requested by the Contractor and approved by the Construction Manager.

3. Lateral rotor and structural dynamics:

a. The complete pumping unit, composed of the entire rotating group and related frames, supports, enclosures, housings, and casings, shall be free from critical speeds from 15 percent below to 25 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than +0.3 that has an interference with a primary excitation order in the critical avoidance zone. Analyze backward rotation for rubber-bearing vertical-column pumps. The critical avoidance zone, interferences, and possible critical speeds can be illustrated on a natural frequency map as presented in the figure below. In the figure, three natural frequencies are shown with forward and backward modes. Only two of those modes, 1F and 2F, have interferences with primary excitation orders. Whether these are critical speeds is determined by the value of log decrement at the intersection. Note that higher order modes, such as 2F, have the same log decrement criterion as the first mode.



b. Process sensitivities are such that operation at infinitely variable speed within the specified operational conditions is an absolute requirement. Any remedy imposing a locked-out speed interval or intervals will not be considered an acceptable remedy for identified critical speeds. Acceptable remedies include combinations of adjustments in rotor geometry or materials, and the substitution of energy-absorbing couplings. Other remedies may be considered so long as they are justified in writing and the proposal is sealed and signed by the design professional retained by the manufacturer to perform the system mass elastic system analyses.

4. Torsional rotordynamics and combined shaft stress:
   a. The complete rotating group shall be free from critical speeds from 10 percent below to 20 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than plus 0.3 that has an interference with a primary excitation order in the critical avoidance zone.

b. If efforts to remove torsional critical speeds are unsuccessful, perform a combined shaft stress analysis to demonstrate that the response does not adversely affect the entire rotating group fatigue life. The combined shaft stress analysis shall consider any speed in the critical avoidance zone and during startup, shutdown, or motor control transients if synchronous motors are specified.

c. For constant-torque applications, the pump-rotating group shall be free from torsional response that produces combined (steady plus alternating torque induced) stresses exceeding 50 percent of the material's fatigue limit or 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) if relevant fatigue data for the selected material are not available.

d. For variable-torque applications (including variable-speed pumps, vertical pumps, and pumps with large overhung loads) the pump rotating group shall be free from torsional response that produces combined (torsional steady and alternating) peak shear stresses at points of stress concentration (calculated in accordance with the requirements of paragraph 1.04E.3 Torsional Shaft Stresses) that exceed 50 percent of the material's fatigue limit or 4 percent of the material's ultimate tensile strength, based upon ASME or other recognized standard, if relevant fatigue data for the selected material are not available.

e. Document the source of fatigue data used in lieu of elastic or ultimate strength ratios in the analysis report submittal.

D. Impeller clearances, vane-passing frequency, and impeller keyways:

1. The radial clearance between the tip of the impeller vane and diffuser or volute vanes shall be not less than 3 percent and 6 percent, respectively, of impeller diameter. Select a pump that is designed so that internal geometry does not cause uneven flow distribution at impeller vane inlets.

2. Impeller vane combinations shall not be an even multiple of diffuser vanes in column-type pumps.

3. Cut impeller keyways for multistage column-type pumps at differing positions and provide equal angular spacing on the impeller shaft to avoid multiple simultaneous vane-passing pulses.

E. Component design criteria:

1. General:

a. Unless otherwise specified, ensure that combined stresses in steel frames and supports does not exceed those permitted by the American Institute of Steel Construction (AISC) Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure-retaining components, frames, and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the American Society of Mechanical Engineers (ASME) Code. Design pressures for pressure-retaining parts shall be not less than 50 percent greater than the pump's shutoff head at the manufacturer's listed maximum operating speed. The pump casing strain at any head on the full-speed operating curve (including allowances for increases caused by specified multistage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.

b. The term “combined stresses” in this section means the sum of operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in planes) include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces include both steady-state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.

2. Anchorage and equipment mounts:
   a. The contractor shall hold the pump manufacturer responsible for the design of the anchor-bolting system and equipment supports for each separately mounted component furnished under the detailed specification. Conform anchorage and equipment support requirements for pumps to the requirements of Section 43 05 13.
   b. Select anchor bolts and connecting bolts for pumps and assemblies supported by other assemblies furnished under this section, or sections referencing this section, that are designed in accordance with Section 01 73 24. All operation and maintenance (O&M) manuals for pumps and assemblies shall contain criteria for anchor and baseplate bolt torque values.
   c. Equipment mounts for vertical (column- and volute-type) pumps weighing more than 1,000 pounds, with discharge nozzles 6 inches in diameter and greater, shall employ soleplates conforming to the requirements of Section 43 05 13. Provide soleplate mounting conforming to Section 43 05 13 for separately supported components in the pump drive system. Fabricated steel supports regardless of design, and the nature of the structural shapes used for such proposed supports, will not be accepted.
   d. Soleplates shall be designed to span openings for equipment connections and provide access to maintenance points. Soleplates shall be of sufficient section to key, not less than 1 inch, into the supporting grout provided for bonding the soleplate to the structure. Provide soleplates of sufficient size to bolt the pump base to the soleplate without encumbering the anchor bolts required for clamping the soleplate to the structure.
   e. Equipment mounts for horizontal pumps shall be designed in accordance with Section 43 05 13 and ANSI/HI 14.3, and shall provide common support for the pump and motor (and flywheel, if one is specified). Conform baseplate bolting to assumptions contained in ANSI/HI 9.6.2.
   f. Use tapered dowel pins when required in the detailed specification to record the final position of machine bases on soleplates or pump baseplates. Where specified, harden and machine-ground dowel pins, conforming to the requirements of ANSI/ASME B18.8.2. Conform holes for tapered dowels to the requirements set forth in Appendix A of ANSI/HI B18.8.2.

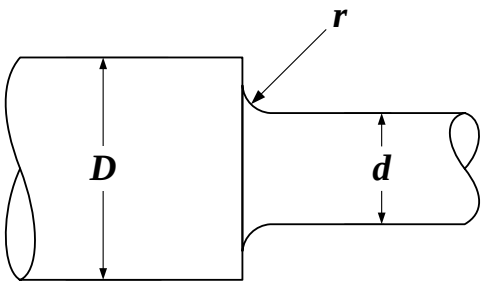
3. Torsional shaft stresses:
   a. Calculate shaft stresses using the following equation and the stress concentration factors in the tables below:

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

where:

S	=	stress, pounds per square inch (psi)
S_{cf}	=	stress concentration factor, dimensionless
D	=	minimum shaft diameter at point of concentration, inches
Δ_{Θ}	=	twist in shaft between adjacent masses, radians
L	=	effective length between masses, inches
G	=	shear modulus of shaft material, psi

   b. S_{cf} shall be applied at changes in shaft diameter is as follows:



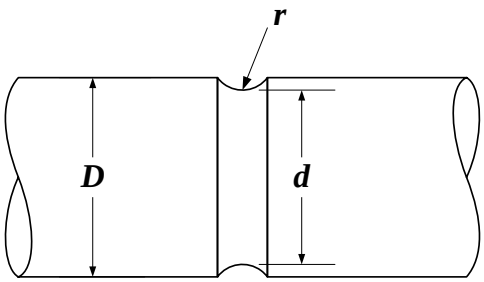
Shaft diameter ratio D/d = 1.05

r/d	S_{cf} [a]
0.0025	2.67
0.0100	1.84
0.0200	1.58
0.0300	1.47
0.0400	1.39
0.0500	1.34
0.1000 and greater	1.22

Shaft diameter ratio D/d = 1.50

r/d	S_{cf} [a]
0.0025	4.05
0.0100	2.54
0.0200	2.07
0.0300	1.85
0.0400	1.72
0.0500	1.62
0.1000 and greater	1.40

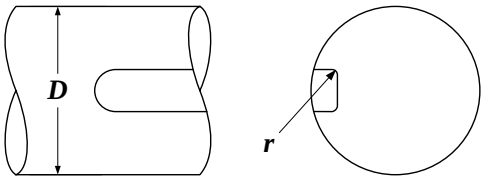
c. Ensure that the S_{cf} to be applied at circumferential shaft grooves is as follows:



Shaft diameter ratio D/d = 1.05	
r/d	S_{cf} [a]
0.0025	3.73
0.0100	2.34
0.0200	1.92
0.0300	1.74
0.0400	1.64
0.0500	1.57
0.1000 and greater	1.39

Shaft diameter ratio D/d = 1.30	
r/d	S_{cf} [a]
0.0025	5.04
0.0100	2.82
0.0200	2.24
0.0300	1.99
0.0400	1.84
0.0500	1.73
0.1000 and greater	1.49

d. Ensure that the S_{cf} to be applied at the roots of keyways is as follows:



r/D	S_{cf} *
0.0025	4.35
0.0100	3.20
0.0200	2.64
0.0300	2.43
0.0400	2.32
0.05 00	2.25
0.1000 and greater	2.12

** Base values of S_{cf} between data points in the tables above upon a straight-line interpolation.*

4. Shaft deflection:
   a. Select pump shafts installed on volute-type pumps to provide sufficient stiffness to operate without distortion or damaging vibration throughout the range of service specified. Limit shaft deflection at the face (impeller side) of the shaft seal to no more than 2 mils at any operating condition within the zone described by the specified continuous-duty operating conditions. Calculate deflection at the shaft seal as required by provisions set forth in ANSI/HI 14.3.

5. Bearings:
    a. Unless otherwise specified, select anti-friction bearings for pumps for a minimum L–10 life of 50,000 hours in accordance with ABMA 9 or 11. Ensure that anti-friction bearings for custom-engineered pumps have bearings selected for an L–10 life of 100,000 hours in accordance with ABMA 9 or 11. Select bearings for other elements in the rotating system such as motors, intermediate shaft bearings, and flywheel bearings using the same criteria as specified for the pump. Base bearing selection upon the worst combination of continuous-duty operating conditions specified and include both steady-state and transient loads. Provide calculations supporting the selection of bearing sizes as and informational submittal.
6. Bearing isolators:
    a. Unless otherwise specified, fit pump and motor bearings with bearing isolators, specifically selected for the size and type of bearing. Provide bearing isolators that are the labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent the escape of lubricants. Provide vapor-block capability. Bearing seals shall be Inpro/Seal, or an approved equal.
7. Pump shaft seals:
    a. Unless otherwise specified in the detailed specification, pump shaft seals must be mechanical seals as specified in Section 43 05 11.

F. NPSH margin limitations:
1. General:
    a. Pumps furnished under this section and sections referencing this section shall be selected for NPSH margin limitations using the criteria set forth in this section. Base NPSH3 characteristics for the candidate pump upon documented test data not more than 5 years old. Perform testing on a pump not more than two nominal pump diameters larger or smaller than the proposed pump with an impeller of the same geometry as that proposed for the pump to be used for the subject application, and operating at either the same speed as the pump for the proposed application or a speed that provides plus or minus 10 percent of the impeller inlet velocity if reduced-speed testing is used. For very large pumps that cannot be accommodated in the manufacturer's test pit, the use of a model pump, sized in accordance with ANSI/HI 14.6, Appendix K, is acceptable. The contractor shall document the basis for pump selection based upon NPSH margin limitations as set forth in this paragraph.

b. The detailed specification sections provide NPSHA information for anticipated operating conditions for each application. This information is generally referenced to a specific elevation, stated in terms of project datum. The contractor is responsible for requiring the pump manufacturer to adjust the NPSHA information in the specification section to the elevation of the pump impeller eye for the specific pump model and size proposed for the application. NPSH3, as used in the following paragraphs, means the NPSH3 at the impeller eye, determined in accordance with ANSI/HI 11.6 or 14.6, as applicable for the proposed pump. The contractor shall require the pump manufacturer to document the method used to determine NPSH3 for the proposed pump and justifying compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 1.08. Include in the documentation justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:
    1) Date, test procedure, and test logs of original NPSH3 information used to project requirements for the pump selected for the application
    2) Test pump size, impeller diameter, impeller model, eye diameter, and speed
    3) Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application
    4) Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph
c. The contractor shall submit the manufacturer's margin calculations justifying the proposed pump selection with the material required under paragraph 1.08. The NPSH margin ratios specified in this paragraph are the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it is the responsibility of the contractor to bear costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure, or through other means. Subject any such adjustments to review and acceptance by the construction manager if necessary.
d. Individual restrictions are applicable to NPSH margin depending upon the type of pumping equipment and the fluid to be pumped as set forth in ANSI/HI 9.6.1, Table 9.6.1.5.5. Under no circumstances may the absolute value of the NPSH3 margin be less than 3.5 feet.

G. Electric Motors:
1. General:
    a. Pumps shall be electric-motor driven unless otherwise specified. Select all motors to be non-overloading at any operating point along the pump's full-speed operating curve, including points located beyond specified operating conditions. Motors shall be capable of carrying the axial/radial load applied to the motor shaft with motor bearing life equivalent to the pump bearing life.
    b. All vertical motors shall be solid-shaft construction. Hollow-shaft motors will not be accepted.
    c. Motors furnished with pumps specified for operation at variable-speed shall be inverter-duty types and shall be compatible with the variable-speed equipment furnished with the pump.
    d. Protect motor bearings with bearing isolators as specified in paragraph 1.04.

2. Motors for custom-engineered pumps:
    a. In addition to the information submitted under the requirements of Section 43 05 21, the contractor shall provide certified reed-frequency calculations for both the motor rotor and frame for vertical motors driving custom-engineered pumps with the data to be submitted under paragraph 1.08. Upon completion of construction of motors for custom-engineered pumps, give each rotor and frame and the completed assembly a bump test to confirm reed-frequency calculations in the dynamic analysis modeling work performed under paragraph 1.05. Provide the results of the bump test, certified by the chief engineer or individual in responsible charge of the test facility, as an informational submittal under paragraph 1.08.
    b. All vertical motors shall meet motor face dimension tolerances as follows:

Motor face bolt circle diameter, inches	Motor face runout, inches
12	0.002
16.5–24.5	0.002
30–42	0.003
42 and larger	0.005

    c. The motor face register concentricity, referenced to the shaft centerline, shall be not greater than 0.002 inch if the motor is furnished without jack screws. The motor shaft total indicated runout (TIR) shall not exceed 0.002 inch.
3. Balance:
    a. Motors rated 50 hp or greater and motors driving custom-engineered pumps shall be precision-balanced, conforming to a balance grade of G2.5 per International Organization for Standardization (ISO) 1940-1.
    b. The contractor shall provide certified balance logs attesting to achieving these requirements and submitted as required by paragraph 1.08. The chief engineer or person in charge of the test facility shall sign the balance logs.

1.05 ADDITIONAL DESIGN REQUIREMENTS [NOT USED]

1.06 QUALITY ASSURANCE: ALL PUMPS

A. Quality Certification:
    1. All manufacturers and manufacturing sites proposed by the contractor for supply of equipment furnished under this section and sections referencing this section shall hold current certification under ISO 9001. Application for certification under ISO 9001 is not deemed as an acceptable substitute for current certification. Provide documentation of the manufacturer's ISO 9001 certification and the manufacturer's written quality assurance/quality control (QA/QC) program.

B. Unit Responsibility:
   1. The contractor shall assign unit responsibility to the pump manufacturer in conformance with the requirements of Section 43 05 11.

C. Performance Confirmation:
   1. Hydrostatic tests:
      a. Subject all pressure-sustaining parts to factory hydrostatic tests. Unless otherwise specified, conform hydrostatic tests to the requirements of ANSI/HI 11.6 for submersible pumps and ANSI/HI 14.6 for dry pit pumps. Unless otherwise indicated in the detailed specifications, hold castings at the test pressure for the duration indicated in ANSI/HI 11.6 and 14.6. For process pumps designed in accordance with ANSI/API 610, hydrostatic testing must comply with the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610. Test results shall be certified correct by the chief engineer or individual in responsible charge of the manufacturing facility.
   2. Performance guarantee:
      a. Unless specified otherwise in the detailed specification, pump performance (flow and head, efficiency, and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.
      b. Equipment performance documentation, including test data, where tests are specified, shall include sufficient test points (not less than eight) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity, and covers full-speed operating points specified in the detailed specification section referencing this section. Tests conducted at specified operating conditions shall be with the inlet throttled to produce the NPSHA indicated for that specific condition in the detailed specification. Perform NPSH3 tests for not less than four full-speed operating conditions, but not less than specified operating conditions and at the best efficiency point (BEPQ).
      c. Test procedures shall be as set forth in ANSI/HI 14.6, and as specifically detailed in these specifications. However, any increase in flow or head permitted under specified acceptance grade[s] cannot result in overload (nameplate basis, S. F. = 1.0) of the specified motor power rating at any location on the pump's head/capacity curve. Conduct performance tests at the specified maximum speed. Affinity relationship-predicted test results will not be accepted. For column-type pumps, include in the performance documentation curves showing both bowl efficiency and overall efficiency (including inlet, bowl, column, and discharge head losses) at maximum operating speed for the application.
      d. The acceptance criteria for head and capacity test results shall be based upon the rated condition specified in the detailed specification and as required in ANSI/HI 11.6 and 14.6 for acceptance Grade 1U, with the above-stated limitation with respect to motor power overload.
      e. Where there are none stipulated, the acceptance criteria for head and capacity test results for the other specified duty conditions in the detailed specification shall be as required in ANSI/HI 11.6 and 14.6 for acceptance grade 3B, with the above-stated limitation with respect to motor power overload.

f. The acceptance criteria for NPSH3 at any specified operating condition shall be the values proposed by the contractor in the curves submitted under paragraph 1.08, and duly accepted by the construction manager, with a tolerance of plus 0, minus unlimited, with the exception that S, as calculated for the specific pump, does not exceed the limitation established under paragraph 1.04B. If the NPSH3 data result in an increase in S, the manufacturer shall confirm that the stable operating region for the pump corresponds to the POR as defined in ANSI/HI 9.6.3, and that the operating conditions specified to be within the POR are within the stable operating region for the pump. In addition, the manufacturer shall identify the onset of suction recirculation and confirm that the onset of suction recirculation is outside of the specified operating range.

g. Include in the guarantee a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. The guarantee shall be in writing and signed by the chief engineer or individual in responsible charge of the test facility. Under no circumstances should deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor should such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

3. Non-witnessed tests:

a. Unless specified otherwise, performance-test pumps in accordance with ANSI/HI 14.6, with the above restrictions on motor power overload. Include in the factory tests test data for each full-speed performance requirement and any other points stipulated for this test procedure in the detailed specification. Conduct these tests with the pump inlet throttled to provide the specified NPSHA. For large-column pumps, model performance testing with reduced NPSHA, pursuant to paragraph 1.07B.4, may be used. If specified in the detailed specification, include shaft vibration and case noise in the test data at the full-speed operating conditions.

b. Duplicate the test setup in the manufacturer's test facility as closely as possible to the inlet conditions in the proposed installation, using temporary baffles and other means, within the limitations of the test facility. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers as a part of the manufacturer's scope of supply, test the pumps with the elbow, adapter, or reducer fitted to the pump and apply specified performance criteria to the complete pump assembly, including losses through any elbow, adapter, or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, test the pumps with these components fitted to the pumps. Apply the specified performance requirements to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Include in the certified test data separate readings for inlet and discharge head for each data point.

c. Take not less than eight test points, including not less than three within plus or minus 8 percent (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within plus or minus 4 percent of the pump's BEP at the test speed. In addition, one test point is sufficient to define head and power requirements at shutoff head.

d. Perform NPSH3 tests in accordance with ANSI/HI 14.6, paragraph 14.6.5.8.2.1, Type 1 Test except that not less than four tests should be performed at the test motor speed to completely cover the range of operating conditions specified in the detailed specification. One of the test points shall be at the BEP flow to confirm the test pump's S. The translation of test results to specified operating conditions shall be in accordance with ANSI/HI 14.6, paragraph 14.6.6.1.1 so long as the exponent used can be supported by certified test data performed on a pump of the same type, size, speed, and specific speed as that of the proposed pump. Include NPSH3 tests at both the proposed and test speeds in test data justifying the exponent, test points at BEP, and at least three other points on the test pump head/capacity curve at least 15 percentage points removed from the BEP. Use the results of the NPSH3 tests to confirm the NPSH margins for each specified operating condition as specified in paragraph 1.04F. Perform NPSH3 tests for column type (axial, mixed-flow, and vertical-turbine) pumps using the open sump/water level or closed tank/tank pressure methods described in ANSI/HI 14.6, Table 14.6.5.8.2.1. Perform NPSH3 tests for submersible wastewater pumps using the method described in Figure 11.6.8 in ANSI/HI 11.6. Extend all NPSH3 tests from 50 percent to 140 percent of best efficiency flow at full speed, or to not less than 10 percent (in terms of flow) past the flow at Operating Condition B, whichever is greater. For a given pump, if the manufacturer can provide documentation that the upper flow limit of the AOR on the right side of the pump curve is less than 140 percent of best efficiency flow, the AOR may be used as the limit for the NPSH3 test. Cause for rejection is failure to achieve specified performance or performance proposed in accepted submittal documents (capacity and head, efficiency, or NPSH3), whichever is more restrictive. Acceptance tolerances are as set forth in paragraph 1.06C.2 Performance Confirmation; Performance guarantee.

e. All test procedures shall be in strict conformance with the referenced standards. However, prediction of performance of a trimmed impeller from test data of the larger impeller will not be permitted. If trimming is required, re-test the pump. Do not allow deviations from specified operating conditions, though allowed by the referenced standards, to result in overload of the driver furnished with the equipment, nor allow such deviations to result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

f. The contractor shall furnish the construction manager with not less than 2 weeks' advance written notice of the date and place of the non-witnessed tests.

g. All test results, including test logs and generated curves, shall be certified correct by the chief engineer or individual in responsible charge of the manufacturer's test facility, and shall be submitted in accordance with paragraph 1.08.

1.07 QUALITY ASSURANCE: ADDITIONAL REQUIREMENTS

A. Scope:

1. In addition to the requirements under paragraph 1.06 applicable to pumps, the following are required for the subset of larger and custom-engineered pumps defined in paragraph 1.01A Scope. Contractor is advised that the results of NPSH3 will be used by the construction manager to determine if the tested pumps conform to the POR requirements set forth in paragraph 1.04. Failure to meet these requirements will likely require remanufacture of the pumps or rework of one or more of the pump components to achieve the required and necessary pump stability characteristics. All costs associated with such remanufacture or rework and retesting shall be borne by the contractor.

2. The performance curves submitted under paragraph 1.08, once accepted by the construction manager, shall become a warranty on the part of the contractor to provide equipment that will provide performance characteristics that accurately duplicate the characteristics presented in the submitted and accepted curves. The factory test results shall confirm performance within the tolerances set forth in ANSI/HI 14.6.3 and paragraph 1.06.C.2, NPSH3, as determined by certified factory test results, shall not cause the pump's S to exceed the limit specified in this section or the detailed specification. The manufacturer may propose a pump with a higher S, provided that documentation showing that the onset of suction recirculation is to the left of the pumps specified operating region. Submit documentation of the procedures used to determine the onset of suction recirculation.

B. Performance Testing:

1. Witnessed tests:

   a. Subject all custom-engineered pumps, and other pumps where required by the detailed specification, to a witnessed factory performance test and NPSH3 tests in accordance with the provisions of this portion of the specifications.

   b. The contractor shall furnish the construction manager with not less than 2 weeks' advance written notice of the date and place of the witnessed tests.

2. Performance tests:

   a. Factory performance tests shall comply with the requirements of ANSI/HI 14.6. Include in the factory tests test data for each full-speed performance requirement and any other points stipulated for this test procedure in the detailed specification. Conduct these tests with the pump inlet throttled to provide the specified NPSHA or as otherwise detailed in the accepted test plan. For large-column pumps, model performance testing with reduced NPSHA, pursuant to paragraph 1.07B.4 Performance Testing; Model tests, may be used. Include shaft vibration and case noise at full speed in the test data.

b. Duplicate the test setup in the manufacturer's test facility as closely as possible the inlet conditions in the proposed installation, using temporary baffles and other means. Where centrifugal pumps are furnished with inlet elbows, inlet adapters, or inlet reducers as a part of the manufacturer's scope of supply, test the pumps with the elbow, adapter, or reducer fitted to the pump. Specified performance criteria shall apply to the complete pump assembly, including losses through any elbow, adapter, or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, test the pumps with the inlet nozzles or adapters. The specified performance requirements shall apply to the complete pumping assembly, including any inlet nozzles, discharge elbows, or adapters. NPSHA shall not exceed that specified in the detailed specification during any performance test. Include separate readings for inlet and discharge head for each data point in certified test data.

c. Take not less than eight test points, including not less than four within plus or minus 8 percent (on the basis of rated flow) of the rated condition (Condition Point A) and not less than two test points within plus or minus 4 percent of the pump's BEP at the test speed. In addition, one test point is sufficient to define head and power requirements at shutoff head, and one test point is sufficient to define flow at Condition Point B.

3. NPSH3 tests:
   a. Perform NPSH3 tests to confirm the data used to establish NPSHA margin for each specified operating condition as specified in paragraph 1.04F. Perform NPSH3 tests for submersible wastewater pumps using the method described in Figure 11.6.8 in ANSI/HI 11.6. Extend all NPSH3 tests from 30 percent to 140 percent of best efficiency flow at full speed, or to the upper limit of the AOR as defined by the manufacturer, whichever is less. Cause for rejection is failure to achieve guaranteed performance or performance proposed in accepted submittal documents, whichever is the more restrictive (capacity and head, efficiency or NPSH3). Tolerances and restrictions are as set forth in paragraph 1.06C.3 Performance Confirmation; Non-witnessed tests, above, for non-witnessed tests.
4. Model tests:
   a. Where allowed in the detailed specification or upon specific application with adequate justification by the manufacturer, confirmation of performance of large pumps may be demonstrated by testing the prototype at reduced speed or by testing a model of the prototype pump. Perform NPSH3 tests to confirm the data used to establish NPSHA margin for each specified operating condition as specified in paragraph 1.04F. Cause for rejection is failure to achieve guaranteed performance (capacity and head, efficiency or NPSH3). Perform physical model testing at qualified, commercial facilities, with at least 10 years of continuous-duty operation. Conduct all tests in accordance with ANSI/HI 1.6 or 2.6. with the following restrictions:
      1) If the prototype is tested at reduced speed, the ratio of test speed to prototype speed shall be not less than 0.66:1.
      2) Model test ratios shall be not less than 0.33:1, model to prototype.
      3) Impellers for model tests shall be a minimum of 12 inches in diameter.

4) Subject impellers for prototype pumps to a model-to-prototype profile comparison using templates ratioed from the impeller used for the completed and accepted model test. Compare impeller profiles for the x, y, and z planes. If model testing is proposed for any or of the specified tests, the contractor shall include the proposed methodology for profile confirmation as a part of the submittal material required under paragraph 1.08. Perform impeller profile comparison with a representative of the construction manager present. All costs associated with travel and subsistence of the construction manager's representative shall be borne by the contractor.

5) Acceptance criteria, based upon projected prototype performance from model test results using ANSI/HI-approved affinity relationships, are as set forth above under paragraph 1.06C.3 Performance Confirmation; Non-witnessed tests.

6) Apply the restrictions set forth above for witnessed tests.

b. The contractor shall furnish the construction manager with not less than 2 weeks' advance written notice of the date and place of the model tests.

5. Test certification and reporting:

a. An officer of the pump manufacturer or chief engineer of the test facility shall certify correct all test results, including test logs and generated curves. The contractor shall submit test results as an informational submittal.

C. Confirmation of passage geometry:

1. For solids-handling pumps, subject the design waterway passages and mating passages between rotating and stationary portions of such passages to confirmation that no mismatch of exiting and entering angles or angular discontinuities exist in pumps furnished under specification sections containing the words "custom-engineered" in the title, and that are not proven designs in accordance with paragraph 1.04B. The confirmation process shall employ CFD modeling techniques in which mesh generation is optimized and mesh size is reduced in the regions of flow attachment, detachment, and separation regions of the impeller and cutwater to detect angular mismatches of 0.25 degree or greater.

2. Use a number of different convergence criteria to assess whether a solution is converged. These criteria may include the residuals given by the software; global imbalances in momentum, energy, etc.; whether key global quantities have reached an equilibrium value; and whether information from various solution monitoring points have stabilized. Note that these monitoring points should be in areas where the flow could be much weaker, and not where the flow could be converged easily. Use high-convergence criteria, and repeat runs with different monitoring points to ensure proper convergence.

3. Provide modeling software that is professionally customized and optimized for the determination of pump fluid dynamics, especially flow attachment, detachment, and separation. Verify the mathematical model and software accuracy by experimental data from test cases including similar dynamics. The individual conducting the modeling effort shall be a CFD specialist with graduate-level education in the subject and over 5 years of relevant experience. Submit the model graphic outputs, signed and notarized by the pump manufacturer's officer in charge of engineering, as a part of the documentation required under paragraph 1.08.

1.08 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. In addition to the material listed in the detailed specification, provide the following submittals:
      a. Documentation of successful pump designs or proposed alternatives as specified under paragraph 1.04B.1 Pump Selection. If included as part of the design, include in the documentation applications where pump cans of a similar size have been provided as part of the design.
      b. A Certificate of Unit Responsibility attesting that the contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
      c. A copy of this specification section and the specification sections listed for submittal in the detailed specification sections. Ensure that the specification copies are complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the contractor with the specifications. Accompany the submittal with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
      d. A copy of the contract document control diagrams and process and instrumentation diagrams (P&IDs) relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings as “no changes required.” Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review.
      e. Documentation of certification in accordance with ISO 9001 as specified under paragraph 1.06A.

f. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the vertical axis plotted against capacity on the horizontal axis, along with the manufacturer's warranty to meet the requirements specified in paragraph 1.07 Scope. Provide curves for variable-speed pumps to demonstrate operation at speeds required to achieve the specified reduced-speed operating conditions. All curves shall clearly display the specified operating conditions and conformance with POR and AOR limits in the individual specification sections. Provide variable-speed plots showing specified operating conditions and POR limits. Plot curves at increments of not more than 5 percent speed or 50 rpm increments, whichever is less, from full speed to the lowest speed required to meet specified operating conditions. Curves for column-type pumps shall show bowl efficiency and allowances for inlet, column, and discharge head losses separately.

g. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 1.04 as applicable and including the information required under paragraph 1.04F.

h. Motor submittal information as specified in Section 43 05 21. In addition, include in this information certified calculations for motor rotor and frame reed frequencies, as specified under paragraph 1.04G.

i. Complete description and sketch of proposed test setup for factory test if a factory test has been required under the detailed specification section or as required by the provisions of this section. Include in submittal material sample calculations and proposed test log format. If the contractor proposes a model test for a part or all of the specified performance tests, include in the submittal information the proposed model details and a complete description of the proposed method for comparing the model impeller profiles with the impeller profiles for the prototype pumps.

j. Drawings showing general dimensions and confirming the size of pumps, motors, drives, and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.

k. Driver unit support calculations and data if the driver is separately supported and if the analysis under the requirements of paragraph 1.01 have been required by the terms of these specifications.

l. Shaft deflection calculations for volute-type pumps: provide calculations to demonstrate compliance with paragraph 1.04E, per the methodology set forth as required by paragraph 1.01.

m. Detail drawings of the pump and driver unit foundation demonstrating conformance to this section and Section 43 05 13. Include in the submittal drawings depicting type, size, number, projection, and arrangement of anchor bolts; dimensional drawings of the sole and baseplates; and dimensional drawings for the concrete supports for both the pump and motor, if applicable. Drawings shall also depict other pertinent information, including location of equipment pads and reinforcement; equipment drains; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment-mounting features embedded in equipment pads.

n. Limiting nozzle loading criteria, if different from that established by ANSI/HI 9.6.2.

o. The qualifications of the personnel proposed by the contractor to perform field alignment procedures in accordance with the requirements of paragraph 3.04.

3. The following are applicable to all vibration testing of pumps, in accordance with the requirements of paragraph 3.06 Field Vibration Tests and, paragraph 3.07 Torsional Vibration Testing, where required:
   a. The qualifications of the independent testing laboratory and individual personnel proposed by the contractor to perform field vibration testing, analysis, and reporting.
   b. Proposed vibration testing plan. including accelerometers mounting and presentation formats.
4. The following are applicable for pumps specified to meet ANSI/HI 9.6.8 Analysis Level 2 or 3:
   a. Qualifications of the design professional, and firm name, proposed to perform the mass elastic design analyses specified under paragraph 1.01, or the manufacturer's qualified design professional conducting Alternate mass elastic design analyses under paragraph 1.04C Critical Speeds and Natural Frequencies, where required by the detailed specification section, if the subject analyses are required by the terms of these specifications.
   b. Descriptive material outlining the methodology and software to be used in the analyses required under paragraph 1.01 and paragraph 1.04 Critical Speeds and Natural Frequencies, as applicable.
   c. "Executive Summary" report of the mass elastic design analyses for pumps as specified in paragraph 1.01, for custom-engineered pumps, and for Alternate mass elastic design specified under paragraph 1.04 Critical Speeds and Natural Frequencies, where required by the detailed specification section.
   d. The proposed instrumentation setup for the in situ torsional vibration test specified under paragraph 1.01.
   e. Can design documentation specified under paragraph 1.01, including bolt patterns for the pump base and soleplate on can.
   f. "Final Report" of the model study specified under paragraph 1.01.
   g. Model graphic outputs specified in paragraph1.07C.

B. Informational Submittals
   1. Procedures: Section 01 33 00:
      a. Performance guarantee as specified in paragraph 1.06C.
      b. Equipment anchor calculations specified in paragraph 1.04E.
      c. O&M information specified in Section 01 78 23.
      d. Motor information submittals as specified in Section 43 05 21.
      e. Bearing L-10 life calculations.
      f. Critical speed calculations demonstrating compliance with paragraph 1.01 if a lateral rotordynamic analysis is required. Otherwise, provide critical speed calculations demonstrating compliance with paragraph 1.04C.
      g. Nozzle loading information required under paragraph 3.01.
      h. Motor balance logs, certified and notarized as specified in paragraph 1.04G.
      i. Certified balance logs and worksheets, as specified in paragraph 2.05.
      j. Installation certification Section 43 05 11-Form A as specified in paragraph 3.01.

k. Training certification Section 43 05 11-Form B as specified in paragraph 3.08.

l. If factory tests are specified in the detail specification section, certification of satisfactory testing of each unit as specified. Include in the certified material copies of test logs and resulting performance curves.

m. Field vibration test reports in accordance with paragraph 3.06.

2. The following are applicable for pumps specified to meet ANSI/HI 9.6.8 Analysis Level 2 or 3:

a. Results of model tests for pump cans if model tests are required by the provisions for paragraph 1.01.

b. "Final Report" of mass elastic systems analyses for pumps as specified in paragraph 1.01, for custom-engineered pumps, and for Alternate mass elastic design specified under paragraph 1.04 Critical Speeds and Natural Frequencies, where required by the detailed specification section.

c. Results of motor rotor, frame, and assembly bump tests, certified as specified under paragraph 1.04G Electric Motors, along with the design professional's "Supplemental Report" as specified under paragraph 1.01.

d. Pump can installation acceptance certification, as specified in paragraph 3.03, if applicable.

e. Results of field vibration tests as specified under paragraph 3.06.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:

1. Where this section and sections referencing this section are silent with respect to materials of construction on any component, material selection shall follow the requirements of Table H.1, ANSI/API 610, Materials Class I-1, with the exception that shafts for vertical column-type pumps be 12 percent chromium stainless steel. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Pumps:

1. Finish for surfaces in contact with pumped fluid:

a. Conform all pump components in contact with the pumped fluid to the following requirements.

b. Indicate surfaces to be machine-finished on the shop drawings by symbols that conform to ANSI B46.1, Surface Texture, Surface Roughness, Waviness, and Lay. Machine surfaces shall be finished to at least the following tolerances:

c. Nominal roughness:

Surface	Grade, Ref: ANSI B46.1 (SI units microns) (Ra: micro inches)
General machine work	3.2 or better (125 Ra)
Flange faces	3.2 or better (125 Ra)
Journal surfaces at sleeve bearings	0.4 or better (16 Ra)
Hydraulic surfaces	
Impeller	4.5 or better (177 Ra)
Impeller bowl and diffuser	6.3 or better (250 Ra)
All other wetted surfaces	6.3 or better (250 Ra)

d. Flaws such as scratches, ridges, holes, peaks, cracks, or checks that will make the part unsuitable will be cause for rejection. Machine-finished surfaces shall be thoroughly cleaned and coated with a protective layer of rust preventive. Oil and wrap small pieces, unassembled pipe, or finished bolts with moisture-resistant paper.

2. Materials:

a. Unless otherwise specified, wetted cast-iron parts for pumps for solids-bearing liquid services shall have 2 to 3 percent nickel added to the cast iron.

b. Provide stainless-steel impellers for the first stage of custom-engineered pumps, pumps intended for pumping screened or unscreened wastewater, and elsewhere when specified. Stainless-steel impellers shall be ASTM A743, Grade CA6NM. Where cast-nickel aluminum bronze impellers are specified, the materials shall conform to ASTM B148, Alloy C95500.

c. Materials for shaft sleeves for packed boxes, fretting seals, and interstage seals shall conform to ANSI/API 610, Annex H 12 percent chromium-hardened or hard-faced 316 austenitic stainless steel. Materials for seal glands for packed boxes and shaft sleeves shall be AISI 316 stainless steel. Fastener parts of all types in wetted areas shall conform to ANSI/API 610, Materials Class S-5 requirements. Regardless of the seal construction, adequately size seal chambers to accommodate specified mechanical seals.

C. Flywheels:

1. Where flywheel assemblies are to be provided with the pumping equipment, the pump pressure-containing parts shall be of ductile iron conforming to ASTM A571. Materials of construction for the flywheels shall be as follows:

Frame	Steel, ASTM A-36, welded and stress relieved.
Shaft	Alloy Steel, ASTM A322, Grade 4142 HT, ST, BHN 375-388 for shafts 3.5 inches in diameter and less; stainless steel, ASTM A564, Type 630 HT, Condition H1150 for shafts larger than 3.5 inches in diameter.
Rotor	Steel, ASTM A36, or cast steel, ASTM A27 for flywheels 3 feet in diameter or less; cast steel, ASTM A148 for flywheels greater in diameter than 3 feet. All stress relieved after machining.

2.02 GENERAL QUALITY

A. The details of manufacture and assembly of equipment furnished under this section and referencing sections shall follow the requirements of ANSI/API 610 with respect to the following features (paragraph references, ANSI/API 610):
   1. Alignment aids (paragraph 6.1.24)
   2. Removal of rotating element (paragraph 6.1.25)
   3. Jackscrews for assistance in alignment on baseplates and equipment supports (paragraph 9.3.8.3.2)
   4. Castings (paragraph 6.12.2)

B. Provide all components or subassemblies weighing 50 pounds or more with at least one lifting eye or a provision for threading in a lifting eye. Provide components 250 pounds or greater with lifting eyes or provisions for at least two lifting eyes. Provide components 1,000 pounds or greater with at least three lifting eyes or provisions for inserting lifting eyes.

2.03 BASEPLATES AND SOLEPLATES

A. Unless otherwise noted in the detailed specification, the pump manufacturer shall furnish pumps with baseplates or soleplates conforming to the requirements of Section 43 05 13. Design baseplates and soleplates to be installed in the housekeeping curb shown and machine flat and co-planar to within 0.002 inch per foot in all directions on the face mating with the pump and motor or driver support. Soleplates shall have the words “THIS SIDE DOWN” permanently affixed to the underside using a welding rod material or stamped prior to milling. Alternative marking methods, using heavy scribing or machining, are acceptable provided that they may be observed following blasting in preparation for coating.

2.04 WEARING RINGS

A. Where specified, fit pumps with both stationary and rotating wearing rings. Except for the difference in hardness between stationary and rotating rings, wearing rings shall be stainless steel and conform to the requirements of ANSI/API 610, paragraph 6.7 and material class S-8 (Table H.1, Annex H). The maximum wearing ring clearances shall not exceed 150 percent of the values stated in Table 6, ANSI/API 610. The minimum wearing ring hardness on the rotating ring is 350 Brinell Hardness Number (BHN), with the stationary ring not less than 100 hardness points greater.

2.05 BALANCE

A. The balancing for pumps with suction nozzle sizes 6 inches in diameter and greater and associated components shall conform to the requirements set forth in ANSI/API 610, paragraph 6.9.4.1 (equivalent to ISO 1940 or ANSI 2.19 Grade 2.5), unless other portions of this project manual impose more restrictive requirements. It is the intent that the components be balanced as an assembly (“rotor”) in accordance with ANSI/API 610 definitions. For extended-shaft pumps, balance impeller(s) and shaft up to the first coupling with the line-shaft.

B. For separately balanced components, perform a residual unbalance inspection after rotor assembly per ANSI/API 610 requirements, as described in Annex J of that document. Provide copies of worksheets and demonstrate that tolerances are in compliance (i.e., rotor has passed) in addition to other reporting requirements of this paragraph.

C. Furnish all balance logs, certified correct and signed by the chief engineer or individual in responsible charge of the manufacturing facility, in accordance with paragraph 1.08.

2.06 DRIVE UNIT SUPPORTS FOR SEPARATELY SUPPORTED MACHINES AND INTERMEDIATE SHAFT SUPPORTS

A. Supports for separately mounted vertical pump drivers and intermediate shaft bearings shall be composite structures of fabricated steel, ASTM A36. Unless otherwise specified, design the supports to span an opening in the floor sufficient to allow removal for the complete pump. Provide rolled steel beams to stiffen the support and mount a fabricated steel driver unit support pedestal on the support plate. The support pedestal top plate and portions of the support plate assembly intended to join with surfaces in the installation structure shall be milled flat and parallel to 0.002 inch per foot. Provide pedestals with access provisions to adjust or assemble/disassemble couplings. Select a support that is designed to be supported on a soleplate or soleplates embedded in a housekeeping pad at the edges of the floor opening or as indicated. Other details for the driver unit support shall be as indicated.

2.07 FLYWHEEL ASSEMBLIES

A. When a flywheel assembly is specified, adjust the moment of inertia (WR^2) of the rotating element for each complete motor/pump set, including entrained water, pump rotor, shafting, couplings, and motor rotor to provide the value specified in the detailed specification by providing a flywheel.

B. The flywheel shall consist of cast or fabricated steel weight in the form of a cylinder or torus with supporting struts, keyed and locked on a shaft supported by bearings at each end of the shaft. Flywheels with diameters greater than 3 feet shall be double-keyed to the shafts. If cast construction is used, cast the struts and weight as a unit. Design and fabricate the flywheel for a coefficient of fluctuation no larger than 0.05. Use a factor of safety of 4 for the ratio of tensile strength to maximum calculated bending or tangential stress, considering applicable stress concentration factors. This is equivalent to a maximum safe operating speed to operating speed ratio of 2. The lateral critical frequency of the flywheel assembly shall be higher than the maximum safe operating speed by a factor of 1.5.

C. If the weight is to be fabricated steel, it shall be machined from a single billet to the diameter and shape required. Stress-relieve all flywheels (cast and fabricated alike) before balancing. The size of the weight and distance of the cylinder or torus centroid from the center of the shaft shall be sufficient to achieve the overall rotating WR^2 specified for the pump rotating system. Cantilevered designs employing only one set of bearings will not be permitted in standalone flywheel assemblies. Flywheels mounted on the motor shaft and using the bearings of a custom-designed drive motor may be of the cantilever type. Include the flywheel assembly in the lateral, torsional, and rotordynamic analyses specified under paragraph 1.01.

D. Select bearings in accordance with ABMA 9 or 11 for an L-10 life of not less than 100,000 hours. Hold input and output bearings in place by rigid fabricated steel struts. Balance the entire rotating assembly in accordance with paragraph 2.05.

E. Furnish the flywheel assembly with a fabricated steel enclosure designed to provide protection against accidental entry of tools or other objects, and to provide enclosure protection in accordance with Occupational Safety and Health Administration (OSHA) requirements. The flywheel enclosure shall have an outside width of at least that of the motor, but not greater than 110 percent of the motor's width. The housing shall match the quality of the motor enclosure and shall be equipped with at least two lifting eyes. Locate a mounting pad on the upper portion of the flywheel housing to permit installation of the vibration detector specified in Division 40 or the referencing section. Support the flywheel bearing housings independently with a rigid frame to maintain alignment.

F. Where horizontal flywheels are required, mount the flywheel assembly on a baseplate common with the pump and motor. Fit frames for horizontally mounted flywheel assemblies with mounting pads for bolting to the pumping unit baseplate. Provide sufficient space on each pad to permit doweling to the baseplate after final alignment. The end plates shall be similar to those provided for the motor and shall provide complete closure to prevent incidental access to the flywheel. The flywheel input shaft shall be direct-connected to the motor output shaft by means of a flexible coupling, and the output shaft designed to accommodate the shaft spacer coupling specified.

G. Where vertical flywheel assemblies are shown supporting the electric motor, select a frame that is designed to support the weight of the motor in accordance with the design requirements of this section. Extend the flywheel assembly frame to carry a support plate that is rabbeted to provide self-aligning features with the motor base. The frame extension shall have access openings to permit assembly/disassembly of the motor output shaft coupling. The lower flywheel assembly end plate shall be finished flat for mating with the support pedestal on the driver unit support, if so mounted, or rabbeted for alignment with the pump drive shaft if mounted on a column pump discharge head.

H. Where vertical flywheel assemblies are mounted separately from the pump and motor, the lower end plate shall be finished flat. Key the input shaft for the specified flexible coupling and provide shaft guards. Provide an access opening as specified herein for coupling assembly/disassembly.

2.08 CANS FOR COLUMN-TYPE PUMPS

A. Unless specified otherwise, fabricate cans for column-type pumps from ASTM A36 steel with internal baffles fillet-welded to the interior surface of the can. Provide seal welds at welded joints and ensure that welds are ground smooth. Prepare and coat all internal surfaces after welding with fusion-bonded epoxy conforming to the requirements of AWWA C213 using NSF/ANSI 61-compliant materials (3M Scotchkote 134, or approved equal). The minimum coating thickness is 12 mils. The external epoxy coating shall be in accordance with Section 09 90 00 requirements.

B. Where the detailed specification requires a can suitable for service with an upstream hydraulic gradient in excess of the elevation required for the pump discharge head, gasket or fit the flanged connection to the pump discharge head with a double O-ring seal designed to withstand not less than twice the pressure specified in the detailed specification

2.09 MACHINING

A. Unless otherwise specified, provide machined surfaces with a 125 Ra (micro-inch) finish without any grooves, surface imperfections, or machining marks. Mating surfaces shall be coplanar within a maximum of 0.002 inch. Bearing housings and seals shall have collinear centerlines within less than 0.001-inch total difference. Provide shafts with a 63 Ra (1.6-micron) finish at fit areas (coupling, sleeves, impeller) and 125 Ra (3.2-micron) finish at the clear spans.

PART 3 EXECUTION

3.01 GENERAL

A. Select restraining rods on equipment connection fittings that is designed specifically to restrain the unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed valve. Torque all restraining rod nuts to ensure that any moment or shear transmitted to the pump nozzles is within the values permitted under ANSI/HI 9.6.2, or that permitted by the equipment manufacturer, whichever is greatest. Where ANSI/HI 9.6.2 is silent with respect to any particular aspect of allowable nozzle loads, the contractor shall follow the written requirements provided by the equipment manufacturer. Install all pumps furnished under specification sections containing the words “custom-engineered” in the title under the presence of a factory-authorized installation specialist or specialists. Under no circumstances shall any installation procedure take place without the installation specialists present. Equipment installation procedures shall conform to the requirements of Section 43 05 13. Upon completion of installation work, the contractor shall submit a complete, properly signed certification Form 43 05 11-A as specified in Section 01 99 90.

3.02 SOLEPLATES

A. Level soleplates, if provided pursuant to this section or any section referencing this section, or where required by the equipment manufacturer’s recommendation, in the presence of a factory-authorized installation specialist to a maximum tolerance of 0.002 inch per foot in all directions. Where the equipment manufacturer requires more stringent tolerances, those tolerances prevail.

3.03 PUMP CANS

A. When specified, install pump cans as indicated to the following tolerances:

Horizontal position	±0.125 inch in all directions
Vertical axis	within 0.5 degree from vertical
Level	0.02 inch per foot of diameter at the pump baseplate bolt circle
Elevation	±0.125 inch from planned elevation

B. Where the equipment manufacturer requires more stringent tolerances, those tolerances prevail.

C. Equipment shall not be installed in pump cans until the pump manufacturer’s factory-trained and authorized installation specialist has furnished the construction manager with written and signed certification that the can has been installed satisfactorily and is acceptable for installation of the equipment.

3.04 ALIGNMENT

A. Journeymen millwrights shall perform alignment of equipment furnished under this section and any referencing section. Carpenters, laborers, or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the contractor shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The contractor shall submit the qualifications of the proposed firm to the construction manager for acceptance prior to performing the work. The construction manager shall personally witness the final alignment procedures for each item of equipment as a condition precedent to beginning any work required under Section 01 45 23. Alignment techniques shall conform to the requirements of Section 43 05 14.

3.05 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 45 23 and the detailed specification sections.

B. For pumps furnished under specification sections containing the words “custom-engineered” in the title, and where the manufacturer’s qualified design professional has conducted the Alternate mass elastic design analyses specified under paragraph 1.04 Critical Speeds and Natural Frequencies, the testing procedure is a plan developed jointly by the contractor and equipment manufacturer to demonstrate performance of each item of equipment at specified operating conditions.

C. Unless otherwise specified in the detailed specifications, field-test centrifugal pumps for lateral vibration in accordance with paragraph 3.06B. In addition, “custom-engineered” pumps, and pumps subjected to Alternate mass elastic design analyses under paragraph 1.04 Critical Speeds and Natural Frequencies, shall undergo field torsional vibration testing (paragraph 3.07A).

3.06 FIELD VIBRATION TESTS

A. Qualifications:
   1. The contractor shall retain the services of an independent testing laboratory to conduct the testing work specified under this paragraph. The work shall be directed by a professional mechanical engineer, registered to practice in any one of the 50 states composing the United States.
      a. The engineer (hereinafter termed “professional vibration analysis specialist”) shall be a graduate of a college holding Accreditation Board for Engineering and Technology Inc. (ABET) accreditation in mechanical engineering and has been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.
      b. As an alternate qualification, the professional vibration analysis specialist shall have an ISO/ANSI Vibration Analyst Category IV and been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.

2. Submit the professional vibration analyst specialist's qualifications and references, certified and notarized, for review and acceptance by the construction manager not less than 6 weeks prior to the date scheduled for the field vibration test work specified herein. The construction manager shall review the required documentation and references and indicate acceptance or rejection of the proposed analyst's qualifications within 14 days of submission. If the analyst proposed by the contractor is rejected, the contractor shall propose an alternative choice with appropriate documentation.
3. The independent testing laboratory's testing team (comprising the professional vibration analysis specialist and any technicians required to complete the specified tasks) shall be fully equipped to provide continuous pressure, velocity, and displacement values for rotating equipment installed under the requirements of this section. Vibration testing equipment shall include sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions as well as vibration levels.

B. Vibration Tests:
1. Submit vibration testing plan, prepared by the professional vibration analysis specialist, for review and acceptance by the construction manager not less than 3 weeks prior to the date scheduled for the field vibration test work specified herein.
   a. Proposed vibration testing plan, incorporating corresponding pump performance testing, shall be developed to demonstrate absence of natural frequency excitation (resonance) and compliance with specified vibration limits within the pump operating range.
   b. The professional vibration analysis specialist shall consider identified standards and others consistent with practice standards of care in preparing the plan and directing the work.
   c. As part of the plan, professional vibration analysis specialist shall specify and justify selection and mounting of the vibration sensors (fully adhered or magnet-mounted) in accordance with accepted practice and specified requirements. Hand-held probe accelerometers shall not be used.
   d. Plan shall also stipulate the data collection and processing method including frequency response averaging of spectra and waveform points for each discrete measurement.
   e. Include example presentation formats consistent with specifications and accepted practice.
2. Unless otherwise specified in the detailed specification, the RMS vibration velocity shall not exceed the limits established in the appropriate standards indicated in the Table below. The measurement locations shall correspond to the guidelines provided in the specific standards given in the Table below.

Component	Standard
All Pumps	ANSI/HI 9.6.4 or ANSI/HI 11.6
Electric Motors of Any type	ISO 10816-3 Table A.1 or A.2, Zone Boundary A/B
Reciprocating engines	ISO 10816-6 Table A.1, Class 3
Support bearings, flywheels	ISO 20816-1

3. Testing:

a. Perform ramp (sweep) test of pump vibrations (at average or higher head conditions) – minimum 10 minutes (mins) start-up run, slow ramp from minimum to maximum speeds (20 mins). 20 mins at maximum speed, 10 mins at reduced (A operating speed), 10 mins to confirm largest peak; then through coast down.

b. The professional vibration analysis specialist shall collect vibration readings during the sweep test, make notes about peaks and then proceed to testing with steady state operation at the design and other targeted points. Prepare report of Overall Velocity Trends including pump speed and flow.

c. Conduct discrete performance and vibration testing of all design points (4), when performance is stable but not less than 10 minutes each. It is not necessary to conduct vibration testing at shut-off.

d. Conduct similar discrete performance and vibration testing at each discrete peak observed during the sweep test.

4. Reporting:

a. Provide vibration test reports as an information submittal in accordance with paragraph 1.08, and provide the signature of the responsible professional vibration analysis specialist.

b. The vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed by the construction manager. Cascade diagrams are not sufficient for variable-speed drive application unless supported by the required data in a format suitable for more detailed analyses. Provide separate spectra at the maximum and minimum operating speeds and any potential resonant frequencies.

c. Depict RMS velocity by axis on same plot and zoom in on 10 highest peaks for each separate axis. Report should clearly address multiples of operating speed and twice vane pass at operating speed, typically associated with pump phenomena.

d. Interpret data, identify anomalies and resonant frequencies (if any), provide discussion of probable sources/causes in test report. Provide interpretation as to why there may be peaks beyond typical phenomena.

e. If deemed necessary by the professional vibration analysis specialist, to determine the potential problem and risk with any identified peaks, further resolve and analyze critical peaks by frequency.

C. Remedial Measures:

a. If required, professional vibration analysis specialist shall provide written recommendations for remedy of problems identified.

b. Contractor shall undertake appropriate remedial action, in conjunction with the pump manufacturer, and provide professional vibration analysis specialist services, and pump manufacturer services throughout the process required to resolve identified problems.

c. Conduct additional testing after modifications or replacements to confirm effectiveness of remedy.

3.07 FIELD TORSIONAL VIBRATION TESTING

A. As required in paragraph 1.05 for custom-engineered pumps, and pumps subjected to Alternate mass elastic design analyses under paragraph 1.04 Critical Speeds and Natural Frequencies, perform field torsional vibration tests.

B. Qualifications:
   1. Work shall be conducted under the direct supervision of the design professional responsible for the mass elastic system design on an installed pumping unit selected by the construction manager.
   2. Submit qualifications of the firm and analyst demonstrating training and competency in the required testing, consistent with the requirements of paragraph 3.06 Field Vibration Tests.

C. Submit testing plan and reporting documentation consistent with the requirements of paragraph 3.06 Field Vibration Tests.

D. Provide remedial measures consistent with the requirements of paragraph 3.06 Field Vibration Tests.

3.08 TRAINING

A. Training shall conform to the requirements of Section 01 79 00 and include separate training sessions for each operator shift maintained by the Owner and a separate session for maintenance personnel.

B. Unless otherwise specified in the referencing section, the training requirement is waived for constant-speed pumping equipment with suction nozzle sizes 6 inches in diameter and smaller and for pumps with connected power requirements 10 hp and less.

C. The training session for maintenance personnel shall include a comprehensive presentation, employing cut-away models or comparable graphics, and documentation on the step-by-step disassembly and subsequent reassembly of a pumping unit.

D. Upon completion of training requirements, the contractor shall submit certified Form 43 05 11-B as specified in Section 01 99 90.

END OF SECTION

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SECTION 43 23 62

VARIABLE SPEED VERTICAL TURBINE PUMP IMPROVEMENTS

1.01 SUMMARY

A. Section includes:
   1. Replacement bowl assemblies for existing variable speed multi-stage vertical turbine diffuser pumps for pumping clean water.
   2. Existing pump motors will be re-used with the new bowl assemblies. Existing pump motor information is included in this section for reference only.
   3. Select equipment furnished under this section that will comply with the requirements of this section and Section 43 23 03.

B. Equipment list:

Item	Equipment Number
Booster Pump 1	B01-PMP100
Booster Pump 2	B01-PMP200

C. All components in contact with water shall be NSF/ANSI/CAN 61 certified.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below:
   1. Section 01 11 80 – Environmental Conditions
   2. Section 01 12 16 – Work Sequence
   3. Section 01 33 00 – Submittal Procedures
   4. Section 01 66 00 – Product Storage and Handling Requirements
   5. Section 01 78 23 – Operation and Maintenance Data
   6. Section 01 99 90 – Reference Forms
   7. Section 09 90 00 – General Coating Specification
   8. Section 43 05 11 – General Requirements for Equipment
   9. Section 43 05 13 – Rigid Equipment Mounts
   10. Section 43 23 03 – General Requirements for Centrifugal and Axial Flow Pumping

1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ABMA 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	Load Ratings and Fatigue Life for Roller Bearings

Reference	Title
AIS	American Iron and Steel Act
AISC	American Institute of Steel Construction –Manual of Practice
ANSI/API 610	Standard for Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: Concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: Thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. See Section 01 12 16: Work Sequence.

B. Sequencing
   1. See Section 01 12 16: Work Sequence, including for maximum allowable plant shutdown times.

C. Unit responsibility: Assign unit responsibility, as specified in Section 43 05 11, to the pump manufacturer for the pump bowl replacement and related necessary upgrades, specified in this section. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

1.06 SUBMITTALS

A. Action submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, and those listed below with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements:
      a. Section 43 05 11: General Requirements for Equipment
      b. Section 43 23 03: General Requirements for Centrifugal and Axial Flow Pumping Equipment

B. Informational submittals:
   1. Procedures: Section 01 33 00
   2. Conform submittals to the requirements of Section 43 23 03.

C. Closeout submittals:
   1. Procedures: Section 01 78 23.
   2. Conform submittals to the requirements of Section 43 23 03.

3. Spare parts:
    a. Procedures: Section 01 33 00.
    b. Provide the following spare parts:
        1) One set bowl bearings
        2) One lineshaft bearing assembly
        3) One set wear rings
        4) One shaft seal, complete
    c. Tag and store spare parts in accordance with provisions of Section 43 05 11.

1.07 QUALITY ASSURANCE

A. Qualifications
    1. Independent testing laboratory for vibration testing: Section 43 23 03.

B. Certifications:
    1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.
    2. Application for certification under ISO 9001 shall not be deemed as an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and shall be notarized.

C. Critical speeds: Critical speeds shall be in accordance with Section 43 23 03-1.04 except when the title of the detailed section includes "Custom Engineered" in which case Section 43 23 03-1.05 applies.

D. Vibration limits: Vibration limits shall be in accordance with Section 43 23 03-3.06 and subject to field testing in accordance with paragraph 3.04 of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

1.09 SPECIAL WARRANTY

A. Not Used

PART 2 PRODUCTS

2.01 OWNER-FURNISHED EQUIPMENT

A. Not Used

2.02 MANUFACTURERS

A. Manufacturers: Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements:
    1. Integrity Pump & Motor
    2. Approved equal

2.03 PERFORMANCE/DESIGN CRITERIA

A. Service conditions:

Description	Value
Equipment number	B01-PMP100 B01-PMP200
Area exposure	Per Section 01 11 80
Fluid type	Potable water containing up to 5 mg/l of solids consisting of grit and organic material.
Maximum operating pressure	100 psi

B. Operating conditions:

Equipment number	B01-PMP100, B01-PMP200
Full Speed Operation	
Condition A [a,d]	
Capacity, gpm	1,679
Total head, feet	222
NPSHA, feet	33.8
Condition B [b,d]	
Capacity, gpm	Per pump H/Q curve
Total head, feet	169
NPSHA, feet	35.8
Reduced Speed Operation	
Condition C [c,d]	
Capacity, gpm	995
Total head, feet	186
Pump speed	Reduced via VFD
NPSHA, feet	33.8

a. Take Condition A as the rated operating condition. Guarantee performance at the rated condition in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Select pumps furnished under this section to achieve Condition A performance, and also operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A shall be located in the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3, and published in the manufacturer's published application data for the specific model proposed for this application.

b. Condition B head is presented to indicate operating conditions when both pumps are operating at maximum speed against minimum anticipated system head, assuming a hypothetical head-capacity curve. Use Condition B for pump selection. Condition B shall be located within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3, and list in the manufacturer's published application data for the specific model proposed for this application. Condition B shall be located to the right of BEPQ, and shall not be less than 110% percent of BEPQ. Pumps with head-capacity curves steeper than that assumed will produce somewhat less flow at somewhat lower head. The reverse will occur with pumps having a shallower head-capacity curve. Proposed pump selections meeting this discharge head requirement by operating the equipment at less than full speed will be rejected. Net positive suction head available (NPSHA), as listed for Condition B is calculated on a pumped flow of 2,000 gpm.

c. *Condition C is the anticipated continuous duty minimum speed condition. Provide pumps furnished under this specification capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 43 23 03. Condition C shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3, and list in the manufacturer's published application data for the specific model proposed for this application.*

d. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 3.1- 3.5. NPSHA in the above tabulation is referred to the pump inlet rim shown and is calculated in accordance with ANSI/HI 3.2 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of 2 feet has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 43 23 03.*

C. Design requirements:

1. Conform equipment provided under this section to the following:

Item	Value
Pump	B01-PMP100 B01-PMP200
Maximum efficiency, minimum, percent [a]	
Bowl	83
Pump	82
Impeller type	Enclosed
Piping connection size, inches, minimum	
Discharge [b]	10
Existing suction column diameter, inches [c]	10
Discharge arrangement	Above Grade
Operating speed, rpm, maximum	1,800
Motor (Existing to Remain)	
Horsepower	125
Type	WP-I – Weather Protected Type I
Inverter duty	Yes
Space heater	Yes
Thermal protection	Yes
Ambient duty rating, deg C	+40
Operating speed, rpm, maximum	1,800
Voltage rating	460 volt, 3 Phase
Hazardous rating	None
Reversing motor	No
Multi-speed motor	No
Motor starting type	Reduced Voltage – VFD
Voltage rating	460 volt, 3 Phase

Notes:

a. *The maximum efficiency is the minimum acceptable peak efficiency and is not required to coincide with any specified operating condition in paragraph 1.01 Performance Requirements. Ensure pump efficiency is as defined in Section 43 23 03. Ensure pump efficiency is within 3 percent of bowl efficiency when calculated at the point of peak bowl efficiency on the pump's head/capacity curve.*

b. *Existing discharge connections are 10". Provide replacement bowl assembly that is compatible with the existing system.*

c. *Existing intake column does not have a suction bell.*

2. The pumps will be installed in an intake structure assuming a pump intake velocity of 5.0 feet per second when the pump is operating at the flow produced at the head specified in Operating Condition B..

2.04 SYSTEM OPERATION

A. Install the pump bowls in the existing pumps in the Treatment Building. Both pumps are duty pumps.

B. Operator may perform wet well pump down operation to clean the wet well. Contractor shall coordinate and get Owner approval for testing and operation of all pumping equipment in conjunction with recommended best practices from pumping equipment manufacturer.

2.05 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

Component	Material
Impeller, first stage	Nickel aluminum bronze, ASTM B148, C95500
Impeller, all other stages	Nickel aluminum bronze, ASTM B148, C95500
Bowls	NSF 61 approved epoxy coating system INT-PWS per coating specification Section 09 97 00 for potable water application
Hydrocones	Type 316L stainless steel

2.06 COMPONENTS

A. Bell: Not Used

B. Suction case:
   1. Design the suction case to provide conservative entrance velocities and evenly distribute the flow to the impeller. Ensure the inner surface of the case is smooth and free from projections or cavities. House the pump shaft lower bearing in a streamlined casing. Center and hold in place by means of rigid cast vanes. Design the bearing housing and vanes to conduct the flow efficiently into the impeller eye

C. Pump bowl:
   1. Flange the pump bowl for registered fit. Provide bolted connections between the suction case and the bowl and between the bowl and adjacent stages or the discharge case. Provide diffuser vanes that are not a multiple of impeller vanes. Polish or porcelain-line flow passages through the bowl and diffuser vanes. If required on multi-stage installations, the first-stage bowl may be designed to facilitate a low NPSH impeller arrangement.
   2. If enclosed impellers are specified, provide replaceable wearing rings on the pump bowl at the impeller inlet connection.

D. Impeller:
   1. Construct impellers free from projections, cavities, or abrupt transitions. Polish the impeller surfaces.
   2. Select impellers of the enclosed or semi-open type as specified in above under the PERFORMANCE/DESIGN CRITERIA - Design Requirements. If of the enclosed type, fit the shroud with wearing rings. Secure impellers to the pump shaft using tapered collets or keyways.

E. Shafts
   1. Size shafts to prevent excessive elongation, and to transmit the required torque without distortion in both the forward and reverse direction. Provide shafts with a first critical speed not less than10 percent below and 20 percent above maximum operating speed. Provide pumping units that use a two-piece headshaft, solid intermediate lineshafts supplied in maximum 10-foot lengths, and provide a single pump shaft extending from the suction case through a discharge case or upper bowl case containing an upper pump shaft bearing.
   2. Provide a lineshaft-enclosing tube to conduct lubricating fluid from the specified seal assembly, around the lineshaft and upper bowl bearings, to be vented through the discharge case bearing struts into the sump. Laterally support the lineshaft-enclosing tube with stabilizing bearings in the pump column at intervals not exceeding 5 feet.

F. Bearings:
   1. Select a suction case, bowl, and lower tube bearings that are close tolerance, spiral-grooved, and sleeve-type. Grease lubricate the suction case bearing. Lubricate bowl sleeve bearings by the pumped fluid. Ensure that bearing spacing does not exceed 5 feet.
   2. Externally thread enclosed lineshaft bearings into the enclosing tube. Provide bearings that are extra length spiral-grooved sleeve-type, spaced at not more than 5 feet apart. Lubricate the lineshaft bearings by gravity flow from the specified shaft seal through the lineshaft enclosing tube.

G. Discharge column: Not Used – Reuse existing

H. Discharge head and drive unit support: Not Used – Reuse existing

I. Seal:
   1. Terminate the lineshaft enclosing tube in a mechanical seal conforming to the requirements of Section 43 05 11-2.04 Mechanical Seals. Provide drilled and tapped connections for connection to an external source of lubricating fluid.

J. Couplings:
   1. Provide a four-piece coupling to connect the motor shaft and headshaft between the motor and the tension nut assembly. Design the four-piece coupling to provide for impeller adjustment, and include a spacer to permit servicing the seal.
   2. Provide lineshaft couplings that are a perfect butt-fit. Design with a safety factor of 1-1/2 times the shaft safety factor and shall have a left-hand thread to tighten during pump operation.

K. Corrosion protection:
   1. Protect the interior of the discharge column, discharge head, and all exterior below grade surfaces of the pump with coating system INT-PWS as specified in Section 09 97 00.

L. Drive unit:
   1. Reuse pump existing motor.

M. Variable frequency drive: Not Used

N. Equipment mounts: Not Used

2.07 CONTROLS

A. Existing controls will remain in place.

2.08 CONTROL PANELS

A. Not Used

2.09 FINISHES

A. Shop applied prime and finish coats with manufacturer's standard NSF/ANSI/CAN 61-600 certified coating system.

2.10 SOURCE QUALITY CONTROL

A. Factory testing shall be non-witnessed in accordance with Section 43 23 03.

B. Hydrostatic tests:
   1. Factory test all pressure sustaining parts in accordance with Section 43 23 03.

C. Performance tests:
   1. Subject each pump to non-witnessed performance test in accordance with Section 43 23 03 to verify the full range of operating condition

PART 3 EXECUTION

3.01 EQUIPMENT MOUNTING

A. Not Used

3.02 ALIGNMENT

A. Not Used

3.03 INSTALLATION

A. Temporarily remove existing pumps. Disconnect all piping, instrumentation, and miscellaneous connections which will remain in place.

B. Remove and replace existing pump bowl assemblies, including the pump bowl, impeller, shafts, bearings, seals, and couplings. Reinstall pumps.

3.04 FIELD QUALITY CONTROL

A. Field testing:
   1. Lateral vibration testing in accordance with Section 43 23 03.
   2. Torsional vibration testing in accordance with Section 43 23 03. Torsional testing performed by Design Professional.
   3. Include in the bid all costs for services of Testing Firms and Design Professionals performing these services.

B. Manufacturer services:
   1. On-site inspections and training: Provide a factory-trained manufacturer's representative at the site for the following activities. Specified durations do not include travel time to or from the site.
      a. Installation inspections: Assist, supervise, and inspect the Contractor's activities during installation. Provide 8 inspection hours. Provide a completed Form 43 05 11-A, Section 01 99 90.
      b. Component test phase inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 23 and this section. Provide 4 inspection hours.
      c. System test phase inspections: Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 23. Provide 4 inspection hours.
      d. Operational test phase inspections: Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 23 Provide 4 inspection hours.

3.05 SYSTEMS STARTUP

A. Procedures: Section 01 45 23.

B. Preoperational (factory) testing; See paragraphs 1.07 and 2.10.

C. Component testing: Perform the following tests:
   1. During initial pumping system installation, verify with clean water that the common pump discharge header, and the individual pump suction elbows can be readily drained to the wet well for maintenance or pump de-ragging without spilling on to the Treatment Building floor.
   2. Complete lateral vibration testing of all pumps in accordance with Section 43 23 03.
   3. Complete torsional vibration testing of one pump in accordance with 43 23 03.

D. System testing: Perform the following tests:
   1. Submit the draft surge testing plan that will measure surge pressures for station pumping rates between station minimum and maximum design capacity in increments of 10 starting with 10 percent above minimum and rising. Incorporate client review comments into the final plan.

2. Perform surge testing in the presence of the Engineer and Construction Manager. Cease testing if so directed.
3. If vibration and surge testing reveal that operation is impaired by poor operation of ancillary equipment (sticking check valves, plugged air/vacuum reliefs, improperly torqued flanges, etc.) repair ancillaries and retest pumps if directed by the Owner.
4. After Owner/Engineer review of the Vibration Design Professional's draft and final reports for lateral and torsional vibration participate with the Owner and Engineer in making any required adjustments to the pumping control strategy that may be required to avoid damaging vibrations, to protect the pumps and meet performance requirements.

END OF SECTION

SECTION 43 23 88.11

SELF-PRIMING CENTRIFUGAL PUMP

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies self-priming centrifugal pumps for pumping of non-potable water.
   1. Equipment furnished under this section is not required to meet the additional pumping requirements of Section 43 23 03 except where specified in this section.

B. Equipment List

Item	Equipment Number
Rinse Tank Pump	PMP101
Rinse Tank Pump Motor	MTR101

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections not specifically listed below may apply.
   1. Section 01 12 13: Work Sequence
   2. Section 01 33 00: Submittals
   3. Section 01 78 23: Operation and Maintenance Data
   4. Section 01 91 00: Commissioning, Testing, and Start-Up
   5. Section 01 99 00: Reference Forms
   6. Section 43 05 11: General Requirements for Equipment.
   7. Section 43 05 13: Rigid Equipment Mounts
   8. Section 43 23 03: General Requirements for Pumps

1.03 REFERENCES

A. This section contains references to the following documents. These references are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. If requirements of this section conflict with those of the listed documents, requirements of this section prevail.

B. Unless otherwise specified, reference documents refer to documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if no Bids). If referenced documents have been discontinued by the issuing organization, refer to replacement documents issued or otherwise identified by that organization. If there are no replacement documents, refer to the last version of the document before it was discontinued. Where document dates are given in the following listing, those documents refer to the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

Reference	Title
ASTM A48 REV A	Gray Iron Castings
ASTM A2276 REV B	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A582/A582M	Free Machining Stainless and heat Resisting Steel Bars
ASTM B584	Copper Alloy Sand Castings for General Applications
Hydraulic Institute Standards	Standards of the Hydraulic Institute, 14th Edition

1.04 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
   2. Mounting pads: thickened or raised areas of baseplates and soleplates where feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. See Section 01 12 16: Work Sequence.

1.06 SUBMITTALS

A. Action Submittals
   1. Comply with procedures described in Section 01 33 00.
   2. Comply with requirements of Section 43 23 03. Sections to be marked-up and submitted in accordance with Section 43 23 03 requirements include:
      a. This section
      b. Section 43 05 11: General Requirements for Equipment
      c. Section 43 05 13: Rigid Equipment Mounts
      d. Section 43 23 03: General Requirements for Pumps
   3. Use check-marks (✓) to denote full compliance with a paragraph as a whole. Underline and denote deviations with a number in the margin to the right of the identified paragraph. Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   4. Submit a completed Certificate of Unit Responsibility attesting that the Contractor has assigned and the manufacturer accepts unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

5. Submit a copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required". Failure to include copies of relevant drawings with the submittal is cause for rejection of the entire submittal with no further review.
6. Show pump performance curves for the specified operating conditions. Show head, capacity, horsepower, efficiency, and net positive suction head (NPSH) requirements.
7. Provide a complete list of construction materials.
8. Provide drawings showing each pump's piping connections with construction details and dimensions.

B. Informational Submittals
   1. Comply with procedures described in Section 01 33 00.

C. Closeout Submittals
   1. Comply with procedures described in Section 01 78 23.
   2. Provide operating and maintenance submittals as specified in Section 01 78 23.
   3. Spare Parts
      a. Comply with procedures described in Section 01 33 00
      b. Provide the following spare parts:
         1) One complete spare pump.

1.07 QUALITY ASSURANCE

A. Certifications
   1. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001.
   2. Application for certification under ISO 9001 is not an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and notarized.

B. Vibration Limits
   1. Vibration limits shall be in accordance with Section 43 23 03-3.06 and subject to field testing in accordance with paragraph 3.04.

C. Warranty
   1. Pump shall come with a one year limited warranty against defects in workmanship or materials under normal use for one year after date of purchase.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Comply with procedures described in Section 01 66 00.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products satisfying the requirements of this section. The manufacturer's standard product may require modification to conform to specified requirements.
   1. Dayton 4UA65
   2. Goulds IRRI-GATOR GT10
   3. Approved equal

2.02 TYPE

A. Self-priming centrifugal pumps capable of constant speed.

2.03 PERFORMANCE/DESIGN CRITERIA

A. General
   1. The pump shall be designed to operate without cavitation and the motor and pump combination shall operate without vibration over the specified range of condition. The pump head capacity curve shall slope in one continuous curve with no point of reverse slope inflection.
   2. All components shall be designed to safely withstand forces resulting from flow reversals up to 125 percent of maximum speed within the pump during shutdowns caused by power failure.
   3. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.

B. Operating Conditions

Operating condition	Value
Condition A [a] (Guaranteed Performance):	
Capacity, gpm	45
Total head, feet	70
Net positive suction head available (NPSHA), feet	29.0

a. Condition A shall be taken as the rated, continuous-duty operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section shall be selected to achieve Condition A performance, and shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application.

C. Vibration and Critical Speeds
   1. Pumps shall comply with requirements of Section 43 23 03-1.04.

2.04 SYSTEM OPERATION

A. The pumps will be installed in a building at an elevation of approximately 270 feet above sea level. The building will have a unit heater. Pumps will be started and stopped to drain backwash water from granular activated carbon (GAC) vessels on an intermittent, infrequent basis. The backwash may contain GAC fines and solids from accumulation of treating groundwater. Fluid temperature will be 40 to 80 degrees F and the anticipated pH range is 6 – 10.

PART 3 EXECUTION

3.01 EQUIPMENT MOUNTING

A. Comply with procedures described in Section 43 05 13.

B. Position equipment pad and equipment anchors for final placement of equipment.

C. Use a bolting template to position equipment anchors.

D. Level mounting plates with grout. Use rubber mounts to reduce vibration.

E. Eliminate grout voids below mounting plate.

F. Tension equipment anchors.

G. Provide a completed Form 43 05 13-A, Section 01 99 90, for each equipment installation.

3.02 SYSTEMS STARTUP

A. Comply with procedures described in Section 01 91 00.

B. Component testing
   1. Perform lateral vibration testing of all pumps in accordance with Section 43 23 03.

C. System testing
   1. If vibration testing reveals that operation is impaired by poor operation of ancillary equipment (sticking check valves, plugged air/vacuum reliefs, improperly torqued flanges, etc.), repair ancillaries and retest pumps if directed by the Owner.
   2. After Owner/Engineer review of the Vibration Design Professional's draft and final reports for lateral and torsional vibration participate with the Owner and Engineer to make any required adjustments to the pumping control strategy to avoid damaging vibrations, protect the pumps, and meet performance requirements.

D. Contractor to conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.

END OF SECTION

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SECTION 43 31 13.13

VERTICAL PRESSURE VESSEL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. This section specifies vertical pressure vessel systems through a System Supplier for treatment of per- and polyfluoroalkyl substances (PFAS) from groundwater. The vessel systems will be installed outside for PFAS treatment for Water Station 14 of the City of Vancouver, Washington.
   2. The System Supplier scope of supply is generally indicated in the drawings and includes the following:
      a. Pressure vessels
      b. Vessel inlet, outlet, backwash, and air release piping,
      c. Isolation valves on the valve manifold,
      d. Associated instrumentation, including pressure transmitters and differential pressure transmitters
      e. Pressure relief valves and air release valves
      f. Other associated ancillary appurtenances and unspecified items necessary for a complete functioning system.
      g. The System Supplier will provide pipe supports for the piping, valves, and other appurtenances associated with the scope of equipment supplied under this specification; pipe supports shall meet site seismic requirements.
   3. The granular activated carbon (GAC) media is specified in Section 46 61 16.

B. Related Sections:
   1. Section 01 11 80: Environmental Conditions
   2. Section 01 33 00: Submittal Procedures
   3. Section 01 66 00: Product Storage and Handling Requirements
   4. Section 01 73 24: Design Requirements for Nonstructural Components and Nonbuilding Structures
   5. Section 01 78 23: Operation and Maintenance Data
   6. Section 01 99 90: Reference Forms
   7. Section 09 90 00: Painting and Coating
   8. Section 40 05 01: Piping Systems
   9. Section 40 05 02: Piping System Schedules
   10. Section 40 05 02.23: Process Water
   11. Section 40 05 60: Valves
   12. Section 40 73 00: Pressure Measurement
   13. Section 43 05 11: General Requirements for Equipment
   14. Section 46 61 16: Granular Activated Carbon Media

1.02 REFERENCES

A. This section contains references to documents that are a part of this section, as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AIS	American Iron and Steel Act
ASME	Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM 380	Practice for Cleaning and Descaling Stainless Steel Part, Equipment, and Systems
AWWA C207	Steel Pipe Flanges for Waterworks Service – Size 4 in. through 144 in.
IBC	International Building Code (Latest Edition)
NSF/ANSI 61	AWWA – Drinking Water System Components
SSPC	Paint Application Specification No. 1

1.03 ENVIRONMENTAL CONDITIONS

A. The units specified in this section shall be designed for outdoor operation. Environmental conditions will be as described in Section 01 11 80.

1.04 DEFINITIONS (NOT USED)

1.05 ADMINISTRATIVE REQUIREMENTS

A. The Contractor shall assign unit responsibility as specified in Section 43 05 11-1.02 Unit Responsibility to the System Supplier for provision of all equipment specified in this section and in the System Supplier's Scope.

1.06 QUALITY ASSURANCE

A. General:

1. The Contractor shall be responsible to assure that the vessel systems furnished under this Section have the proper connections and are made of the proper materials to satisfy this and other applicable specifications and as shown on the drawings. Strict adherence to the standards of design, fabrication, product quality, and long-term performance is required by the system supplier.
2. The System Supplier shall be one who is regularly engaged in the business of supplying and erecting the type of vessel specified herein. The entire pressure vessel system and connections shall be designed, fabricated, and supplied by a single manufacturer.
3. The System Supplier shall have provided equipment for at least ten similar facilities with a minimum treatment capacity of 500 gpm that have been successfully operating for at least three years.
4. The System Supplier's trained field representative shall have overseen the installation and startup of not less than five separate GAC contactor installations.
5. The pressure vessel shall be fabricated in an ASME Code certified manufacturing facility.

1.07 SUBMITTALS

A. Action Submittals

1. Comply with procedures described in Section 01 33 00.
2. Copy of this Section, with each paragraph, with addendum updates included, (referenced sections need not be included) check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation.
4. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration. Copies of this specification section shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.
5. Form 43 05 11-C: Certificate of Unit Responsibility attesting that the Contractor has assigned and that the manufacturer accepts unit responsibility in accordance with the requirements of this Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

6. A copy of all related contract schematic, structural, and mechanical drawings with all piping, foundations, supports, anchors and layout sizes and dimensions required for installation either confirmed by a checkmark or adjustments marked in red ink.
7. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
8. Manufacturer's equipment catalog information and equipment data including product literature, materials of construction, lining and coating systems, construction details, dimensions, piping connections, weight of equipment, and instrument calibration ranges. Clearly note model numbers, appurtenances, and selected options.
9. Structural design calculations per Section 01 73 24.
10. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall depict size and location of equipment pads and reinforcement; equipment drains; vents, equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate; soleplate; or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or mounting blocks shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements. Equipment anchorage and pipe supports shall be designed to the requirements of Section 01 73 24 and stamped by an Engineer registered in the State of Washington.
11. System Supplier shall provide a list of at least ten similar facilities with a minimum treatment capacity of 500 gpm that have been successfully operating for at least three years.
12. Signed calculations determining sizing for any pressure relief valves associated with the pressure vessels. Calculations shall be stamped by an Engineer registered in the State of Washington.

B. Informational Submittals
   1. Comply with procedures described in Section 01 33 00.
   2. All applicable forms per Section 01 99 90.
   3. Empty bed (excluding media) head loss curve from inlet flange to outlet flange with head loss in ft of water on the y-axis versus flow rate in gpm for flow rates from 0 gpm to 1,100 gpm per vessel on the x-axis.
   4. Certified copies of ASME inspection reports, including ASME certification.
   5. Affidavits of compliance with referenced standards and codes including NSF 61 certification for equipment in contact with potable water.
   6. Coating and lining inspection and testing reports as defined herein.

C. Closeout Submittals

1. As-built drawings of the completed system to supply to the Contractor for assembly and anchoring in the field.
2. Comply with procedures described in Section 01 78 23.
3. Provide operation and maintenance submittals as specified in Section 01 78 23.
4. Provide the following product data:
    a. Installation certification Form 43 05 11.
    b. Form 46 05 29-A, Rigid Equipment Mount Installation Checklist for all mounted equipment.
    c. Training Certification Form 43 05 11.
    d. Equipment warranty.
5. Spare Parts
    a. Comply with procedures described in Section 01 33 00.
    b. Provide the Manufacturer's recommended spare parts list for the initial two years of operation.

1.08 DELIVERY, STORAGE AND HANDLING

A. The equipment shall be protected during shipment as specified in Section 01 66 00.

B. Ship equipment, materials, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

C. Where applicable, pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

D. Provide short-term and long-term storage requirements to the CONTRACTOR.

E. Immediately upon fabrication, store equipment in a secure area controlled by the System Supplier. Make provisions for properly storing and protecting all material and equipment against theft, injury, or damage from all causes. Damaged material and equipment will not be accepted.

F. Use non-marring slings for loading, unloading, and handling units for prevent rope or cable damage to surfaces and protective coverings.

G. Any damage to the shop-applied factory coating must be repaired as specified in Section 09 90 00 before installation of the vessels. Repairs to the factory coating are the responsibility of the Contractor.

1.09 WARRANTY

A. A two-year 100% parts and labor warranty against manufacturing defects or failure of the equipment or coatings specified in this section caused by normal wear and tear shall be provided. The warranty period shall start from the date of final acceptance of the equipment specified in this section. The equipment shall be warranted to be free of defects in materials and workmanship and to meet the performance criteria.

PART 2 PRODUCTS

2.01 CONTRACTOR AND OWNER FURNISHED EQUIPMENT

A. Contractor Furnished Equipment
   1. The Contractor is responsible for the supply piping, pipe supports, hangers, and anchors to each pressure vessel pair up to the tee connections on the valve manifold.
   2. The Contractor is also responsible for process piping and connecting pressure vessels systems to the rest of the piping infrastructure.
   3. The Contractor is responsible for the supply and installation of the anchor bolts for the pressure vessels and valve manifold rack. The System Supplier shall provide the anchor bolt templates based on as-built drawings if the anchor bolts are cast in place.

B. Owner Responsibilities
   1. The Owner will procure an integrator separately to program the PFAS treatment system.

2.02 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard products will comply with the requirements of this Section. Candidate manufacturers include the following manufacturers, or manufacturers that are approved equal:
   1. Calgon Carbon Corporation
   2. Aqueous Vets
   3. Newterra

2.03 PERFORMANCE/DESIGN CRITERIA

A. Equipment List:

Item	Equipment No.
Pressure Vessel 0100	F0100
Vessel 0100 Pressure Indicating Transmitter	PIT 0101
Vessel 0100 Pressure Differential Indicating Transmitter	PDIT 0102
Vessel 0100 Combined Air Vacuum/Release Valve	CAV0101
Vessel 0100 Pressure Relief Valve	PRV0101
Pressure Vessel 0200	F0200
Vessel 0200 Pressure Indicating Transmitter	PIT 0201
Vessel 0200 Pressure Differential Indicating Transmitter	PDIT 0202
Vessel 0200 Combined Air Vacuum/Release Valve	CAV0201
Vessel 0200 Pressure Relief Valve	PRV0201
Pressure Vessel 0300	F0300
Vessel 0300 Pressure Indicating Transmitter	PIT 0301
Vessel 0300 Pressure Differential Indicating Transmitter	PDIT 0302

Item	Equipment No.
Vessel 0300 Combined Air Vacuum/Release Valve	CAV0301
Vessel 0300 Pressure Relief Valve	PRV0301
Pressure Vessel 0400	F0400
Vessel 0400 Pressure Indicating Transmitter	PIT 0401
Vessel 0400 Pressure Differential Indicating Transmitter	PDIT 0402
Vessel 0400 Combined Air Vacuum/Release Valve	CAV0401
Vessel 0400 Pressure Relief Valve	PRV0401
Pressure Vessel 0500	F0500
Vessel 0500 Pressure Indicating Transmitter	PIT 0501
Vessel 0500 Pressure Differential Indicating Transmitter	PDIT 0502
Vessel 0500 Combined Air Vacuum/Release Valve	CAV0501
Vessel 0500 Pressure Relief Valve	PRV0501
Pressure Vessel 0600	F0600
Vessel 0600 Pressure Indicating Transmitter	PIT 0601
Vessel 0600 Pressure Differential Indicating Transmitter	PDIT 0602
Vessel 0600 Combined Air Vacuum/Release Valve	CAV0601
Vessel 0600 Pressure Relief Valve	PRV0601

B. The pressure vessel system provided under this section shall be designed specifically for treatment of PFAS from groundwater. Periodic disinfection of vessel components may be required using hydrogen peroxide, chlorine, or sodium hydroxide. The height and internal geometry of the pressure vessels shall be determined by the pressure vessel manufacturer to ensure that media is properly fluidized during hydraulic washing cycles without any measurable media losses (less than 5 percent per year) or clogging of the underdrain system and inlet distributor/backwash collector. The vessel underdrain system and inlet distributor should be designed with 0.008" slot openings for compatibility with alternative medias, including IX resin in the future.

C. Physical Design Criteria:

Description	Value
Pressure Vessels	
Number	6
ASME Pressure Rating, psig (minimum)	125
Diameter, ft	12
Height	As required by pressure vessel manufacturer to achieve a 30% bed expansion of GAC media within the straight side, while meeting media loss requirements. All pressure vessels shall be the same height.
Empty Bed Contact Time Per Vessel, min	9.6
Backwash Loading Rate, gpm/sf	10
Media Weight per Vessel, lb	40,000
Pressure Vessel System Weight (per pair), Operating, lb	391,000

D. Operation: The pressure vessel system shall operate in lead-lag mode (three pairs of pressure vessels) where the lead vessel can be reversed and also become the lag vessel.

E. Operating Conditions

Characteristic	Value
Temperature Range, °F	40 to 80
pH Range	6 to 10

F. Performance Requirements: Backwash will be initiated manually.

Description	Value
Maximum Plant Flow Rate (gpm)	3,200
Minimum Plant Flow Rate (gpm)	1,000
Maximum Flow Rate per Vessel (gpm)	1,067
Minimum Flow Rate per Vessel (gpm)	333
Allowable clean bed headloss based on 40,000 lbs GAC media as specified in Section 46 61 16, inlet flange to outlet flange at design flow rate (psig)	16
Allowable dirty bed headloss based on 40,000 lbs GAC, media as specified in Section 46 61 16, inlet flange to outlet flange at design flow rate (psig)	28

2.04 MATERIALS

A. All components in contact with water shall be NSF/ANSI/CAN 61 certified.
   1. Minor deviations from the specifications listed in this section may be permitted if the system, as a whole, is NSF/ANSI 61 certified. Deviations from this section must be submitted to the Engineer for review and approval as described in Section 01 33 00 and paragraph 1.07 of this section.

B. Materials of construction shall be as follows:

Component	Material
Vessel	ASTM SA-516 Gr. 70
Structural Steel	ASTM A-36
Inlet Distributor/Backwash Collector/Underdrain	316 Stainless Steel
Underdrain nozzles	316 Stainless Steel
Process piping and valves	See Section 40 05 02.23

2.05 CONFIGURATION, COMPONENTS, FEATURES

A. General:
   1. Each pressure vessel shall be complete including, but not limited to the following:
      a. Pressure vessels including vessel internal distributors/collectors, underdrain, and backwash and effluent water collection, sample ports and lines, media fill and discharge lines, air vacuum release and washdown lines, manways, and all associated accessories.

B. Pressure Vessel:

1. Each pressure vessel shall be of welded steel construction and shall be provided with four (4) I-beam legs to support the vessel. Vessels shall be designed and fabricated in accordance with the ASME code Section VIII Div 1 and shall be stamped and certified. In addition, vessels including support systems and anchors shall be designed by the Pressure Vessel Supplier in accordance with Section 01 73 24. Structural calculations shall be performed and signed by a structural or civil engineer registered in the State of Washington. The Pressure Vessel Supplier shall provide the pipe supports. The Contractor shall provide the anchors and anchor templates if anchors are cast in place.
2. Provide a minimum 24-inch diameter manway on the side of the vessel. Manway shall be complete with manhead cover, yoke, ¼" EPDM gasket, and hinged for manway cover.
3. Provide a minimum 14 x 18-inch elliptical coned manway (submarine style) at the bottom of the vessel (if proposing internal cone underdrain design). Manways shall be complete with manhead cover, yoke, and gasket. This manway is only required for vessel with an internal cone underdrain system.
4. Five (5) 1/2" nozzles shall be provided on the side of each vessel for sampling (25-50-75% of bed depth for GAC, and 50-75% of bed depth for IX) and a 2" vent for the underdrain system (internal cone underdrain only). Nozzle locations are shown in part 2.05.K of this section and are based on a media depth of 12'-6" for GAC and 3'-8" for IX. Three 4" connections shall be provided for filling the vessels with media and for removing media, one fill line and two removal lines. Provide additional piping connections as needed for operation of the vessels. Support points for influent piping, air release piping, carbon fill piping, spent carbon outlet piping, sample piping, and vent piping shall be provided integrally to each vessel.
5. Provide a minimum 20-inch round manway on the top of the vessel, with manway center 34-inches from vessel center at 90 degrees. Manways shall be complete with manhead, yoke, ¼" EPDM gasket, and horizontal davit (integral lifting device) for manway cover.
6. Provide flanged connections for 10-inch diameter inlet/outlet piping.
7. Safety tie-off near elevation of inlet piping on top of the vessel.

C. Inlet Distributor/Backwash Collector:

1. Provide a header/lateral type or weir/trough type inlet distributor/backwash collector system for each vessel. The distributor/collector shall be designed for even distribution of flow over the entire media bed and for the uniform collection of backwash water during the backwash cycle. Provision shall be made for field leveling of the distributor/collector to ensure uniform distribution/collection. The distance from the underdrain system to the backwash collector shall be not less than the depth of 40,000 lbs of GAC, with 30% expansion. All bed expansion must be contained in the vessel straight side.
2. The distribution system shall be designed such that it can be dismantled and reassembled from within the vessels without cutting any vessel or distribution system physical members. The inlet distributor/backwash collector shall be designed to minimize swirling in the headspace of the vessel which may disrupt future IX media beds.
3. The distribution point(s) shall be located near, but not closer than 3 inches to the upper head.

4. Header/lateral type distributors shall be designed with type 316 stainless steel pipe and threaded fittings. Laterals shall terminate in upturned 90 degree elbows with vertical piping extending from the upturned elbows providing the specified freeboard.
5. The inlet distributor shall be designed to be compatible with IX media in the future.

D. Underdrain System:
1. Each vessel shall be provided with an underdrain system designed to support the media bed, uniformly distribute backwash water, and collect treated water. Mal-distribution of any of these flows shall not exceed 5 percent over any part of the underdrain system. The underdrains shall also be so designed to reduce the water velocity, discharging the water horizontally without impeding its flow, thereby preventing channeling in the media bed. Under no circumstances shall the GAC media be upset during normal backwash procedures. The underdrain systems are to be installed by the vessel manufacturer prior to shipment. Costs for any repairs or replacement of the underdrain system, or media as a result of poor distribution or media upset shall be borne solely by the vessel supplier. Septa slot size openings shall be 0.008" or less and shall be manufactured from stainless steel.
    a. Internal Cone Style Underdrains - The cone shall be welded to the tank wall around the entire circumference to form a watertight seal between the media chamber above and the water inlet chamber below.
    b. External Header Style Underdrains – The septa and underdrain system shall be designed in such a way such that removal of the septa can be accommodated without having personnel enter the vessel.
    c. Internal Header/Lateral Style Underdrains – The septa and underdrain system shall be constructed entirely of stainless steel within the vessel.
2. The underdrain must be fully assembled in the vessel prior to shipping.

E. Fresh Media Fill, Spent Media Removal, and Sample Ports, Piping, and Valves:
1. Provide a minimum of five combined process water sample ports to collect water quality samples. Sample port locations should target empty bed contact times of 25%, 50% and 75% of bed depth, top of bed to bottom of bed, for GAC (9.6 min EBCT) and empty bed contact times of 50% and 75% of bed depth, top of bed to bottom of bed, for IX (3 min EBCT).
    a. Water quality sample lines shall all terminate at the same elevation and the elevation shall be easily accessible for operator sample collection. Each sample line shall have a 45-degree bend, followed by a minimum 6-inch long straight pipe. Sample lines shall terminate under a metal rain canopy, supplied by the Contractor, to prevent contamination of samples. The canopy shall not interfere with the minimum clearances between vessels per the Drawings.
    b. Each sample line shall have a 1/2" full port threaded stainless steel ball valve with a locking mechanism at the end.
    c. The entire width of the sampling station (all five sample valves together) shall not exceed 4 feet horizontally for minimizing footprint and easy personnel access. Provision should be made in the spacing for heat trace, insulation, and cladding around each sample line for freeze protection. Heat tracing, insulation, and cladding will be supplied and installed by the General Contractor.
    d. Each sample port shall be equipped with a lockable security camlock.

2. Provide a 4” media fill port and line. Lines shall terminate at an elevation that can be easily accessed for fresh media fill hose connection and shall have 4” flanged stainless steel ball valve and male quick connect terminal with cap and ¾” compressed air connection with ¾” steel ball valve.
3. Provide a 2” diameter vent port and line. Line shall terminate at an elevation that can be easily accessed for operator manual operation and shall have 2” full port threaded stainless steel ball valve.
4. Provide two 4” spent media ports and lines, one at the bottom, and one located at the intermediate part of the bed such that the media can be removed in 20,000 lb increments. Supplier shall submit with their proposal a detailed report documenting full scale test work performed to verify media side discharge locations with enables the removal of spent media in 20,000 lb increments, which is the legal load. Each line shall terminate at an elevation that can be easily accessed for spent media removal and each line shall have a 4” flanged stainless steel ball valve and male quick connect terminal with cap.

F. Piping and Valve Manifold
1. A carbon steel valve and interconnecting piping manifold shall be supplied to the limits shown on the P&IDs with manual wafer style butterfly valves to connect two pressure vessels and allow for parallel or series flow, as well as swapping lead-lag operation. Valves shall be elastomer lined with a cast iron disc and stainless-steel edge. Manual valves above 6’ from the finished floor shall be equipped with chainwheel actuators. Valves and piping shall be rated for a working pressure of 125 psi.
2. The valve manifold shall accept four (4) 10” diameter pipes (from the bottom up): backwash supply, vessel effluent, vessel influent, and backwash waste. Additionally, there should be a sufficient number of valves provided in the manifold to allow for flow from the vessel effluent, to directly travel to the backwash waste connection, to act as a filter to waste process. Provide flange at all points of connection to Contractor-provided piping.
3. Pressure relief valves shall be included in the manifold by the System Supplier. Pressure relief valves shall be designed and sized by the System Supplier. Rupture disks are not permissible.
4. Provide all valves indicated on the P&IDs within the System Supplier’s limits of supply. All valves to be per Section 40 05 02.23.

G. Pipe Supports:
1. System Supplier to design pipe supports in vendor package. Number of pipe supports to be verified by Pressure Vessel Supplier via design.
    a. Each vessel shall include at least one (1) external side mounted pipe support for the 10” dia Sch 40 carbon steel influent pipe.
    b. Each vessel shall include two (2) external side mounted pipe support for the 4” dia Sch 40 carbon steel fresh carbon fill line.
    c. Each vessel shall include one (1) external bottom mounted pipe support for each 4” dia Sch 40 carbon steel spent carbon outlet.
    d. Each vessel shall include two (2) external side mounted pipe support for the 2” dia Sch 40 galvanized steel combination air / vacuum valve line.
    e. Each vessel shall include one (1) external side mounted pipe supports for each 2” dia Sch 40 galvanized steel vent lines and 1/2" dia Sch 40 sample lines.

f. Vessel Supplier shall also design pipe supports for the valve manifold area between each pair of vessels for the piping of 10” diameter and smaller.

H. Lifting Lugs:

1. Each vessel shall include four (4) external top mounted lifting lugs suitable for lifting and placing the vessel into position.

I. Instrumentation

1. Each vessel shall include pressure indicating transmitter per Section 40 73 00.
2. Each vessel shall include pressure differential indicating pressure differential transmitter across the GAC per Section 40 73 00.

J. Carbon Acceptance Canister:

1. Provide one carbon acceptance canister for the entire site.
2. Carbon acceptance canister shall be used for the collection of a sample of spent GAC without the need to open the vessel manways or drain line.
3. The carbon acceptance canister shall include the canister, tubing connections to the vessel influent and effluent lines, a total of four isolation valves (2 at the canister, 2 at the common headers), and a flow control valve on the canister effluent set to 1 gpm.

K. Nozzle Schedule:

1. The following nozzles shall be incorporated into the construction of the vessels

Nozzle No.	Surface of Penetration	Service	Description	Fitting Type	Distance from Bottom	Distance from Center	Rotation (degrees)
NZL-0100-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0100-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7"	N/A	30 DEG
NZL-0100-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5"	N/A	285 DEG
NZL-0100-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3"	N/A	280 DEG
NZL-0100-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10"	N/A	275 DEG
NZL-0100-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11"	N/A	270 DEG
NZL-0100-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11"	N/A	265 DEG
NZL-0100-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9"	N/A	260 DEG
NZL-0100-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	50 DEG
NZL-0100-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0100-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	90 DEG
NZL-0100-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0100-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG

Nozzle No.	Surface of Penetration	Service	Description	Fitting Type	Distance from Bottom	Distance from Center	Rotation (degrees)
MNWY-0100-2	Sidewall	N/A	24" Manway	Flat Face	2'-2"	N/A	0 DEG
MNWY-0100-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG
NZL-0200-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0200-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7" CL	N/A	330 DEG
NZL-0200-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5" CL	N/A	75 DEG
NZL-0200-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3" CL	N/A	80 DEG
NZL-0200-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10" CL	N/A	85 DEG
NZL-0200-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11" CL	N/A	90 DEG
NZL-0200-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11" CL	N/A	95 DEG
NZL-0200-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9" CL	N/A	100 DEG
NZL-0200-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	310 DEG
NZL-0200-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0200-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	270 DEG
NZL-0200-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0200-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG
MNWY-0200-2	Sidewall	N/A	24" Manway	Flat Face	2'-2" CL	N/A	0 DEG
MNWY-0200-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG
NZL-0300-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0300-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7" CL	N/A	30 DEG
NZL-0300-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5" CL	N/A	285 DEG
NZL-0300-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3" CL	N/A	280 DEG
NZL-0300-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10" CL	N/A	275 DEG
NZL-0300-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11" CL	N/A	270 DEG
NZL-0300-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11" CL	N/A	265 DEG
NZL-0300-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9" CL	N/A	260 DEG
NZL-0300-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	50 DEG
NZL-0300-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0300-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	90 DEG

Nozzle No.	Surface of Penetration	Service	Description	Fitting Type	Distance from Bottom	Distance from Center	Rotation (degrees)
NZL-0300-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0300-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG
MNWY-0300-2	Sidewall	N/A	24" Manway	Flat Face	2'-2" CL	N/A	0 DEG
MNWY-0300-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG
NZL-0400-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0400-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7" CL	N/A	330 DEG
NZL-0400-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5" CL	N/A	75 DEG
NZL-0400-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3" CL	N/A	80 DEG
NZL-0400-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10" CL	N/A	85 DEG
NZL-0400-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11" CL	N/A	90 DEG
NZL-0400-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11" CL	N/A	95 DEG
NZL-0400-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9" CL	N/A	100 DEG
NZL-0400-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	310 DEG
NZL-0400-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0400-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	270 DEG
NZL-0400-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0400-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG
MNWY-0400-2	Sidewall	N/A	24" Manway	Flat Face	2'-2" CL	N/A	0 DEG
MNWY-0400-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG
NZL-0500-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0500-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7" CL	N/A	30 DEG
NZL-0500-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5" CL	N/A	285 DEG
NZL-0500-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3" CL	N/A	280 DEG
NZL-0500-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10" CL	N/A	275 DEG
NZL-0500-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11" CL	N/A	270 DEG
NZL-0500-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11" CL	N/A	265 DEG
NZL-0500-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9" CL	N/A	260 DEG
NZL-0500-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	50 DEG

Nozzle No.	Surface of Penetration	Service	Description	Fitting Type	Distance from Bottom	Distance from Center	Rotation (degrees)
NZL-0500-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0500-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	90 DEG
NZL-0500-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0500-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG
MNWY-0500-2	Sidewall	N/A	24" Manway	Flat Face	2'-2" CL	N/A	0 DEG
MNWY-0500-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG
NZL-0600-1	Top	GFM	4" GAC Fresh Media (Inlet)	150# Flange	N/A	1'-6"	0 DEG
NZL-0600-2	Sidewall	GSM	4" GAC Spent Media 1 (Outlet)	150# Flange	1' 7" CL	N/A	330 DEG
NZL-0600-3	Sidewall	SMP	1/2" GAC 25% Sample Tap	150# Flange	9'-5" CL	N/A	75 DEG
NZL-0600-4	Sidewall	SMP	1/2" GAC 50% Sample Tap	150# Flange	6'-3" CL	N/A	80 DEG
NZL-0600-5	Sidewall	SMP	1/2" GAC 75%/IX 25% Sample Tap	150# Flange	2'-10" CL	N/A	85 DEG
NZL-0600-6	Sidewall	SMP	1/2" IX 50% Sample Tap	150# Flange	1'-11" CL	N/A	90 DEG
NZL-0600-7	Sidewall	SMP	1/2" IX 75% Sample Tap	150# Flange	0'-11" CL	N/A	95 DEG
NZL-0600-8	Sidewall	VT	2" Undercone Vent (if applicable)	150# Flange	0'-9" CL	N/A	100 DEG
NZL-0600-9	Top	PD	2" Air/Vacuum Valve	150# Flange	N/A	2'-11"	310 DEG
NZL-0600-10	Top	RAW	10" Influent Connection	150# Flange	N/A	0'-0"	0 DEG
NZL-0600-11	Bottom	PEF	10" Effluent Connection	150# Flange	N/A	0'-0"	270 DEG
NZL-0600-12	Bottom	GSM	4" GAC Spent Media 2 (Outlet)	150# Flange	N/A	0	0 DEG
MNWY-0600-1	Top	N/A	20" Manway	Flat Face	N/A	3'-9"	0 DEG
MNWY-0600-2	Sidewall	N/A	24" Manway	Flat Face	2'-2" CL	N/A	0 DEG
MNWY-0600-3	Bottom	N/A	18x14" Manway (if applicable)	Flat Face	N/A	0	15 DEG

2.06 VENDOR CONTROL PANELS

A. Not required.

2.07 COATINGS

A. All paints, coatings, and sealants in contact with water shall be NSF/ANSI/CAN 61 listed.

B. Linings and coatings for pipe, valves, etc., shall be as specified in Section 40 05 02.23.

C. Interior surfaces of all pressure vessels shall be completely factory finish coated prior to shipment with a suitable coating system for GAC potable water service.

D. Interior surfaces shall be coated with an abrasion-resistant, high solids epoxy amine, Sherwin Williams Sherplate PW or equal. Coating shall be uniform and minimum 35-45 mils dry film thickness (DFT) for all surfaces in contact with GAC and 20-25 mils DFT for all other surfaces. For vessels with an internal cone style underdrain, coat to a minimum dry film thickness of 20-25 mils below the cone.

E. Fabricated steel or ferrous metal vessel components shall be fully prepared and coated in accordance with the requirements of Section 09 90 00.

F. All piping surfaces shall be power tool cleaned to the degree specified by SSPC-SP3-63.

G. Vessel exteriors shall be factory primed and finished using Section 09 90 00 system EU-1.

H. The equipment warranty specified in this Section shall include a warranty on the coating system.

I. All hardware (nuts, bolts, and washers) shall be hot dipped galvanized. Galvanic corrosion isolation kits shall be included at areas of dissimilar metal contact.

J. Lining and coating inspection and testing shall be per AWWA D102 and include:
   1. General: Before the primer coating is applied, verify that surface preparation parameters of the coating manufacturer have been satisfied for interior and exterior surface. The wet film thickness of each coat shall be measured during application. Before application of successive coats, the DFT shall be measured for compliance.
   2. Film thickness: The DFT of the total system shall be measured in accordance with SSPC-PA-2.
   3. Holiday Testing: the coating on interior wet surfaces below the max water level (MWL) shall be tested and identified in accordance with NACE SP0188. Locations where holidays are detected shall be retested after repair work has been completed.

K. The System Supplier shall pay for all of the above coating testing and any required re-testing of the lining prior to shipment.

2.08 SOURCE QUALITY CONTROL

A. Manufacturer to perform factory testing prior to delivery to demonstrate the accuracy and performance of the systems as specified.

B. Factory Testing shall be non-witnessed.

C. Manufacturer to certify and provide copies of the tests and guarantee the equipment's performance as specified in this Section. Submit all certifications of Factory Testing for approval, prior to shipping equipment.

D. Factory Testing to include all standard tests recommended by the Manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with Section 43 05 11 – General Requirements for Equipment.

B. Manufacturer to provide the Contractor with detailed recommendations and instructions for installation of the equipment specified in this Section.

C. Provide a completed Manufacturer's Installation Certification Form, Section 01 99 90 – Reference Forms, for each equipment installation.

3.02 MANUFACTURER'S FIELD SERVICES

A. Installation, testing, training and commissioning shall be performed in accordance with Sections 01 45 23. The System Supplier shall provide a factory representative, knowledgeable of the system and components, to inspect the final installation, supervise the initial testing and operation, and train necessary personnel in the proper operation and maintenance for the system, certified on Form 43 05 11.

B. A pre-commissioning service visit shall be provided to inspect the installation of the vessels, with a minimum of 8 hours on site.

C. Start and test equipment provided under this Section only under the direction of personnel provided by the System Supplier. System Supplier to provide field services by the System Supplier as required to support the receipt/inspection upon arrival, installation, field testing and commissioning, and training of the equipment supplied in order to provide a fully functioning system in accordance with the Contract Documents. Provide the following minimum field services. These are set as minimum requirements to be at the project site and additional time may be required as deemed necessary by the Manufacturer and Contractor to provide a fully functioning system.
   1. Inspection/Receipt upon arrival: Two (2) days over two (2) separate visits.
   2. Field Services and Commissioning: 40 hours over five (5) separate days for system start up.
   3. Training: Reference Paragraph 3.04 of this Section.

D. A vessel filing service visit shall be provided to assist with loading carbon and initial backwashing, with a minimum of 40 hours on site over five (5) days.

3.03 COMMISSIONING, TESTING, AND STARTUP

A. General
   1. Provide Field Testing and Commissioning in accordance with the requirements of Section 01 91 00 - Commissioning, Testing and Startup.
   2. System Supplier to provide detailed procedures for Field Testing and Commissioning procedures.
   3. Provide Field Testing and Commissioning under the direction of experienced and qualified personnel provided by the System Supplier.

B. Following successful Acceptance Testing, provide a System Supplier's Operation Certification, Form 43 05 11, Section 01 99 00 – Reference Forms

3.04 DEMONSTRATION AND TRAINING

A. Provide training as specified in Section 01 79 00 – Demonstration and Training.
   1. The minimum training hours shall be comprised of the following:
   2. Operations Training: 2 sessions, 4 hours per session.
   3. Maintenance Training: 2 sessions, 4 hours per session.

B. Upon completion of the training activities, the Manufacturer to provide a Manufacturer's Instruction Certification, Form 43 05 11, Section 01 99 90 – Reference Forms

END OF SECTION

SECTION 46 22 30

FLOATING SUPERNATANT DECANTERS

PART 1 GENERAL

1.01 SUMMARY

A. Scope of Section
   1. Work included: This section includes furnishing one supernatant decanter and associated accessories. The decanter shall be installed as shown on the contract drawings and as specified herein.
   2. Equipment furnished under this section shall include floating decanter, decanter hose, and necessary components to provide a completely functional system. Only floating style decanters shall be acceptable.

B. Related Sections:
   1. Section 01 11 80 - Environmental Conditions
   2. Section 01 33 00 - Submittal Procedures
   3. Section 01 61 45 - Area Exposure Designations
   4. Section 01 66 00 - Product Storage and Handling Requirements
   5. Section 01 73 24 - Design Requirements for Nonstructural Components and Nonbuilding Structures
   6. Section 01 78 23 - Operation and Maintenance Data
   7. Section 01 79 00 - Demonstration and Training
   8. Section 01 99 90 - Reference Forms
   9. Section 43 05 11 - General Requirements for Equipment

C. Equipment List
   1. The numbered equipment in the scope of supply of this Section are as follows.
   2. Refer to the drawings for the items enumerated in the equipment list below which are to be supplied under this Section and which are specified in this Section.

Item	Equipment Number
Rinse Water Tank Decanter	DCT100

D. Provide the following minimum documentation per Section 01 33 00 - Submittal Procedures.
   1. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations.
      a. Checkmarks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Equipment literature, cut sheets and data sheets for all equipment supplied under this Section.
   3. Dimensional drawings for the equipment supplied under this Section. In addition to dimensional information for the equipment specified, these drawings depict the position of connection points and sizes for piping, electrical, instrumentation, and structural connections.
   4. Weights of equipment and major components.
   5. Information regarding materials of construction for all equipment supplied under this Section.
   6. Performance guarantee as specified in this Section.
   7. Draft Warranty information as specified.
   8. Spare parts list.
   9. Special shipping, storage and protection, and handling instructions.
   10. Installation Instructions.
   11. Manufacturer's qualifications in accordance with specified requirements in this Section.
   12. Lubricant information provided as specified in Part 2 (Spare Parts) of this Section.
   13. Factory Testing Plan including proposed data collection and reporting procedures.

E. Action Submittals - Construction: The following shall be submitted during construction of this element of the Work.
   1. Operations and Maintenance Manuals (including Warranty) in accordance with Section 01 78 23 – Operations and Maintenance Data
   2. Factory Test Reports
   3. Field Testing Plan
   4. Field Test Reports

F. Closeout Submittals: The following minimum submittals shall be submitted for inspection.
   1. Final Operations and Maintenance Manuals (including final Warranty documents) in accordance with Section 01 78 23 – Operations and Maintenance Data.

2. Manufacturer's Installation Certification, Form 43 05 11-A as found in Section 01 99 90 – Reference Forms.
3. Certificate of Testing and Commissioning, Form 01 91 00-A, as found in Section 01 99 90 – Reference Forms.
4. Manufacturer's Instruction Certification, Form 43 05 11-B as found in Section 01 99 90 – Reference Forms.
5. Manufacturer's Operations Certification, Form 43 05 11-D as found in Section 01 99 90 – Reference Forms.

1.02 QUALITY ASSURANCE

A. The manufacturer of the floating supernatant decanter shall be completely responsible for the proper design of their system. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the Drawings and Specifications.

B. The floating supernatant decanter unit shall be supplied by a company that is regularly engaged in the manufacture and fabrication of floating decanters. The manufacturer's experience shall include a minimum of ten installations where equipment of similar size and design has been in operation successfully in a similar process for a minimum of five years.

C. Contractor shall assign full responsibility for the functional operation of the floating supernatant decanter to a Single Source Supplier. This Supplier shall be responsible for all engineering necessary in order to select, furnish, inspect the installing contractor's equipment installation and connections, calibrate, and place into operation the floating supernatant decanter along with all other equipment and accessories as specified herein.

D. The minimum acceptable standards for the equipment shall conform to the Project contract documents as outlined in the respective sections of the Specifications and Drawings.

1.03 SHIPMENT AND STORAGE

A. Ship and store products in accordance with Section 01 66 00 – Product Storage and Handling Requirements.

B. Provide the Contractor with detailed recommendations and instructions for product storage.

1.04 WARRANTIES

A. The Manufacturer shall provide a written warranty against defects in materials and workmanship. Manufacturer shall warrant the goods provided by the Manufacturer to be free from defects in materials and workmanship under normal conditions and use for a period of two years from the earlier of either the date established for partial utilization or Substantial Completion of the Project.

PART 2 PRODUCTS

2.01 TYPE

A. Floating supernatant decanter.

2.02 MANUFACTURERS

A. Manufacturers: Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Megator Floating Suction Strainer, Megator Corporation, Pittsburgh, Pennsylvania
   2. Approved equal

2.03 CONDITIONS/PERFORMANCE/DESIGN CRITERIA

A. Equipment furnished under this Section shall be suitable for operation in the conditions described, provide the performance required and with the design criteria specified.

B. Environmental Conditions
   1. Equipment in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 – Environmental Conditions.

C. Service Conditions
   1. Refer to Section 01 61 45 – Area Exposure Designations for site-wide area exposure designations and environmental conditions.
   2. Specific service conditions for the rinse water tank are provided in the table below:

Description	Value
Equipment number	TNK100
Fluid Type	Granular Activated Carbon Rinse Water
Fluid Temperature	40 to 80 degrees F
Fluid pH Range	7-8 during standard operation, up to 10 on startup while rinsing GAC

2.04 OVERVIEW OF EQUIPMENT OPERATION

A. One floating decanter shall be provided in the rinse water storage tank to remove supernatant from the tank. Decanter shall be designed to accommodate the full range of travel between maximum water level in rinse water storage tank and decanter rest elevation and shall remove a full decant volume at an average rate of 45 gpm.

B. The floating decanter shall feature a freely turning outlet tube that eliminates the twisting effect of attached hose and always ensures correct upright position.

C. The decanter shall operate at all possible tank levels from 3.3-feet to 23-feet above the tank floor. The internal diameter of the tank is 26-feet.

D. The floating decanter shall be sufficiently small to allow removal from the covered rinse water tank through a 24-inch by 30-inch hatch. Otherwise, the decanter shall be assembled in sections to allow its removal through the hatch.

E. All hoses, piping, supports, gaskets, and hardware downstream of the floating decanter itself shall be provided and installed by Contractor.

2.05 SOURCE QUALITY CONTROL

A. Manufacturer to perform factory testing prior to delivery to demonstrate the accuracy and performance of the systems as specified.

B. Factory Testing shall be non-witnessed.

C. Manufacturer to certify and provide copies of the tests and guarantee the equipment's performance as specified in this Section. Submit all certifications of Factory Testing for approval, prior to shipping equipment.

D. Factory Testing to include all standard tests recommended by the Manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with Section 43 05 11 – General Requirements for Equipment.

B. Decanter to be secured to drain hose with two hose clamps provided by the manufacturer.

C. Manufacturer to provide the Contractor with detailed recommendations and instructions for installation of the equipment specified in this Section.

3.02 COMMISSIONING, TESTING, STARTUP AND TRAINING

A. General
   1. Provide Field Testing and Commissioning in accordance with the requirements of Section 01 91 00 - Commissioning, Testing and Start-Up.
   2. Manufacturer to provide detailed procedures for Field Testing and Commissioning procedures.

B. The initial start-up of floating supernatant decanter will be performed by equipment manufacturer personnel. The equipment manufacturer personnel will verify the proper operation, installation, and provide training to the equipment operators with start-up of the decanters. Training shall conform to the requirements in Section 01 79 00.

C. The equipment manufacturer shall furnish the services of a factory-trained representative for a minimum of 2 separate trips with 1 days (6 hours a day) at the jobsite. The equipment manufacturer trained representative shall schedule each trip for the startup of each decanter to inspect the installed equipment, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

D. Upon completion of the training activities, the Manufacturer to provide a Manufacturer's Instruction Certification, Form 43 05 11-B, Section 01 99 90 – Reference Forms.

END OF SECTION

SECTION 46 61 16

GRANULAR ACTIVATED CARBON MEDIA

PART 1 GENERAL

1.01 SUMMARY

A. Scope:
   1. Granular activated carbon (GAC) media for treatment of drinking water through six pressure vessels for adsorptive removal of per- and poly-fluoroalkyl substances (PFAS). The media shall be 100 percent virgin GAC, and shall comply with all AWWA, NSF, and AIS requirements.

1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 66 00 – Product Storage and Handling Requirements
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Demonstration and Training
   5. Section 01 91 00 – Commissioning, Testing and Start-up
   6. Section 43 05 11 – General Requirements for Equipment
   7. Section 43 31 13.13 – Vertical Pressure Vessel System

1.03 REFERENCE STANDARDS

A. This section contains references to the following documents which are a part of this section, as specified and modified. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the local building code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.

Reference	Title
AIS	American Iron and Steel Act
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM D2854	Test Method for Apparent Density of Activated Carbon

Reference	Title
ASTM D2862	Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D2866	Standard Test Method for Total Ash Content in Activated Carbon
ASTM D2867	Standard Test Methods for Moisture in Activated Carbon
ASTM D4607	Standard Test Method for Determination of Iodine Number of Activated Carbon
ASTM D5029	Test Method for Water Solubles in Activated Carbon
ASTM E11	Specification for Wire-cloth Sieves for Testing Purposes
AWWA B604	Standard for Granular Activated Carbon
AWWA B100	Standard for Granular Filter Media
NSF/ANSI 61/600	Standard Drinking Water System Components – Health Effects
SDWA	Safe Drinking Water Act

1.04 DEFINITIONS

A. PFAS: per- and polyfluoroalkyl substances

B. HFPO-DA: Hexafluoropropylene Oxide or GenX

C. PFBS: Perfluorobutanesulfonic Acid

D. PFHxS: Perfluorohexane Sulfonic Acid

E. PFNA: Perfluorononanoic Acid

F. PFOA: Perfluorooctanoic Acid

G. PFOS: Perfluorooctane Sulfonic Acid

H. TOC: Total Organic Carbon

I. Cumulative Volume: Volume of water treated by one vessel pair in the system since equipment start up.

J. Apparent Density is the “as-delivered” bulk density.

K. Bed density is the mass of dry GAC to Operational Volume, backwashed and drained.

L. “Conforming influent water quality” means the average concentration of the influent for the Performance Guarantee Period is not more than the specified maximum of the Influent Water Quality in Section 1.08 for the Contaminants of Concern.

M. Contaminants of Concern are PFAS regulated substances for which GAC adsorption is being used to remove from water being treated. Specific Contaminants of Concern for this project are listed Influent Water Quality.

N. Bed Volume is the operational volume of media used to calculate [Total] EBCT. In operation, Bed Volumes is an expression of the volume of water treated and calculated as volume of water treated divided by the in-situ volume of GAC. Required Bed Volumes represents minimum expected service life of the GAC as it pertains to performance

guarantees. Actual Treated Bed Volumes represents actual service life of the GAC as it pertains to performance guarantees.

O. Empty Bed Contact Time (EBCT) is the volume of *in situ* GAC (after initial backwashing) divided by the flow rate, or *in situ* GAC bed length (after initial backwashing) divided by the hydraulic loading rate (HLR), for a single GAC absorber.

P. Total EBCT is the sum of EBCT for two adsorbers in series.

Q. NSF is the National Sanitation Federation.

R. Hazard Index (HI) is used in the National Primary Drinking Water standard as a Maximum Contaminant Level (MCL) for PFAS with a limit of 1 (unitless) to reduce the risk from a mixture of different PFAS contaminants. The HI is calculated as the sum of fractions which compare the level of each PFAS measured in the water to the highest level determined not to have risk of health effects for that specific PFAS for PFBS, PFNA, PFHxS, and GenX or HFPO-DA.

S. Hydraulic Loading Rate (HLR) is the flow rate divided by the plan area of a single GAC adsorber.

T. Operational Volume is the volume of GAC after initial backwashing and representative of normal operations.

U. Additional terms used in this Section conform to definitions in the referenced AWWA and ASTM standards.

1.05 SUBMITTALS

A. Procedures: Section 01 33 00 – Submittal Procedures.

B. Action Submittals:
   1. Copy of this Section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. Check-marks (✓) to denote full compliance with a paragraph as a whole. Underline deviations and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance. Include a detailed, written justification for each deviation.
   3. Provide as required for System Supplier under Section 43 31 13.13 Pressure Vessel Systems a statement that the System has been coordinated to provide the required performance under the design Operating Conditions and the GAC being provided is compatible with the adsorber design. Failure to include a copy of the marked-up specification sections with justification(s) for any requested deviation will cause rejection of the entire submittal with no further consideration.
   4. Provide Action Submittals in three steps:
      a. STEP ONE – Initial Submittal,
         1) Affidavit of compliance certifying conformance to the specified manufacturing experience.
         2) GAC Manufacturer's specified ISO certification.

3) Qualifications statement for Manufacturer's Field Representative
4) NSF/ANSI 61/600 certification for proposed product.
5) Source of coal, location of manufacture of the GAC.
6) Description of the agglomeration/thermal process used in the manufacture of the GAC.
7) Manufacturer's standard product data for proposed GAC media:
    a) Iodine number
    b) Moisture content
    c) Particle Size distribution, US standard mesh size
    d) Effective size (d10)
    e) Uniformity coefficient
    f) Abrasion number (Ro-tap Method)
    g) Apparent density
    h) Bed density
    i) Water extractables
8) Clean bed headloss curves for the GAC media during adsorber operation under specified conditions.
9) Standard adsorber bed expansion curves for GAC media during backwashing as a percentage of in-service bed depth versus backwash water flow rate and temperature for the range of specified operating conditions.
10) Prior to testing, certification documentation of the independent laboratory as specified under Steps Two and Three.

b. STEP TWO – Sample Analysis
    1) Test report with results from laboratory analysis of the proposed media, completed within twelve months of the receipt of submittal for GAC media from the proposed source (location and manufacturer) demonstrating compliance with the specified GAC Characteristics.

c. STEP THREE – GAC Lot Analysis
    1) Test report(s) with results from laboratory analysis of each GAC media lot demonstrating conformance with the specified GAC Characteristics prior to shipping.

C. Informational Submittals:
1. Media sample (2 lb) accompanied with a certificate, stating the sample is from the same batch that will be shipped to the Project
2. Detailed description of the procedure for installation, commissioning and testing of the activated carbon.
3. Operation and maintenance manuals as per requirements of Section 01 78 23.

D. Closeout Submittals:
1. Final Operations and Maintenance Manual in accordance with Section 01 78 23 – Operations and Maintenance Data.
2. Manufacturer's Installation Certification Form 43 05 11-A as found in Section 01 99 90 – Reference Forms.

3. Manufacturer's Instruction Certification, Form 43 05 11-B as found in Section 01 99 90 – Reference Forms.
4. Manufacturer's Operations Certification, Form 43 05 11-D as found in Section 01 99 90 – Reference Forms.
5. Written report of field tests, procedures, instrumentations, test conditions and results including all data as necessary to demonstrate compliance.

1.06 QUALITY ASSURANCE:

A. Experience and certifications: Provide GAC media manufactured in the United States by a producer certified for ISO 9001:2000 quality standards and at the specific plant or site holding such certification. The manufacturer must have at least 15 years of experience manufacturing and regenerating GAC in the United States.

B. The manufacturer must have a GAC reactivation facility located in the United States.

C. The manufacturer must have provided the same GAC planned for this project at not less than five installations successfully removing PFAS compounds, including PFOS and/or PFOA, for a period of not less than 1 year.

D. The manufacturer shall offer services to remove and transport spent GAC media for thermal reactivation, provided that the spent GAC media is classified as non-hazardous. Spent media shall be stored and reactivated separately from other media to allow for potential reuse at Owner sites. The manufacturer shall have the capability to store a swing load of reactivated media.

E. Provide a Manufacturer's Field Representative with at least 5 years of experience installing and commissioning GAC filters/adsorbers.

F. Testing Laboratory. Provide quality assurance testing of GAC media samples by an independent and certified testing laboratory prior to submittal of samples. The laboratory must be certified to meet the qualifications to perform the analyses specified and as required by AWWA B100 – Granular Filter Material and in accordance with ASTM D75 as modified and supplemented by AWWA B100, by an appropriate agency such as the American Association for Laboratory Accreditation.

G. Samples: After approval of the supplier's standard information for the media, furnish a sample of the specific GAC media proposed for use. The sample shall be placed in a tight jar holding not less than two pounds and shall be properly labeled. In addition, submit laboratory analyses in accordance with AWWA B100 – Granular Filter Material of the granular activated carbon filter media sample. The media manufacturer(s) shall perform analysis to confirm gradation, effective size, uniformity coefficient, iodine number, total ash content, and apparent density of the GAC media prior to shipment.

H. Laboratory Analysis: Conduct laboratory analyses of the GAC media sample to demonstrate compliance with the specified material quality requirements in accordance with specified test methods. Conduct particle size analysis by screening through standard sieves calibrated per ASTM E11. Report particle size gradation results in tabular form and plotted on semi-log or log-probability paper.

I. Media Lot Tests: Before GAC media is shipped to the site, divide the media into lots for testing, with the size of a lot no larger than one truckload. Collect representative samples from each lot using a core sampler and then combine to produce the required composite sample. The minimum number of samples per lot and the minimum size of the composite sample shall be per AWWA B100 – Granular Filter Material.

1. Conduct laboratory analysis of each GAC media lot to demonstrate compliance with the specified material quality requirements.
2. Schedule the GAC media testing and deliveries to allow ample time for sampling, testing, submittal of test results, and ENGINEER review. Do not ship GAC media lots prior to ENGINEER's approval of the test results for that lot.
3. Prior to shipment to the Site, Manufacturer to verify that each bag of GAC media is properly labeled and that they clearly indicate the customer, lot, and bag number. Verify same upon receipt of each shipment at the Site.
4. The OWNER reserves the right to re-test (at the OWNER's expense) the granular activated carbon filter media at any time upon delivery or placement.

1.07 DELIVERY, STORAGE AND HANDLING

A. Procedures: in accordance with Section 01 66 00.

B. For the slurry shipping option, deliver GAC media in enclosed food grade hopper trucks dedicated to hauling GAC for potable water applications. The trailers must be lined with an NSF approved lining material for potable water use. The transport vehicle must be capable of filling and emptying the adsorber tanks via direct connection to quick-connect fittings.

C. Do not order material for shipment until Engineer has approved the results of the Certified Test Results.

1.08 OPERATING CONDITIONS

A. GAC adsorber influent is untreated groundwater, with quality as specified, for subsequent use as potable water. GAC adsorbers will be located upstream of the point of chlorination and fluorine addition as indicated on the drawings.

B. Influent Water Quality Design Basis:

Parameter	Units	Range	Average
Temperature	F	40 - 80	52
pH	S.U.	6 – 10	8.1
Turbidity	NTU	0.1 - 0.30	0.19
TOC	mg/L	<0.7 – 1.0	<0.7 [a]
PFAS – Contaminant of Concern			
Parameter	**Units**	**Maximum**	**Average**
PFOS	ng/L	30	22
PFOA	ng/L	20	13
PFHxS	ng/L	7	4
PFNA	ng/L	2	ND [a]
PFBS	ng/L	9	7
HFPO-DA	ng/L	2	ND [a]

1.

a. ND = non-detect. The sample result was below the MRL.

1.09 WARRANTY

A. Provide warranty in accordance with General Conditions.

1.10 PERFORMANCE GUARANTEE

A. Provide a two year performance guarantee with respect to PFAS in compliance with the following. These criteria were developed based on the bench and pilot studies provided in the Contract Documents.

1. If PFAS removal fails in any vessel pair prior to treating a Guaranteed Cumulative Volume of 550 million gallons, or within two (2) years after commissioning—whichever occurs first—while operating with Conforming Influent Quality, the Manufacturer shall replace the GAC media in the affected vessel pair(s).
2. Media replacement shall include all labor and materials required for removal and disposal of spent media and installation of new media. The total cost of the replacement media shall be charged on a straight-line pro-rated basis, calculated using the cost of virgin GAC media at the time of replacement and based on the Total Actual Treated Accumulated Volume as a percentage of the Guaranteed Cumulative Volume.
3. PFAS removal failure is defined as concentrations exceeding the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for any listed compound shown in the table below in two consecutive samples collected from the 50% media depth sampling port of the lag vessel.

PFAS Compound	Units	MCL
PFOA	ng/L	4
PFOS	ng/L	4
PFHxS	ng/L	10
PFNA	ng/L	10
HFPO-DA (or GenX)	ng/L	10
Mixtures containing two or mor of PFHxS, PFNA, GenX and PFBS	Unitless	1 (unitless) [a]

Notes:

a. *Hazard* index is *based on individual Health Based Water Concentrations (HWBC) for four compounds and is a sum of the ratio of these four compounds' measured concentrations compared to the HBWC as follows:*

$$Hazard\ Index = \frac{GenX_{water}}{10} + \frac{PFBS_{water}}{2000} + \frac{PFNA_{water}}{10} + \frac{PFHxS_{water}}{10}$$

PART 2 PRODUCTS

2.01 GRANULAR ACTIVATED CARBON ADSORBER MEDIA

A. General: Conduct of GAC media and granular activated carbon filter media testing methods shall conform to the requirements of AWWA B100 – Granular Filter Material and AWWA B604 – Granular Activated Carbon, except as otherwise indicated.

B. Adsorber System: Provide GAC media compatible with the pressure vessel underdrain system specified in Section 43 31 13.13.

C. Uniformity: Provide GAC media equal in all respects to the approved samples. Provide samples for testing by the OWNER on request during the preparation and placing of the GAC media.

D. Material Quality: Provide GAC media from bituminous coal mined in the United States, 100% virgin, composed of hard and durable grains, specifically manufactured for continuous exposure to untreated groundwater for removal of Per- and Poly-Fluoroalkyl Substances (PFAS) meeting the following requirements.

1. Provide GAC media from only selected grades of bituminous coal combined with suitable binders as required to produce a highly active, durable granular material capable of withstanding the abrasion and dynamics associated with repeated backwashing and hydraulic transport. Lignite, peat, wood, coconut shell, and sublignite based activated carbons will not be accepted.
2. Control activation to produce a material having a high internal surface area with optimum pore size for effective adsorption of a broad range of high and low molecular weight organic contaminants.
3. Provide GAC media designed for packed bed pressure filter type of adsorption.
4. Provide GAC media with sufficient density to allow backwash agitation and bed expansion, yet settle rapidly for immediate resumption of service.
5. Provide GAC media visually free of foreign materials such as clay, dirt, etc. and free from any significant amounts of iron sulfides, clay, shale, dust, or other foreign matter.
6. Provide GAC Media meeting the following characteristics.

Parameter	Value	Test Method
Effective size, millimeters	0.55 – 0.75	ASTM D2862
Uniformity Coefficient, max	1.9	ASTM D2862
Apparent Density (tamped), lb/ft^3	30 to 34	ANSI/AWWA B604
Bulk density (backwashed and drained), lb/ft^3	26 to 29	ASTM C559
Iodine number, mg/g (minimum)	1000	ASTM D4607
Moisture content, percent (maximum)	2	ASTM D2867
Abrasion number (Ro-tap Method, minimum)	75	AWWA B604
Water extractables, percent (maximum)	1.0	Not applicable

2.02 ADSORBER DESIGN/OPERATION/PERFORMANCE

A. Operating Conditions:

Parameter	Value
Pressure Vessel Diameter, ft	12
Adsorber Surface Area, each adsorber, sf	113
Maximum Water Flow per adsorber, gpm	1,067
Maximum filtration rate, gpm/sf	9.4
Minimum empty bed contact time (EBCT), min	9.6
Media weight, dry, each adsorber, lbs [a]	40,000
High backwash rate, gpm/sf	10

a. Based on media bed density of 28 lb/cf.

2.03 MANUFACTURERS

A. The following candidate manufacturers are capable of producing products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard products will comply with the requirements of this Section. Candidate manufacturers include
   1. Calgon Carbon Corporation, Product Filtrasorb 400 (F400),
   2. or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. GAC Media Manufacturer's Field Representative to inspect the equipped adsorber including underdrains, and appurtenant piping, and notify the ENGINEER of all concerns prior to installation of the GAC media.

B. Install GAC media after cleaning, testing, and disinfection of adsorbers and appurtenant piping. In no case shall the GAC media be installed prior to acceptance of hydrostatic pressure testing and bacteriological testing results.

C. Install GAC media in strict accordance with manufacturer's recommendations and AWWA B604 under direction of the Manufacturer's Field Representative. Pack each bed uniformly to the density specified with sample probes installed as shown. Leave no void pockets including bed areas around the sampling probes and near the adsorber walls. Complete each bed with a smooth surface and uniform bed depth throughout.

D. Contractor shall provide potable water supply connection for GAC media loading and backwash. GAC media supplier shall provide compressed air and all necessary hoses, site glasses, piping, and appurtenances for using this water.

E. Contractor shall be responsible for cleanup of all GAC media and slurry spills that may occur during the GAC transfer operation.

F. GAC supplier(s) shall coordinate with Contractor for training of city staff on GAC media filling operation procedures during initial installation of media.

3.02 MANUFACTURER'S FIELD SERVICES

A. Manufacturer to provide field services to support receipt/inspection upon arrival, installation, field testing and commissioning, and training. Provide the following minimum field services. These are set as minimum requirements to be at the project site and additional time may be required as deemed necessary by the Manufacturer and Contractor to provide a fully functioning system.
   1. Inspection/Receipt upon arrival: Eight (8) hours in one (1) visit.
   2. Installation: Sixteen (16) hours over two (2) days.
   3. Field Services and Commissioning: Sixty-four (64) hours onsite over eight (8) days.
   4. Training: Reference Paragraph 3.04 of this Section.

3.03 COMMISSIONING, TESTING AND STARTUP

A. Provide commissioning, testing and startup in conformance with the requirements of Section 01 91 00.

B. Provide Commissioning, Testing and startup under the direction of the Manufacturer's Field Representative. Special Requirements:
   1. Follow the manufacturer's recommended protocol for startup, including an initial soak, backwash, and rinse-to-waste sequences which are critical to achieving NSF/ANSI/CAN 61 Compliance, removal of fines and conditioning of the media bed. Dispose of all related wastewater (drain or backwash) through the new grinder pump system and sewer connection. Settle all rinse water for removal of particulates prior to discharge and comply with Clark Regional Wastewater District's (CRWWD) discharge water quality requirements. Remove all GAC fines/particulates from the rinse water tank and dispose of GAC fines off site on completion of media bed conditioning.

Parameter	Acceptable Value
pH	< 8.3
Arsenic, mg/L	< 5
Turbidity, NTU	< 0.3

2. Functional Test Phase: Manufacturer's Field Representative to witness the Functional Test Phase and notify Engineer of all concerns regarding adsorber operations including backwash protocol and effectiveness.
    a. Operate each adsorber through the full range of hydraulic loading rates recording headloss at each flow rate, observations on flow distribution, velocity anomalies across the adsorber surface which may lead to media scouring or mounding, and stability of automated isolation and flow control systems.
    b. Operate each adsorber through the full range of backwash rates recording observations of any localized boils or other evidence of maldistribution, and stability of automated isolation and flow control systems.
    c. Manufacturer's Field Representative to witness the adsorber Functional Test Phase and notify Engineer of all concerns regarding adsorber operations and performance including backwash cycles.
3. Operational Test Phase: Collect and analyze one sample per day from each adsorber or train for compliance with Effluent Water Quality requirements. Collect and analyze one sample per day from each adsorber effluent (PEF) for compliance with Safe Drinking Water Act or Washington Strate drinking water requirements prior to sending adsorber effluent (PEF) to drinking water distribution system.

3.04 DEMONSTRATION AND TRAINING

A. Provide training as specified in Section 01 79 00 – Demonstration and Training.
    1. The minimum training hours shall be comprised of the following:
        a. Operations Training: 2 sessions, 4 hours per session.
        b. Maintenance Training: 1 session, 4 hours per session.
    2. Upon completion of the training activities, the Manufacturer to provide a Manufacturer's Instruction Certification, Form 43 05 11-B, Section 01 99 90 – Reference Forms.
    3. Manufacturer's Field Representative to return approximately 30 days after completion of the Operational Test, scheduled subject to Owner's approval, to provide 8 hours of confirm satisfactory installation provide additional training and operations guidance for maintenance of the Process Guarantee.

END OF SECTION

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