CLACKAMAS WATER ENVIRONMENT SERVICES

OREGON CITY, OREGON

CONTRACT DOCUMENTS

for the construction of the

TRI-CITY WRRF AERATION BASIN IMPROVEMENTS

WES Project No. 700224304

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JACOBS

Corvallis, Oregon

September 2026

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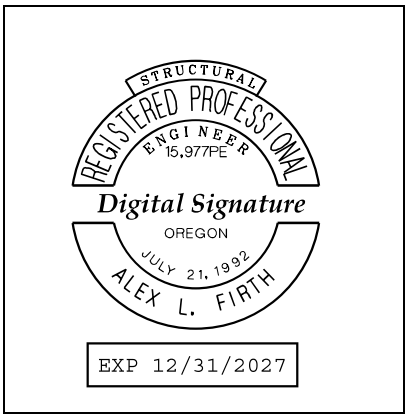
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SPECIFICATIONS



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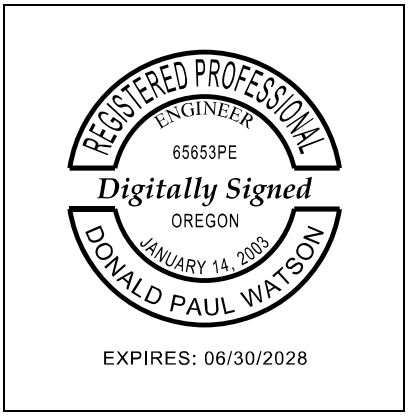
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PART 1

SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work will provide Owner with modifications and improvements to existing facilities as follows:

1. Prior to each Phase of this Project requiring access to or work within an Aeration Basin or associated channel the Owner will take offline a pair of interlock Basins, Influent and Effluent channels and drain these areas, at which point the offline areas will be turned over to the Contractor for the season's work activities directly related to these areas There are two main Phases for this Project to take place over two summer shut-down seasons.
2. Cleaning: Once the Owner has taken offline, drained and turned over to the Contractor an area of work for the season, the Contractor shall completely clean all aeration basins, influent channels, side and end effluent channels which have been drained. Cleaning activities to include pressure wash clean, removal of all moss, vegetation, debris, sludge, etc.
3. Aeration Basins:
    a. ALP Piping:
        1) In Aeration Basin 1 (AB1), AB2, AB3, and AB4, reconfigure and replace ALP piping sections containing the flow transmitters and control valves in Aeration Zones 2-5. Add piping to incorporate control valve and flow transmitter to Aeration Zone 2. This piping is to be elevated from its current position so that control valves and flow transmitters are over the deck and be easily accessed. The final configuration will result with each of the four basins having four fully automated aeration zones.
        2) Replace diffuser membranes in AB1, AB3, and AB4 to match the previously replaced diffuser membranes in AB2. (Contractor to replace damaged diffusers with Owner provided replacements).
    b. AHP Piping:
        1) Extend the AHP piping for Aeration Basins AB1, AB2, AB3, and AB4 to supply high-pressure air to the new Zone 2 pneumatic flow control valves.

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2) Tie into and extend the existing AHP line(s) to provide high-pressure air supply to the ACP panel(s), for instrument cleaning, on basins AB1, AB2, AB3, and AB4.
3) Install new stainless-steel tubing between each basin's ACP and its four associated dissolved oxygen (DO) probes to provide dedicated air lines for cleaning service.

c. Valves:
1) Replace AB1, AB2, AB3, and AB4 Aeration Zone 3, Zone 4, and Zone 5, flow control valves and pneumatic actuators. Add new flow control valve and actuator to Zone 2 in all four basins. And replace manual isolation butterfly valves on each ALP control valve manifold for Zone 2, Zone 3, Zone 4 and Zone 5 for all (four) basins.
2) Replace Isolation Valves to the inlets of conventional activated sludge (CAS) AB1-2 and (CAS) AB3-4 Dewatering Pumps. 10-inch manual valves accessed through floor grating in Gallery. Four valves in total.
3) Inspect and recondition AB1 butterfly valve in weir wall to restore smooth linear function. (36-inch valve tag 560-32-001).
4) W5 - Flush Water System: Replace all valves, and lubricate remote manual actuator, confirm smooth linear operation, if remote operator does not functional in a smooth linear manor, and requires additional replacement or repair report actions require to correct to Owner, 10 per basin in all four basins.
5) Replace ALP butterfly isolation valves for effluent channel ALP bubbles (not currently used) at the west end of the aeration basins, along with the effluent channel ALP header isolation valve. One 8-imch butterfly and four 6-inch butterfly valves.
6) Replace the mud valve located at the effluent channel feeding the two metering flumes going to the clarifiers. (Located west of end of Basin 3 near Parshall flumes.)
7) Replace four 16 inches RAS discharge control valve actuators (pneumatic actuators only not the valves), in gallery.
8) Replace four 16-inch leaking manual RAS isolation valves in gallery with new full bonnet knife gate valves.
9) Replace two RAS pump header inlet control valve actuators (actuators only not valves), RAS Pump Building basement. (20-inch butterfly valves with pneumatic actuators).

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10) Remove four abandoned (locked open) 16-inch ALP flow control butterfly valves located in east end of gallery, and fill the gap left in the ALP piping with a spacer spool, repair or replace insulation damaged from the valve removal.

d. Gates:
   1) Repair and reseal ML Flume No. 1 and No. 2 Effluent Gates. (These gates are downstream of the Parshall flumes to isolate flow to secondary clarifiers 1 and 2. Gate 1 is currently leaking at the bottom).
   2) Refurbish basin influent slide gates, replace seals and resurface slide gates on all four aeration basins. (Each basin has four 24-inch by 24-inch gates and eleven 12-inch by 12-inch gates. Gates at the ends of the basins are reverse acting).

e. Aeration Basin Structures:
   1) Repair AB1, AB2, AB3, and AB4 basin structures including the following:
      a) Repair of cracks.
      b) Cleaning and resealing of expansion joints (including addressing leakage into RAS building and pipe galleries).
      c) Removal of organic debris from surfaces of the effluent channel.
      d) Securing end supports of the walkway bridges.
      e) Filling gaps in the walkways to ensure a safe walking surface.
      f) Pressure washing of the entire basins.
   2) This item does not include full refurbishment of the concrete surfaces within the basins to address concrete carbonation.
   3) Install access hatches in all four aeration basins from the RAS pump station. Construction of hatches shall be a separate bid item in the Project bid package.
   4) Remove all weir/cover plates between the aeration basins and the effluent channels, ten slots (5 feet long by 1 foot tall) per basin with cover plates located on both sides of the slots in some cases. Replace weir/cover plates with full stainless steel cover plates on the effluent channel side.
   5) Provide and install Davit Crane base plates one per basin and modify handrail at Davit Crane location.

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f. Instrumentation and Controls:
   1) Demolish AB1, AB2, AB3, and AB4 Aeration Zone 3, Zone 4, and Zone 5, existing flow indicating transmitters and sensors. Furnish and install new thermal mass flow transmitters with flow conditioner in the AB1, AB2, AB3, and AB4 Aeration Zone 2, Zone 3, Zone 4, and Zone 5 ALP piping.
   2) Demolish AB1, AB2, AB3, and AB4 Aeration Zone 3, Zone 4, and Zone 5, Dissolved Oxygen (DO)Transmitters. Furnish and install new DO Probes and mounting hardware at AB1, AB2, AB3, and AB4 Aeration Zone 2, Zone 3, Zone 4, and Zone 5.
   3) Furnish and install level type flow meters at the two existing Parshall flumes.
   4) Furnish and install new PLC panel CP-3B in MCC6 Room above the RAS pump station sized to handle future cutover of existing PLC-3A Remote I/O drops.
   5) Furnish and install two remote I/O panels on the Aeration Basin deck, one located between Aeration Basins AB1 and AB2, and one located between Aeration Basins AB3 and AB4. Panels shall serve to reduce instrument cable lengths and provide local I/O termination points for basin instrumentation.
   6) Furnish and install remote I/O panel in the RAS Gallery. Panel serves to reduce instrument cable lengths and provide local I/O termination points for RAS flow control valves.
   7) Demolish existing basin panel LCP-3214 after panel is no longer in use.
   8) Furnish and install four new Analyzer Control Panels, one each for Aeration Basins AB1, AB2, AB3, and AB4. Panels shall house the dissolved oxygen (DO) transmitters, air-cleaning assemblies.
   9) Assist with startup activities as defined in Section 40 90 00, Instrumentation and Control for Process Systems.

g. Other Work:
   1) Clean four side effluent channels, each adjacent to an aeration basin.
   2) Demolish the two polymer tanks located west of AB3 and AB4. Mixers to be salvaged and returned to the Owner.
   3) Relocate hose station in gallery at west end of Basin 4 to make room to add the submarine hatch to the basin wall.
   4) Specify demolition work to remove out of service control boxes and other equipment no longer in use.
   5) Install new 480V-120V/208V transformer, new 120V/208V electrical panel, wiring, and conduit.

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h. SCADA: Furnish and install fiber optic and copper network cabling between CP-3A, CP-3B, CP-3B-RIO-1, CP-3B-RIO-2, CP-3B-RIO-3, and existing basin mixers, as noted in the network design.

1.02 WORK NOT COVERED BY CONTRACT DOCUMENTS

A. As shown on the Drawings.

1.03 PROVISIONS FOR FUTURE WORK

A. Provisions for future construction are as shown on the Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUMMARY

A. The intent of this section is to provide a sequence to perform the Work in such a manner that continuous, uninterrupted plant treatment processes and all essential plant services and facilities are maintained operational throughout the construction period.

1.02 SUBMITTALS

A. Informational:

1. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the Owner and Engineer.
2. Removal from Service Requests.
3. Schedule and hold Work Sequence Plan coordination meeting with the Owner and Engineer within 10 business days of the submittal of the Work Sequence Plan, before any work activity starts.
4. Temporary Power Plans.
5. Work Sequence Plan: Submit within 30 days of Notice to Proceed.
6. Videotape survey, photographs, and other data of the preconstruction conditions shall be submitted to the Engineer for record purposes prior to, but not more than 3 weeks before, commencement of any construction activities.

1.03 RELATED WORK AT SITE

A. General:

1. Other work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

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B. Applications Software Development:

1. Engineer will perform programming of applications software for certain portions of Process Instrumentation and Control Subsystem (PICS). Refer to Section 40 90 00, Instrumentation and Control for Process Systems, for detailed information pertaining to Engineer programming.
   a. Sequencing: Include sequencing constraints specified herein as part of Progress Schedule.
   b. Key activity for scheduling and coordination is the installation of the PLC panel CP-3-B in the Electrical Room above the RAS pump station. Allow a minimum of 60 days prior to scheduled PLC installation for Engineer software development using the PLC CPU. Include this activity in the Project Schedule.
2. Following Contractor completion of Functional Test Part 1, specified in Section 40 90 00, Instrumentation and Control for Process Systems, allow 10 working days for Functional Test Part 2 for each PLC area.
   a. When applications software testing is delayed because of altered equipment interfaces, receipt of incorrect Shop Drawing information, failed equipment, or incomplete Functional Test Part 1 testing, duration of delay will be excluded from interruption allowance, unless notified otherwise by Engineer and Owner.

1.04 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

1. Clackamas County Sheriff: (503) 655-8218.
2. Water Environment Services: (503) 742-4567.
3. Portland General Electric: (503) 228-6322.
4. Comcast: (800) 266-2278.
5. NW Natural: (503) 226-4211.
6. Oregon Utility Notification Center: (800) 332-2344.

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1.05 PROJECT MILESTONES

A. Project Milestones:

1. Generally described in the Agreement Form. Following is a detailed description of each:

No.	Milestone	Substantial Completion (Date or Calendar Days from Notice to Proceed)
1	Substantial Completion and Return to Service Aeration Basin 1 and 2 Improvements.	September 30, 2027
2	Substantial Completion and Return to Service Aeration Basin 3 and 4 Improvements, and Clarifier Interface scope.	September 30, 2028
3	Substantial Completion of Entire Contract	As specified in the Agreement
4	Final Completion of Entire Contract	As specified in the Agreement

1.06 EXISTING TREATMENT PLANT

A. The Work shall be executed while the existing wastewater treatment facilities are in operation. Operation of the existing facility shall not be jeopardized nor shall the efficiency or volume of wastewater conveyance be reduced as a result of the execution of the Work. Impairing the operational capabilities of the treatment plant will result in serious environmental damage and monetary fines. Conduct work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit. Contractor shall be responsible for fines or other monetary damages that are a direct result of Contractor’s failure to complete work in a timely fashion or other deficiencies that result in permit violations or measures to mitigate operational impacts to existing treatment plant operations. The status of the treatment plant shall be defined as “operational” when it is capable of treating the entire quantity of wastewater received to the water quality limits specified in the discharge permit.

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B. The construction sequence and constraints in this section do not include all items affecting the completion of the Work but are intended to describe the sequence of critical events and associated constraints necessary to minimize disruption of the ongoing treatment plant processes and to ensure compliance with NPDES Permit requirements. It shall be understood and agreed by the Contractor that the critical events described are not all inclusive and that additional items of work not included may be required to minimize disruption and ensure compliance. Deviation from or modification of the suggested sequence is permitted if techniques and methods known to the Contractor will result in reducing disruption to the facility operation and maintaining treatment efficiency, avoiding violation of scheduling constraints, and if deviation is approved in advance by the Engineer.

C. Maintain traffic on existing roads as specified in Section 01 50 00, Temporary Facilities and Controls.

1.07 GENERAL WORK SEQUENCING CONSTRAINTS

A. For the purposes of this Article General Work Sequencing Constraints, and the following Article Facility Operations and Work Sequence, terms, such as "…work…must be completed" and "…completed and in operation", and "…in successful operation" are defined as meeting the terms of "Substantial Completion" and "Partial Substantial Completion" as defined in the General Conditions and Supplementary Conditions.

B. Include the following work sequencing constraints in the Progress Schedule:

1. All aeration basins must remain in service from the period October 1 to May 31 annually.
2. Work requiring aeration basins to be out of service shall occur between June 1 and September 30 annually.
3. A maximum of two aeration basins and associated channels (Aeration Basin 1 and Basin 2 (set) or Aeration Basin 3 and Basin 4 (set)) may be out of service at a time during the period between June 1 and September 30 annually. In the case of the effluent channels some additional coordination may be required with the owner to keep the Aeration process operational while also allowing the contractor dry access to channel gates needing refurbishment and the install of new flow measurement instruments.
4. ALP and AHP Air flow to in-service aeration basins shall not be interrupted for a period longer than 30 minutes.

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5. Manual operation of blowers providing air flow to in-service aeration basins shall not exceed a period of 8 hours. Periods of manual operation shall be scheduled for times when Owner's Operations Personnel are present during their day shift (typically 6:00 a.m. to 3:00 p.m., coordinate with operations).
6. Provide temporary pumps and size pump(s) to transfer mixed liquor to or from an Aeration Basin to remove or return it to service within an 8-hour period. Wash down and clean the aeration basins and associated equipment as necessary to complete Work. Coordinate with Owner personnel on removal of aeration basins from service and return to service.
7. More detailed constraints are given in Article Facility Operations and Work Sequence below.
8. Software Functional Testing and Phased Facility Integration:
    a. Software Functional Testing (FT) of the Programmable Logic Controller (PLC) software shall be conducted in accordance with Section 40 90 00, Instrumentation and Control for Process Systems, and Section 01 91 14, Equipment Testing and Facility Startup. Functional Testing is divided into two parts (FT Part 1 and FT Part 2) and shall be completed in alignment with the phased construction and commissioning of the Aeration Basin improvements.
    b. The Project shall be commissioned in two major phases that align with Project Milestones. Each phase shall be treated as a standalone functional area for the purposes of PLC integration, functional testing, and return to service:
        1) Phase 1: Aeration Basin 1 and Basin 2 Improvements.
        2) Phase 2: Aeration Basins 3 and Basin 4 Improvements, and Clarifier Interface.
    c. FT Part 1 is performed by Contractor or PIC System Integrator without the PLC software. FT1 shall be completed per phase, covering all new equipment, instrumentation, wiring, and PLC I/O associated with the Aeration Basins included in that phase. Confirm readiness of field devices, panels, terminations, communications, and PLC hardware.
    d. FT Part 2 can only commence after FT Part 1 is complete (per phase). FT Part 2 is performed by the Contractor or PIC System Integrator, as well as the Engineer with the PLC software.

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1.08 FACILITY OPERATIONS AND WORK SEQUENCE

A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.

B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.

C. Provide safe access to Owner's existing facilities, including access for:

1. Biosolids trucks.
2. Chemical deliveries (including lime, polymer, hypochlorite, and bisulfite).
3. Fuel deliveries for generator re-fueling.
4. Garbage pickup.
5. Other construction activities.

D. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.

E. Do not close pipes, OPEN or CLOSE valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.

F. Work Sequence:

1. To meet the overall objectives of the Project, certain tasks and task elements should be generally performed, completed, or substantially completed in the herein-specified sequences. However, two or more of the tasks or task elements may be pursued simultaneously when consistent with the requirements specified herein; the requirements of Article Project Milestones, Article General Work Sequencing Constraints, Removal from Service (RFS) and Facility Shutdown, and the Project Schedule.
2. The specified sequences and tasks are not all-inclusive. They are intended to convey overall constraints and suggested construction sequences. The Contractor shall plan the Work, relocate facilities, reroute utilities, and provide for temporary connections and terminations as necessary in an appropriate sequence of operation to perform the Work, while minimizing interferences with and providing for continuous operation of the Owner's existing wastewater facilities.

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3. Task headings and descriptions set forth below are descriptive only and are not intended to define the scope of Work included therein.
4. Major tasks and sequences have been identified for the Owner's purposes. Although all Work is not listed herein, the tasks listed shall be understood to include all accompanying tasks such as, but not limited to, sitework, interconnecting utilities associated infrastructure, and applicable temporary provisions necessary to sequence the Work. Temporary provisions shall include pipeline endcaps, other utility terminations, and temporary utilities as necessary to allow operation of portions of the Work prior to completion of other portions of the Work, consistent with the Contractor's sequence of operations, although such provisions are not shown.
5. All existing Owner facilities shall remain in continuous operation except as specified herein.
6. Required Constraints and Suggested Task Sequencing:
    a. Initial Sitework:
        1) Install erosion control measures.
        2) Install staging areas, separate Contractor entrance gates, and other site security measures.
        3) Relocate existing utilities as shown and specified.
    b. Phase 1 - Aeration Basin 1 and Basin 2 Improvements:
        1) Preparation:
            a) Coordinate with Owner for removal from service and disable Aeration Basin 1 and Basin 2 alarming from the control system during this outage.
            b) Electrical and I&C Considerations for Aeration Basins and Related Facilities: Modifications of existing circuits require close coordination with Owner, documentation of removal from service request, and may require temporary power.
            c) Install temporary, and quickly removable bulkheads in aeration basin influent channel to isolate and allow Contractor dewatering of channel.
            d) Transfer mixed liquor, dewater and wash down aeration basin.
            e) Clean and prepare concrete surfaces for rehabilitation.

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2) Work:
   a) Perform crack repair, controlled concrete surface rehabilitation, concrete joint cleaning and resealing and weir opening plate cleaning and resealing. This structural repair Work may be performed as a separate aeration basin removal from service, or concurrently with mechanical, electrical, and I&C Work associated with the aeration basins, provided the aeration basins are returned to service within the timeframe provided herein.
   b) Install new gallery Access Hatches for Aeration Basin 1 and Basin 2.
   c) Refurbish Aeration Basin 1 Valve: 560-32-001.
   d) Replacement of pneumatic actuators with hand wheel operators for manual actuation of flow control valves 560-3251 and 560-3252.
   e) Demo ALP header actuated valves, pneumatic actuators, thermal mass air flow meters, dissolved oxygen (DO) analyzers.
   f) Replace flush-water valves for Aeration Basin 1 and Basin 2.
   g) Recondition the Influent side wall slide gates serving Aeration Basin 1 and Basin 2.
   h) Demolish existing Effluent weir plates and install ten new full cover plates per basin.
   i) Replace Effluent Channel ALP isolation valve 560-3221, valve 560-3222 and valve 560-3223.
   j) Replace RAS flow control pneumatic actuator 560-3471, and actuator 560-3472.
   k) Replace manual Knife Gate valve 530-3411 and valve 530-3412.
   l) Replace MLR manual plug valve 540-3211 and valve 540-3212.
   m) Install piping and pipe supports.
   n) Install AHP piping for Zone 2 valves and supply air for ACPs in Basin 1 and Basin 2.
   o) Install air header valves with pneumatic actuators, and thermal mass air flow meters on Aeration Basin 1 and Basin 2 for Zone 2, Zone 3, Zone 4, and Zone 5.
   p) Installation of Control Panels: CP-3B, CP-3B-RIO-1, CP-3B-RIO-3, ACP-3261, and ACP-3262 including completion of electrical, communications, sensor cabling, and pneumatic tubing work.

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q) Install DO probe mounting hardware in preparation for sensor installation and testing at Zone 2, Zone 3, Zone 4, and Zone 5 of Aeration Basin 1 and Basin 2.
r) Modify handrail systems and install davit-crane baseplates on Aeration Basin 1 and Basin 2.
s) Replace diffuser membranes for Aeration Basin 1. (AB-2 is already complete.).

3) Testing:
a) Perform leak testing of modified piping and take corrective actions as needed. Most leak testing can be done as in-service testing with bubble testing of all flanges and mechanical joints.
(1) ALP piping at each basin flow control manifolds.
(2) ALP valves replace in Effluent Channels.
(3) AHP piping alongside Basins for control valves and oxygen sensors.
(4) Flush Valves in Basins.
(5) Slide Gates along Influent side walls in Basins.
(6) AHP Tubing associated with new RAS valve actuators in Gallery.
(7) RAS Knife Gate Valves in Gallery.
(8) MLR plug valve in Gallery.
b) Perform Functional Testing Part 1 for all new equipment (see Section 40 90 00, Instrumentation and Control for Process Systems).
c) Provide support for the Engineer's Software Testing and perform Functional Testing Part 2 (see Section 40 90 00, Instrumentation and Control for Process Systems).
d) The Phase 1 startup, Functional Testing Part 2, and Performance testing of Aeration Basins 1 and 2 can begin after the following work is complete:
e) Installation and Commissioning of:
(1) Panels: CP-3B, CP-3B-RIO-1, CP-3B-RIO-3, ACP-3261, and ACP-3262.
(2) ALP pneumatic actuators, thermal mass air flow meters, and DO probes.
(3) RAS flow control valves 560-3421, 560-3471, and 560-3472.

4) Once each aeration basin Performance Test is complete and the basin meets Substantial Completion requirements, the Owner will operate those facilities.

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c. Phase 2 - Aeration Basins 3 and 4 Improvements:
   1) Preparation:
      a) Coordinate with Owner for removal from service and disable Aeration Basins 3 and 4 alarming from the control system during this outage.
      b) Electrical and I&C Considerations for Aeration Basins and Related Facilities: Modifications of existing circuits require close coordination with Owner, documentation of removal from service request, and may require temporary power.
      c) Install temporary, and quickly removable bulkheads in aeration basin influent channel to isolate and allow Contractor dewatering of channel.
      d) Transfer mixed liquor, dewater and wash down aeration basin.
      e) Clean and prepare concrete surfaces for rehabilitation.
   2) Work:
      a) Perform crack repair, controlled concrete surface rehabilitation, concrete joint cleaning and resealing and weir opening plate cleaning and resealing. This structural repair Work may be performed as a separate aeration basin removal from service, or concurrently with mechanical, electrical, and I&C Work associated with the aeration basins, provided the aeration basins are returned to service within the timeframe provided herein.
      b) Relocate hose station at west end of Basin 4 in Gallery to make space for new Access Hatch.
      c) Install new gallery Access Hatches for Aeration Basins 3 and 4.
      d) Demolish the two polymer storage tanks by RAS Pump Building.
      e) Replacement of pneumatic actuators with hand wheel operators for manual actuation of flow control valves 560-3253 and 560-3254.
      f) Demo Air header actuated valves, pneumatic actuators, thermal mass air flow meters, dissolved oxygen (DO) analyzers.
      g) Replace W5 flush-water valves for Aeration Basins 3 and 4.
      h) Recondition the Influent side wall slide gates serving Aeration Basins 3 and 4.
      i) Demolish existing Effluent weir plates and install ten new full cover plates per basin.

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j) Replace Effluent Channel ALP isolation valves 560-3224 and 560-3225.
k) Replace RAS flow control pneumatic actuators 560-3473 and 560-3474.
l) Replace manual Knife Gate valves 530-3413 and 530-3414.
m) Replace MLR plug valves manual 540-3213 and 540-3214.
n) Set channel gates to divert Basins 1 and 2 effluents to Clarifier 1, this should allow for drying out Effluent channels and flumes in front of RAS Pump Building.
o) With the Effluent channels in front of RAS Pump building dried out; Mud Valve 590-3215 can be replaced. Additionally, flume gate 510-3275 can be refurbished and the operator can be replaced. And finally, both Effluent Flow Elements FE-3274 and FE -3275 can be installed.
p) While Clarifier 2 is offline the RAS pump inlet flow control valve actuator for valve 560-3422 can be replaced.
q) Also replace Effluent Channel ALP isolation valves 560-3224 and 560-3225 before reconfiguring the channel gates.
r) Once the above work is addressed, the channel gates can be set to divert the Basins 1 and 2 effluent flows to Clarifier 2, allowing for Flume Gate 510-3274 to be dried out.
s) Then Flume Gate 510-3274 can be refurbished and the operator replaced.
t) And with Clarifier 1 offline the RAS pump inlet flow control valve actuator for valve 560-3421 can be replaced.
u) Install piping and pipe supports.
v) Install AHP piping for Zone 2 valves and supply air for ACPs in Basins 3 and 4.
w) Install air header valves with pneumatic actuators, and thermal mass air flow meters on Aeration Basins 3 and 4 for Zones 2, 3, 4, and 5.
x) Installation of control panels: CP-3B-RIO-2, ACP-3263 and ACP-3264 including completion of electrical, communications, sensor cabling, and pneumatic tubing work.
y) Install DO probe mounting hardware in preparation for sensor installation and testing at Zones 2, 3, 4, and 5 of Aeration Basins 3 and 4.

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z) Modify handrail systems and install davit-crane baseplates on Aeration Basins 3 and 4.
aa) Replace diffuser membranes for Aeration Basins 3 and 4.
bb) Coordinate with Owner the demolition of existing control panel LCP-3214 and salvage of internal hardware to the Owner.

3) Testing:
a) Perform leak testing of modified piping and take corrective actions as needed. Most leak testing can be done as in-service testing with bubble testing of all flanges and mechanical joints.
(1) ALP piping at each basin flow control manifolds.
(2) ALP valves replace in Effluent Channels.
(3) AHP piping alongside Basins for control valves and oxygen sensors.
(4) Flush Valves in Basins.
(5) Slide Gates along Influent side walls in Basins.
(6) AHP Tubing associated with new RAS valve actuators in Gallery.
(7) RAS Knife Gate Valves in Gallery.
(8) MLR plug valve in Gallery.
b) Perform Functional Testing Part 1 for all new equipment (see Section 40 90 00, Instrumentation and Control for Process Systems).
c) Provide support for the Engineer's Software Testing and perform Functional Testing Part 2 (see Section 40 90 00, Instrumentation and Control for Process Systems).
d) The Phase 1 startup, Functional Testing Part 2, and Performance Testing of Aeration Basins 3 and 4 can begin after the following work is complete.
e) Installation and Commissioning of:
(1) Panels: CP-3B-RIO-2, ACP-3263 and ACP-3264.
(2) ALP pneumatic actuators, thermal mass air flow meters, and DO probes.
(3) RAS flow control valves 560-3422, 560-3473, and 560-3474.

4) Once each aeration basin Performance Test is complete and the basin meets Substantial Completion requirements, the Owner will operate those facilities.

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d. Non-Phase-Specific Tasks:
   1) Testing: Upon completion of leak testing for all of the disturbed ALP piping, the owner requests a complete system leak test be performed on the complete ALP piping system from the blowers in the Blower Building to the ALP flow control manifolds in the basins. Being some of this piping is buried and some is insulated this will be a simple leak down test rather than a bubble test. Report test results to Owner.
   2) Once Phases 1 and 2 are complete along with the non-phase specific tasks provide support for the Engineer's Facility Performance Demonstration test of the automated logic.

G. Site Electrical System: No work required outside of aeration basin and RAS pump station facilities.

H. Removal from Service (RFS) and Facility Shutdown:

1. Unless indicated otherwise herein, removal from service (RFS) of existing treatment processes, facilities, or services (including connection of existing pipelines, electrical systems, or structures) shall be coordinated with the Owner and Engineer through a written RFS plan. RFS plans shall be submitted sufficiently in advance of the RFS period (minimum of 2 weeks) and in appropriate detail to be reviewed and approved in a dedicated meeting a minimum of 2 days prior to the requested RFS date. The RFS plan shall include the purpose, procedures, and schedules for shutdown and startup of the subject process, facilities, or service; and emergency procedures and appropriate staffing levels for prevention of an extended shutdown period.
2. Contractor shall include the discussion of all current and expected RFS plans as part of the weekly construction meeting.
3. All diversions and shutdowns to plant flows and processes shall be subject to actual process, flow, and weather conditions existing at the time of the requested RFS. Owner's determination regarding the acceptability of proceeding with a planned RFS shall be final.
4. In addition to the RFS plan, incorporate the following constraints regarding plant flow manipulation, duration, and/or time of year:
   a. Potable (City) Water (W1, W2), and Plant (Treated Effluent) Water (W3, W4, W5, W6): The maximum shutdown period is 2 hours. Plant staff will determine the time of day, and day of the week (Monday through Friday) that shutdown is acceptable. To maintain acceptable plant operation and fire protection, only one of these services may be shut down at a time.

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b. Raw Wastewater (Headworks Flows), Primary Influent and Primary Effluent (PI and PE): No shutdowns permitted.
c. Primary Sludge and Scum (PS and SC): The maximum shutdown period is 4 hours.

5. High Pressure Air (AHP): The Maximum Shutdown Period is 2 hours. Plant staff will determine the time of day that shutdown is acceptable.
6. Power outages will be through the RFS process, with a minimum 2-week notice. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.
   a. Anticipated power outages and durations for major electrical modifications are as specified in this section.

I. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.

J. Relocation of Existing Facilities:

1. During construction, it is expected that minor relocations of Work will be necessary.
2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.
3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.09 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

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B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs and Article Audio-Video Recordings.
2. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.10 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
3. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.

B. Preconstruction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take photographs of Site and property adjacent to perimeter of Site.
2. Format: Digital, minimum resolution of 1680 pixels by 2240 pixels and 24-bit, millions of color.

C. Construction Progress Photos:

1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
2. Weekly: Take a minimum of 20 digital photographs.
3. Monthly: Take a minimum of 20 digital photographs.

D. Documentation:

1. Digital Images:
   a. Electronic image shall have date taken embedded into image.
   b. Archive using a commercially available photo management system that provides listing of photographs including date, keyword description, and direction of photograph.

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c. Label file folders or database records with Project and Owner's name, and month and year images were produced.

1.11 AUDIO-VIDEO RECORDINGS

A. Prior to beginning the Work on Site or of a particular area of the Work, and again within 10 days following date of Substantial Completion, videograph Site and property adjacent to Site.

B. In the case of preconstruction recording, no work shall begin in the area prior to Engineer's review and approval of content and quality of video for that area.

C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within project area and areas adjacent to and within the right-of-way or easement, and on Contractor storage and staging areas.

D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.

E. Video Format and Quality:

1. DVD format, with sound.
2. Video:
   a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
   b. Electronically, and accurately display the month, day, year, and time of day of the recording.
3. Audio:
   a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
   b. Indicate date, project name, and a brief description of the location of recording, including:
      1) Facility name.
      2) Street names or easements.
      3) Addresses of private property.
      4) Direction of coverage, including engineering stationing, if applicable.

F. Documentation:

1. DVD Label:
   a. DVD number (numbered sequentially, beginning with 001).
   b. Project name.

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2. Date and time of coverage.
3. Project Video Log: Maintain an ongoing log that incorporates above noted label information for DVDs on Project.

1.12 REFERENCE POINTS AND SURVEYS

A. Location and elevation of benchmarks are shown on the Drawings.

B. Contractor's Responsibilities: Provide survey and layout required to layout the Work.

1.13 ELECTRONIC DOCUMENT MANAGEMENT SYSTEM

A. The Owner and Contractor shall utilize an Owner provided electronic document management system (EDMS) similar to Procore, "or-equal," for electronic submittal of all data and documents throughout the duration of the Contract. The Owner furnished EDMS will be made available to all Contractors' Project personnel, subcontractor personnel, suppliers, consultants, and the Designer of Record. The joint use of this system is to facilitate, electronic exchange of information, automation of key processes, and overall management of the Contract. The EDMS shall be the primary means of Project information submission and management. When required by the Owners representative, paper documents will also be provided. In the event of discrepancy between the electronic version and paper documents the paper documents will govern.

B. User Access Limitations:

1. The Owner's Representative will control the Contractor's access to the EDMS by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system, determine assigned function-based authorizations (determines what can be seen), and user privileges (determines what they can do). Subcontractors and suppliers will be given access to the EDMS through the Contractor. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on the EDMS shall be the responsibility of the Contractor.
2. Joint Ownership of Data: Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EDMS) by the Owner's Representative and the Contractor will be jointly owned.

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C. Automated System Notification and Audit Log Tracking: Review comments made (or lack thereof) by the Owner on Contractor submitted documentation shall not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

D. Submittals: See Section 01 33 00, Submittal Procedures.

E. Computer Requirements: The Contractor shall use computer hardware and software that meets the requirements of the Owner furnished EDMS as recommended by the EDMS supplier, to access and utilize the EDMS. As recommendations are modified by the EDMS supplier, the Contractor will upgrade their system(s) to meet the recommendations or better. Upgrading of the Contractor's computer systems will not be justification for a cost or time modification to the Contract. The Contractor will ensure that connectivity to the EDMS (whether at the home office or jobsite) is accomplished through DSL, cable, T-l, or wireless communications systems. The minimum bandwidth requirements for using the system is 128 kb per second. It is recommended a faster connection be used when uploading pictures and files into the system. The EDMS is expected to support commonly available web browsers for accessing the application.

F. Contractor Responsibility: The Contractor shall be responsible for the validity of their information placed in the EDMS and for the abilities of their personnel. Accepted users shall be knowledgeable in the use of computers, including Internet browsers, email programs, CAD drawing applications, and Adobe Portable Document Format (PDF) document distribution program. The Contractor shall utilize the existing forms in the EDMS to the maximum extent possible. If a form does not exist in the EDMS, the Contractor must include a form of their own or provided by the Owner's Representative as an attachment to a submittal. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of the EDMS (outside what is provided by the Owner), and the other programs indicated above as needed.

G. User Access Administration: Provide a list of Contractor's key EDMS personnel for the Owner's Representative acceptance. Contractor is responsible for adding and removing users from the system. The Owner's Representative reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to the EDMS.

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H. Connectivity Problems: The EDMS is subject to the inherent speed and connectivity problems of the Internet. The Contractor is responsible for its own connectivity to the Internet. The EDMS response time is dependent on the Contractor's equipment, including processor speed, Internet access speed, etc., and current traffic on the Internet. The Owner will not be liable for any delays associated from the usage of the EDMS including, but not limited to slow response time, downtime periods, connectivity problems, or loss of information. The Contractor will ensure that connectivity to the EDMS (whether at the home office or jobsite) is accomplished through DSL, cable, T-l, or wireless communications systems. Under no circumstances shall the usage, of the EDMS be grounds for a time extension or cost adjustment to the Contract.

I. Training:

1. The Project Owner has arranged for the following training to be provided to the Contractor:
   a. Up to two training sessions will be offered for Contractor and Subcontractor personnel to be coordinated at a time arranged by Contractor with Owner's Representative within 21 days of Notice to Proceed. Contractor participation in training is strongly encouraged and shall be considered incidental to the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Materials to be salvaged include:

1. Polymer tank mixers.
2. MCC feeder breaker unit.
3. LCP-3214 internal hardware.

B. Salvage materials for Owner's use.

C. Remove material with extreme care so as not to damage for future use.

D. Meet with Engineer prior to starting to dismantle equipment or piping designated to be salvaged. Engineer will indicate locations where equipment is to be disconnected.

E. Provide new or repair damaged equipment or material specified or indicated to be salvaged. Clean and protect equipment from dust, dirt, natural elements, and store as directed.

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3.02 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather-resistant or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on the Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

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3.02 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather-resistant or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on the Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, 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 PARTNERING MEETINGS

A. Attend and participate in partnering meetings as specified.

1.03 PRECONSTRUCTION CONFERENCE

A. Contractor shall be prepared to discuss and present the following subjects, as a minimum:

1. Required schedules.
2. Preliminary Schedule of Submittals including dates for major submittals (Concrete surface repairs; Division 40, Process Interconnections, equipment; at minimum).
3. Schedule of Values.
4. First 60 days plan of operation and construction.
5. Safety Plan.
6. Status of Bonds and insurance.
7. Sequencing of critical path work items.
8. Progress payment procedures.
9. Project changes and clarification procedures.
10. Use of Site, access, office and storage areas, security and temporary facilities.
11. Major product delivery and priorities.
12. Contractor’s safety plan and representative.
13. Contractor’s Workplace Harassment Prevention Program Plan.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s resident superintendent.

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4. Contractor's quality control representative.
5. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer's representatives.
7. Others as appropriate.

1.04 PRELIMINARY SCHEDULES REVIEW MEETING

A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.

1.05 PROGRESS MEETINGS

A. Engineer 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.
2. Contractor, Subcontractors, and Suppliers, as appropriate.
3. Engineer's representative(s).
4. Others as appropriate.

1.06 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control.

B. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work and work of other Contractors.

C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and Suppliers, as necessary.
4. Engineer's representatives.

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1.07 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

A. Engineer will schedule meetings at Site, conducted monthly to review specific requirements of PICS work.

B. Attendees will include:

1. Contractor.
2. Owner.
3. Owner’s Integrator of Record.
4. PICS Subcontractor/Installer.
5. Engineer’s representatives.

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 Engineer 4 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. Schedule and attend facility startup meetings.

1. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.
2. Weekly meetings starting 2 months prior to the startup of all new equipment.

B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.

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C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer's representatives.
5. Owner's operations personnel.
6. Owner's Integrator of Record.
7. Others as required by Contract Documents or as deemed necessary by Contractor.

1.10 OTHER MEETINGS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit within time specified in Paragraph 2.03 of the General Conditions.
2. Detailed Progress Schedule:
   a. Submit initial Detailed Progress Schedule within 60 days after Effective Date of the Agreement.
   b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
3. Submit with Each Progress Schedule Submission:
   a. Contractor's certification that Progress Schedule submission is actual schedule being used for execution of the Work.
   b. Electronic file compatible with latest version of Microsoft Project by Microsoft Corporation.
   c. Progress Schedule: Two legible copies (PDF format).
   d. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
4. Prior to final payment, submit a final Updated Progress Schedule.

1.02 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 120 days, and a summary of balance of Project through Final Completion.

B. Show activities including, but not limited to the following:

1. Notice to Proceed.
2. Permits.
3. Submittals, with review time. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
4. Early procurement activities for long lead equipment and materials.
5. Initial Site work.
6. Earthwork.
7. Specified Work sequences and construction constraints.
8. Contract Milestone and Completion Dates.
9. Owner-furnished products delivery dates or ranges of dates.

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10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
11. System startup summary.
12. Project close-out summary.
13. Demobilization summary.

C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.

D. Format: In accordance with Article Progress Schedule—Critical Path Network.

1.03 DETAILED PROGRESS SCHEDULE

A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.

B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.

C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.

D. Format: In accordance with Article Progress Schedule—Critical Path Network.

E. Update monthly to reflect actual progress and occurrences to date, including weather delays.

1.04 PROGRESS SCHEDULE—CRITICAL PATH NETWORK

A. General: Comprehensive computer-generated schedule using CPM, 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.

B. Contents:

1. Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. Identify Work calendar basis using days as a unit of measure.

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3. Show complete interdependence and sequence of construction and Project-related activities reasonably required to complete the Work.
4. Identify the Work of separate stages and other logically grouped activities, and clearly identify critical path of activities.
5. Reflect sequences of the Work, restraints, delivery windows, review times, Contract Times and Project Milestones set forth in the Agreement and Section 01 31 13, Project Coordination.
6. Include as applicable, at a minimum:
    a. Obtaining permits, submittals for early product procurement, and long lead time items.
    b. Mobilization and other preliminary activities.
    c. Initial Site work.
    d. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s) Subcontract Work.
    e. Major equipment design, fabrication, factory testing, and delivery dates.
    f. Sitework.
    g. Concrete Work.
    h. Structural steel Work.
    i. Conveying systems Work.
    j. Equipment Work.
    k. Mechanical Work.
    l. Electrical Work.
    m. Instrumentation and control Work.
    n. Interfaces with Owner-furnished equipment.
    o. Other important Work for each major facility.
    p. Equipment and system startup and test activities.
    q. Project closeout and cleanup.
    r. Demobilization.
7. No activity duration, exclusive of those for Submittals review and product fabrication/delivery, shall be less than 1 day nor more than 30 days, unless otherwise approved.
8. Activity duration for Submittal review shall not be less than review time specified unless clearly identified and prior written acceptance has been obtained from Engineer.

C. Network Graphical Display:

1. Plot or print on paper not greater than 30 inches by 42 inches or smaller than 22 inches by 34 inches, unless otherwise approved.
2. Title Block: Show name of Project, Owner, date submitted, revision or update number, and the name of the scheduler. Updated schedules shall indicate data date.
3. Identify horizontally across top of schedule the time frame by year, month, and day.

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4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Indicate the critical path.
6. Show, at a minimum, the controlling relationships between activities.
7. Plot activities on a time-scaled basis, with the length of each activity proportional to the current estimate of the duration.
8. Plot activities on an early start basis unless otherwise requested by Engineer.
9. Provide a legend to describe standard and special symbols used.

D. Schedule Report:

1. On 8-1/2-inch by 11-inch white paper, unless otherwise approved.
2. List information for each activity in tabular format, including at a minimum:
    a. Activity Identification Number.
    b. Activity Description.
    c. Original Duration.
    d. Remaining Duration.
    e. Early Start Date (Actual start on Updated Progress Schedules).
    f. Early Finish Date (Actual finish on Updated Progress Schedules).
    g. Late Start Date.
    h. Late Finish Date.
    i. Total Float.
3. Sort reports, in ascending order, as listed below:
    a. Activity number sequence with predecessor and successor activity.
    b. Activity number sequence.
    c. Early-start.
    d. Total float.

E. Cost-Loading:

1. Note the estimated cost to perform each Work activity, with the exception of Submittals or Submittal reviews, in the network in a tabular listing.
2. The sum of all activity costs shall equal the Contract Price. An unbalanced or front-end-loaded schedule will not be acceptable.
3. The accepted cost-loaded Progress Schedule shall constitute the Schedule of Values.

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1.05 PROGRESS OF THE WORK

A. 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 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.

B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.

C. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times (or Milestones), submit, within 7 days of such failure, a written statement as to how nonperformance will be corrected to return Project 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.

D. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to:

1. Complete a Milestone activity by its completion date.
2. Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.06 NARRATIVE PROGRESS REPORT

A. Format:

1. Organize same as Progress Schedule.
2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

B. Contents:

1. 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).

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2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
3. Contractor's plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential Contract changes.
4. Identification of new activities and sequences as a result of executed Contract changes.
5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from Contractor-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

1. Proposed schedule is accepted with respect to:
   a. Contract Times, including Final Completion and all intermediate Milestones, are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected.
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. Startup testing duration is as specified and timing is acceptable.
2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

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B. Unacceptable Preliminary Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, including updating schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Detailed Progress Schedule:

1. Make requested corrections; resubmit within 10 days.
2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.08 ADJUSTMENT OF CONTRACT TIMES

A. Reference General Conditions.

B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Float:

1. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
2. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of Owner and Contractor.
3. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.

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D. Claims Based on Contract Times:

1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.
2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
3. Revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.

B. Deferred Submittal: Information in accordance with 2024 IBC Section 107.3.4.2 submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer's review documentation that submittal has been found to be in general conformance with Project's design.

C. Informational Submittal: Information submitted by Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

A. Direct submittals to Engineer at the following, unless specified otherwise.

1. Submit via Owner furnished electronic document management system (EDMS) software. See Section 01 31 13, Project Coordination, for description of the EDMS software and required use.

B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.

1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
3. PDF files shall be set to open "Bookmarks and Page" view.
4. Add general information to each PDF file, including title, subject, author, and keywords.
5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
6. Submit new electronic files for each resubmittal.

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7. Include a copy of the Transmittal of Contractor's Submittal form, provided by the Owner, with each electronic file.
8. Engineer will reject submittal that is not electronically submitted, unless specifically accepted.
9. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. Contractor shall:
   a. Review each submittal and check for compliance with Contract Documents.
   b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at the end of this section.
3. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
   b. Specification section and paragraph to which submittal applies.
   c. Project title and Engineer's project number.
   d. Date of transmittal.
   e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

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D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

E. Timeliness: Schedule and submit in accordance Schedule of Submittals and requirements of individual specification sections.

F. Processing Time:

1. Time for review shall commence on Engineer's receipt of submittal.
2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 30 days after receipt, unless otherwise specified.
3. Resubmittals will be subject to same review time.
4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.

G. Resubmittals: Clearly identify each correction or change made.

H. Incomplete Submittals:

1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
2. When any of the following are missing, submittal will be deemed incomplete:
    a. Contractor's review stamp; completed and signed.
    b. Transmittal of Contractor's Submittal; completed and signed.
    c. Insufficient number of copies.

I. Submittals not required by Contract Documents:

1. Will not be reviewed and will be returned stamped "Not Subject to Review."
2. Engineer will keep one copy and return submittal to Contractor.

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1.03 ACTION SUBMITTALS

A. Prepare and submit Action Submittals required by individual specification sections.

B. Shop Drawings:

1. Copies: Electronic.
2. Identify and Indicate:
   a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
   b. Equipment and Component Title: Identical to title shown on the Drawings.
   c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
   d. Project-specific information drawn accurately to scale.
3. Manufacturer's standard schematic drawings and diagrams as follows:
   a. Modify to delete information that is not applicable to the Work.
   b. Supplement standard information to provide information specifically applicable to the Work.
4. Product Data: Provide as specified in individual specifications.
5. Deferred Submittal: See the Drawings for list of deferred submittals.
   a. Contractor-design drawings and product data related to permanent construction.
      1) Written and graphic information.
      2) Drawings.
      3) Cut sheets.
      4) Data sheets.
      5) Action item submittals requested in individual specification section.
   b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Engineer. Documentation of review and approval provided on Engineer's comment form, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
6. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

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C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation:
   a. Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
      1) Manufacturer name.
      2) Model number.
      3) Material.
      4) Sample source.
3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
4. Full-size Samples:
   a. Size as indicated in individual specification section.
   b. Prepared from same materials to be used for the Work.
   c. Cured and finished in manner specified.
   d. Physically identical with product proposed for use.

D. Action Submittal Dispositions:

1. Engineer will review, comment, stamp, and distribute as noted:
   a. Approved:
      1) Contractor may incorporate product(s) or implement Work covered by submittal.
      2) Distribution: Electronic.
   b. Approved as Noted:
      1) Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
      2) Distribution: Electronic.
   c. Partial Approval, Resubmit as Noted:
      1) Make corrections or obtain missing portions, and resubmit.
      2) Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
      3) Distribution: Electronic.
   d. Revise and Resubmit:
      1) Contractor may not incorporate product(s) or implement Work covered by submittal.
      2) Distribution: Electronic.

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1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: Electronic.
2. Refer to individual specification sections for specific submittal requirements.
3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

C. Construction Photographs and Video: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.

D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.

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E. Contractor-Design Data (Related to Temporary Construction):

1. Written and graphic information.
2. List of assumptions.
3. List of performance and design criteria.
4. Summary of loads or load diagram, if applicable.
5. Calculations.
6. List of applicable codes and regulations.
7. Name and version of software.
8. Information requested in individual specification section.

F. Deferred Submittals: See the Drawings for list of deferred submittals.

1. Contractor-Design Data Related to Permanent Construction:
   a. List of assumptions.
   b. List of performance and design criteria.
   c. Summary of loads or load diagram, if applicable.
   d. Calculations.
   e. List of applicable codes and regulations.
   f. Name and version of design software.
   g. Factory test results.
   h. Informational submittals requested in individual specification section.
2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer. Documentation of review and indication of compliance with general design intent and project criteria provided on Engineer's comment form as meets conditions of the Contract, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.

G. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.

H. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

I. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.

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J. Schedules:

1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Section 01 32 00, Construction Progress Documentation.
    a. Show for each, at a minimum, the following:
        1) Specification section number.
        2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
        3) Estimated date of submission to Engineer, including reviewing and processing time.
    b. On a monthly basis, submit updated Schedule of Submittals to Engineer if changes have occurred or resubmittals are required.
2. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

K. Special Guarantee: Supplier's written guarantee as required in individual specification sections.

L. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.

M. Submittals Required by Laws, Regulations, and Governing Agencies:

1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.

N. Test, Evaluation, and Inspection Reports:

1. General: Shall contain signature of person responsible for test or report.
2. Factory:
    a. Identification of product and specification section, type of inspection or test with referenced standard or code.
    b. Date of test, Project title and number, and name and signature of authorized person.
    c. Test results.
    d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.

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e. Provide interpretation of test results, when requested by Engineer.
f. Other items as identified in individual specification sections.

3. Field:
   a. As a minimum, include the following:
      1) Project title and number.
      2) Date and time.
      3) Record of temperature and weather conditions.
      4) Identification of product and specification section.
      5) Type and location of test, Sample, or inspection, including referenced standard or code.
      6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
      7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
      8) Provide interpretation of test results, when requested by Engineer.
      9) Other items as identified in individual specification sections.

O. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

P. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual specification sections.

B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.

C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.

D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.

E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.

F. Copies of standards and specifications of technical societies:

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor’s personnel, Subcontractors, Owner, and Engineer.

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1.02 ABBREVIATIONS

A. Abbreviations for Trade Organizations and Government Agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association

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34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer
36.	CCSD	Clackamas County Sewer District
37.	CDA	Copper Development Association
38.	CGA	Compressed Gas Association
39.	CISPI	Cast Iron Soil Pipe Institute
40.	CMAA	Crane Manufacturers' Association of America
41.	CRSI	Concrete Reinforcing Steel Institute
42.	CS	Commercial Standard
43.	CSA	Canadian Standards Association
44.	CSI	Construction Specifications Institute
45.	DIN	Deutsches Institut für Normung e.V.
46.	DIPRA	Ductile Iron Pipe Research Association
47.	EIA	Electronic Industries Alliance
48.	EJCDC	Engineers Joint Contract Documents' Committee
49.	ETL	Electrical Test Laboratories
50.	FAA	Federal Aviation Administration
51.	FCC	Federal Communications Commission
52.	FDA	Food and Drug Administration
53.	FEMA	Federal Emergency Management Agency
54.	FIPS	Federal Information Processing Standards
55.	FM	FM Global
56.	Fed. Spec.	Federal Specifications (FAA Specifications)
57.	FS	Federal Specifications and Standards (Technical Specifications)
58.	GA	Gypsum Association
59.	GANA	Glass Association of North America
60.	HI	Hydraulic Institute
61.	HMI	Hoist Manufacturers' Institute
62.	IBC	International Building Code
63.	ICBO	International Conference of Building Officials
64.	ICC	International Code Council
65.	ICEA	Insulated Cable Engineers' Association
66.	IFC	International Fire Code
67.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
68.	IESNA	Illuminating Engineering Society of North America
69.	IFI	Industrial Fasteners Institute
70.	IGMA	Insulating Glass Manufacturer's Alliance
71.	IMC	International Mechanical Code
72.	INDA	Association of the Nonwoven Fabrics Industry
73.	IPC	International Plumbing Code
74.	ISA	International Society of Automation

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75.	ISO	International Organization for Standardization
76.	ITL	Independent Testing Laboratory
77.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
78.	MGD	Million gallons per day
79.	MIA	Marble Institute of America
80.	MIL	Military Specifications
81.	MMA	Monorail Manufacturers' Association
82.	MSS	Manufacturer's Standardization Society
83.	NAAMM	National Association of Architectural Metal Manufacturers
84.	NACE	NACE International
85.	NBGQA	National Building Granite Quarries Association
86.	NEBB	National Environmental Balancing Bureau
87.	NEC	National Electrical Code
88.	NECA	National Electrical Contractor's Association
89.	NEMA	National Electrical Manufacturers' Association
90.	NESC	National Electrical Safety Code
91.	NETA	International Electrical Testing Association
92.	NFPA	National Fire Protection Association
93.	NHLA	National Hardwood Lumber Association
94.	NICET	National Institute for Certification in Engineering Technologies
95.	NIST	National Institute of Standards and Technology
96.	NRCA	National Roofing Contractors Association
97.	NRTL	Nationally Recognized Testing Laboratories
98.	NSF	NSF International
99.	NSPE	National Society of Professional Engineers
100.	NTMA	National Terrazzo and Mosaic Association
101.	NWWDA	National Wood Window and Door Association
102.	OSHA	Occupational Safety and Health Act (both Federal and State)
103.	PCI	Precast/Prestressed Concrete Institute
104.	PEI	Porcelain Enamel Institute
105.	PPI	Plastic Pipe Institute
106.	PS	Product Standards Section-U.S. Department of Commerce
107.	PWCM	Project Wise® Construction Management
108.	RMA	Rubber Manufacturers' Association
109.	RUS	Rural Utilities Service
110.	SAE	SAE International
111.	SDI	Steel Deck Institute
112.	SDI	Steel Door Institute
113.	SJI	Steel Joist Institute

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114.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
115.	SPI	Society of the Plastics Industry
116.	SSPC	The Society for Protective Coatings
117.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
118.	SWI	Steel Window Institute
119.	TEMA	Tubular Exchanger Manufacturers' Association
120.	TCA	Tile Council of North America
121.	TCWRRF	Tri-City Water Resource Recovery Facility
122.	TIA	Telecommunications Industry Association
123.	UBC	Uniform Building Code
124.	UFC	Uniform Fire Code
125.	UL	formerly Underwriters Laboratories Inc.
126.	UMC	Uniform Mechanical Code
127.	USBR	U.S. Bureau of Reclamation
128.	WCLIB	West Coast Lumber Inspection Bureau
129.	WES	Water Environment Services
130.	WI	Wood Institute
131.	WRRF	Water Resource Recovery Facility
132.	WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Manufacturer's Field Services Agreement.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual specification section.

B. Representative subject to acceptance by Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required by an individual specification section, to meet the requirements of this section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

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C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. When specified in individual specification sections, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Engineer.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

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3.03 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

C. Lesson Plan:

1. When manufacturer or vendor training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:
   a. Title and objectives.
   b. Recommended attendees (such as, managers, engineers, operators, maintenance).
   c. Course description, outline of course content, and estimated class duration.
   d. Format (such as, lecture, self-study, demonstration, hands-on).

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e. Instruction materials and equipment requirements.
f. Resumes of instructors providing training.

D. Prestartup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Complete at least 14 days prior to beginning of facility startup.

E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

F. Recording of Training Sessions: Provided by Owner. Coordinate with Owner's designated video production representative, to facilitate appropriate audio and video recording of prestartup and post-startup instruction sessions, including manufacturers' representatives' hands-on equipment instruction and classroom sessions.

3.04 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

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MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20___

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

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SECTION 01 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 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; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.

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

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

E. 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 (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.

B. Maintain complete inspection records and make them available at all times to Owner and Engineer.

C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

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

B. Develop a mutual understanding of the system details, including the forms for recording the CQC 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.

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3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
3. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
4. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
5. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

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3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:

1. Preparatory Phase:
   a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
   c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
   d. Perform prior to beginning Work on each definable feature of Work:
      1) Review applicable Contract Specifications.
      2) Review applicable Contract Drawings.
      3) Verify that all materials and/or equipment have been tested, submitted, and approved.
      4) Verify that provisions have been made to provide required control inspection and testing.
      5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
      6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
      7) Review the appropriate activity hazard analysis to verify safety requirements are met.
      8) Review procedures for constructing the Work, including repetitive deficiencies.
      9) Document construction tolerances and workmanship standards for that phase of the Work.
      10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.

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2) Perform prior to beginning Work on each definable feature of Work:
   a) Review minutes of the preparatory meeting.
   b) Check preliminary Work to verify compliance with Contract requirements.
   c) Verify required control inspection and testing.
   d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
   e) Resolve all differences.
   f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

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3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
   a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
   b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
   c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager 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.
   d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
   e. 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.

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f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. 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:

1. Contractor/subcontractor and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. 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.
4. 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.
5. Material received with statement as to its acceptability and storage.
6. Identify submittals reviewed, with Contract reference, by whom, and action taken.

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7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in the Drawings and/or Specifications.
10. Contractor's verification statement.
11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. 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.

3.07 SUBMITTAL QUALITY CONTROL

A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
    a. Verify testing procedures comply with contract requirements.
    b. Verify facilities and testing equipment are available and comply with testing standards.
    c. Check test instrument calibration data against certified standards.
    d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
    e. Documentation:
        1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
        2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
        3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.

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4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.

B. Punchlist:

1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen (AAN): American Standards for Nursery Stock.
2. Federal Emergency Management Agency (FEMA).
3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1-Year to 100 Years.

1.02 SUBMITTALS

A. Informational Submittals:

1. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
2. Temporary Utility Submittals:
   a. Electric power supply and distribution plans.
   b. Water supply and distribution plans.
   c. Sanitary.
3. Temporary Construction Submittals:
   a. Access Roads: Routes, cross-sections, and drainage facilities.
   b. Parking area plans.
   c. Contractor’s field office, storage yard, and storage building plans, including gravel surfaced area.
   d. Fencing and protective barrier locations and details.
   e. Staging area location plan.
   f. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
   g. Plan for maintenance of existing plant operations.

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4. Temporary Control Submittals:
    a. Noise control plan.
    b. Dust control plan.
    c. Plan for disposal of waste materials and intended haul routes.

1.03 MOBILIZATION

A. Mobilization includes, but is not limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor's field office and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite Internet service and telephones.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of Contractor's work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having Contractor's superintendent at Site full time.

B. Use area designated for Contractor's temporary facilities as shown on the Drawings.

C. Upon written request, Owner will provide connection to internet outside of a single Contractor office trailer. No internet network infrastructure will be provided by Owner. Owner will make this connection available to Contractor at no cost. Contractor shall be responsible for providing Contractor's own internet services at no additional cost to Owner should the Owner-provided internet connection be unsatisfactory to Contractor or otherwise fail to meet Contractor's needs.

1.04 PROTECTION OF WORK AND PROPERTY

A. Comply with Owner's safety rules while on Owner's property.

B. Keep Owner informed of serious onsite accidents and related claims.

C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

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1.05 VEHICULAR TRAFFIC

A. Traffic Control Plan:

1. Adhere to traffic control plan reviewed and accepted by Engineer. Changes to this plan shall be made only by written approval of Engineer. Secure approvals for necessary changes so as not to delay progress of the Work.
2. Maintain traffic lanes wide enough or located to include an allowable travel path for semitrailer trucks to turn onto cross streets.

B. Traffic Routing Plan: Show sequences of construction affecting use of roadways, time required for each phase of the Work, provisions for decking over excavations and phasing of operations to provide necessary access, and plans for signing, barricading, and striping to provide passages for pedestrians and vehicles.

PART 2 PRODUCTS

2.01 ENGINEER'S FIELD OFFICES

A. Owner will furnish Engineer's Field Office.

2.02 PROJECT SIGN

A. Refer to Division 00, Procurement and Contracting Requirements, for Project signage requirements. Provide and maintain one, 8-foot-wide by 4-foot-high sign constructed of 3/4-inch exterior high density overlaid plywood. Sign shall bear name of Project, Owner, Contractor, Engineer. Lettering shall be black applied on white background by an experienced sign painter. Provide exterior type enamel paint. Information to be included and logo graphic will be provided by Engineer.

PART 3 EXECUTION

3.01 ENGINEER'S FIELD OFFICE

A. No work for Contractor for Engineer's field office.

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3.02 TEMPORARY UTILITIES

A. Power:

1. Electric power will be available at or near Site. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay costs for electric power used during Contract period, except for portions of the Work designated in writing by Engineer as substantially complete.
2. Cost of electric power will be borne by Contractor.

B. Lighting: Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials and equipment, and observation or inspection of the Work.

C. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finishes from damage because of temperature or humidity. Costs for temporary heat shall be borne by Contractor responsible for constructing structure or building as specified in Section 01 11 00, Summary of Work.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

D. Water:

1. Hydrant Water:
   a. Is available from nearby hydrants. Secure written permission for connection and use from water department and meet requirements for use. Notify fire department before obtaining water from fire hydrants.

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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.

2. Include costs to connect and transport water to construction areas in Contract Price.
3. Non-Potable Water: Owner will provide a place of temporary connection for non-potable (W3) water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Availability of W3 water is subject to timing and maximum flow rate restrictions to be coordinated with the Owner.

E. Sanitary and Personnel Facilities:

1. Provide and maintain facilities for Contractor's employees, Subcontractors, and other onsite employers' employees. Service, clean, and maintain facilities and enclosures.
2. Obtain Owner's permission before allowing construction personnel to use existing sanitary facilities at Site. Use of Owner's existing sanitary facilities by construction personnel will not be allowed.

F. Telephone Service:

1. Contractor: Arrange and provide onsite telephone service for use during construction. Pay costs of installation and monthly bills.
2. Engineer: Provided by Owner. No Contractor work required.
3. No incoming calls allowed to Owner's plant telephone system.

G. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.03 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. No residence or business shall be cut off from vehicular traffic for a period exceeding 1 hour, unless special arrangements have been made.
3. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform Work to their satisfaction.

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4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
6. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
7. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
8. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
9. Maintain original Site drainage wherever possible.

B. Site Security:

1. Erect a Temporary Security Fence: Maintain fence throughout construction period. Obtain Engineer's written permission before removal of temporary security fencing.
2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Trees and Plantings:

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 the 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.

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g. No trees, except those specifically shown on the 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 Association of Nurserymen. 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.

D. Existing Structures:

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.
2. Move mailboxes to temporary locations accessible to postal service.
3. Replace items removed in their original location and a condition equal to or better than original.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

G. Dewatering: Construct, maintain, and operate cofferdams, channels, flume drains, sumps, pumps, or other temporary diversion and protection works. Furnish materials required, install, maintain, and operate necessary pumping and other equipment for the environmentally safe removal and disposal of water from the various parts of the Work. Maintain foundations and parts of the Work free from water.

H. Archaeological Finds:

1. General: Should finds of an archaeological or paleontological nature be made within Site limits, immediately notify Owner and Engineer and proceed in accordance with General Conditions. Continue the Work in other areas without interruption.
2. Archaeological Finds: Evidence of human occupation or use of an area within contract limits prior to the Year 1840. Evidence may consist of skeletons, stone, or other utensils, or evidence of habitations or structures.

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3. Paleontological Finds: Evidence of prehistoric plant or animal life, such as skeletons, bones, fossils, or casts and other indications such as pictographs.
4. Owner may order the Work stopped in other areas if, in Owner's opinion, find is more extensive than may appear from uncovered material.
5. Protection of Finds:
    a. Cover, fence, or otherwise protect finds until notice to resume the Work is given.
    b. Cover finds with plastic film held in place by earth, rocks, or other weights placed outside the find. Should additional backfilling be necessary for safety or to prevent caving, place backfill material loosely over plastic film.
    c. Sheet or shore as necessary to protect excavations underway. Place temporary fence to prevent unauthorized access.
    d. Dewater finds made below water table as necessary to protect construction Work underway. Divert groundwater or surface runoff away from find by ditching or other acceptable means.
6. Removal of Finds:
    a. Finds are property of Owner. Do not remove or disturb finds without Owner's written authorization.
    b. Should Owner elect to have a find removed, provide equipment, labor, and material to permit safe removal of find without damage. Provide transportation for delivery to individuals, institutions, or other places as Owner may find desirable, expedient, or required by law.

I. Endangered and Threatened Species:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
2. Notify Engineer of construction activities that might threaten endangered and threatened species or their habitats.
3. Engineer will mark areas known as habitats of endangered and threatened species prior to commencement of onsite activities.
4. Additional areas will be marked by Engineer as other habitats of endangered and threatened species become known during construction.

3.04 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.

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3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

1. Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
2. Noise Control Ordinance: As described in the Oregon City Municipal Code.
3. 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. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Engineer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
3. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
4. Concrete Repair and Surface Preparation Waste Steam Disposal: Wastewater from high-pressure water blasting (hydro-demolition) operations, if used may be disposed at the Tri-City WRRF after pretreatment (by Contractor).
    a. Pre-treatment shall consist of filtration, solids settling, and pH adjustment, at minimum.

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b. Water shall be pretreated to the meet the following discharge limits prior to discharge to the plant:
   1) pH: Between 6 and 9.
   2) Total Suspended Solids: 250 mg/L.
c. Collect samples of treated water at a minimum frequency as follows:
   1) Batch Discharge: one sample per treatment batch prior to discharge.
   2) Continuous Discharge: Two samples per week for the duration of the continuous discharge period.
d. Coordinate with Owner for point of discharge to the treatment plant.

5. Concrete Repair and Surface Preparation Waste Stream Disposal: Waste from concrete surface preparation shall be disposed of at a permitted disposal facility in accordance with local, state, and federal regulations.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period. Install stormwater best management practices (BMPs) including but not limited to sediment fence, storm drain inlet protection, and culvert inlet protection to prevent discharge of sediment from construction activities. Inspect and maintain all stormwater BMPs for the duration of construction activities. Engineer may require installation of additional BMPs if Contractor's BMPs are insufficient to prevent runoff of sediment.

E. Waste Management and Disposal:

1. Handle, store, package, label, transport, and dispose all waste streams in accordance with federal, state, and local regulations for waste transport and disposal at facilities permitted for the type of waste disposed.
2. Segregate recyclable materials from waste streams (e.g., metal, cardboard, paper, plastic) to minimize waste disposal volume.
3. Waste Management Plan:
   a. Prior to commencing construction, obtain Engineer’s agreement with detailed plans showing procedures intended to package, handle, label, transport and dispose of solid and liquid waste streams generated during construction. The waste management plan shall include:
      1) Proposed onsite waste storage and management areas including inspection and labeling of stored wastes.
      2) Intended haul routes and vehicle type.
      3) Waste transporter names, contact information, licenses, and EPA ID numbers.

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4) Procedures for packaging and transporting wastes including lining and tarping procedures to prevent leakage or spread of contamination during transport.
5) Proposed permitted disposal facilities for each waste stream.
6) Procedures for waste stream characterization samples and proposed analytical laboratories.

4. Collect waste stream characterization samples for non-hazardous solid waste and hazardous waste streams to establish a waste profile with a permitted disposal facility. Sampling frequency shall be as required to meet disposal facility acceptance criteria for each type of waste. Waste samples for potentially hazardous and hazardous waste streams shall include Toxicity Characteristic leaching Procedure sampling if required by the disposal facility. Submit waste profile sampling for each non-hazardous solid waste and hazardous waste stream.
5. Submit written acceptance from permitted waste disposal facility for each non-hazardous solid waste and hazardous waste stream.
6. Hazardous waste generated shall be transported to an approved hazardous waste treatment, storage and disposal facility within 90 days of the accumulation start date on each container.

3.05 STORAGE YARDS AND BUILDINGS

A. Coordinate requirements with Section 01 61 00, Common Product Requirements.

B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

3.06 ACCESS ROADS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits. Use existing roads where shown. Alignments for new routes shall be approved by Engineer.

B. Maintain drainage ways. Install and maintain culverts to allow water to flow beneath access roads. Provide corrosion-resistant culvert pipe of adequate strength to resist construction loads.

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C. Provide gravel, crushed rock, or other stabilization material to permit access by all motor vehicles at all times.

D. Maintain road grade and crown to eliminate potholes, rutting, and other irregularities that restrict access.

E. Coordinate with Engineer detours and other operations affecting traffic and access. Provide at least 72 hours' notice to Engineer of operations that will alter access to Site.

F. Upon completion of construction, restore ground surface disturbed by access road construction to original grade. Replace damaged or broken culverts with new culvert pipe of same diameter and material.

3.07 PARKING AREAS

A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.

B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner's existing paved areas.

C. Use area designated on the Drawings for parking of Contractor's and Contractor's employees' vehicles. Contractor parking outside of designated areas shall not be permitted.

3.08 VEHICULAR TRAFFIC

A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be CLOSED, except by written permission of proper authority. Ensure the least possible obstruction to traffic and normal commercial pursuits.

B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.

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D. Road Closures: Maintain satisfactory means of exit for persons residing or having occasion to transact business along route of the Work. If it is necessary to close off roadway or alley providing sole vehicular access to property for periods greater than 2 hours, provide written notice to each owner so affected 3 days prior to such closure. In such cases, closings of up to 4 hours may be allowed. Closures of up to 10 hours may be allowed if a week's written notice is given and undue hardship does not result.

E. Maintenance of traffic is not required if Contractor obtains written permission from Owner and tenant of private property, or from authority having jurisdiction over public property involved, to obstruct traffic at designated point.

F. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen shoulder on opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

G. Maintain top of backfilled trenches before they are paved, to allow normal vehicular traffic to pass over. Provide temporary access driveways where required. Cleanup operations shall follow immediately behind backfilling.

H. When flaggers and guards are required by regulation or when deemed necessary for safety, furnish them with approved orange wearing apparel and other regulation traffic control devices.

I. Provide snow removal to facilitate normal vehicular traffic on public or private roads affected by construction. Perform snow removal promptly and efficiently by means of suitable equipment whenever necessary for safety, and as may be directed by proper authority.

J. Notify fire department and police department before closing street or portion thereof. Notify said departments when streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without written permission from fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access. Furnish Contractor's night emergency telephone numbers to police department.

K. Coordinate traffic routing with that of others working in same or adjacent areas.

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3.09 CLEANING DURING CONSTRUCTION

A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.

B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.

C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.

D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

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SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 100 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 degree F to 115 degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

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B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.
4. Deliver materials to Site.
5. Notify Engineer upon arrival for transfer of materials to Owner.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date and place of arrival.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

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B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

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G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. When manufacturer's product model has been superseded by another commercially-available product model from same manufacturer, provide the latest model of product.

D. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

E. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

F. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.

G. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

H. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

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I. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

J. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

K. Equipment Finish:

1. Provide manufacturer’s standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with gray finish as approved by Engineer.

L. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

M. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

N. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

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2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

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PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

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G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Manufacturer’s Certificate of Compliance.

END OF SECTION

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MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

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SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Approved Shop Drawings and Samples: As required in the General Conditions.
   c. Special bonds, Special Guarantees, and Service Agreements.
   d. Consent of Surety to Final Payment: As required in General Conditions.
   e. Releases or Waivers of Liens and Claims: As required in General Conditions.
   f. Releases from Agreements.
   g. Final Application for Payment: Submit in accordance with procedures and requirements stated in the Agreement.
   h. Extra Materials: As required by individual Specification sections.
   i. Documentation required to support Owner's reporting requirements to Energy Trust of Oregon, related to incentive funding for portions of the Work.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of the Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.

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4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.

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3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on the Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
    a. Color Coding:
        1) Green when showing information deleted from the Drawings.
        2) Red when showing information added to the Drawings.
        3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
    a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
    b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
    c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
    d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
    e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer’s written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.

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5. Dimensions on Schematic Layouts: Show on the Record Drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
    a. Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.
    b. Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).
    c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor’s request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor’s notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and Engineer.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Broom clean exterior paved driveways and parking areas.
5. Hose clean sidewalks, loading areas, and others contiguous with principal structures.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

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SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Supplement Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to installation of equipment or system field functional testing. Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.

B. Materials and Finishes Data:

1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
2. Final Data: Submit within 10 days after final inspection.

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1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. Prepare final data in data compilation format and on electronic media.

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover:
    a. Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
        1) Project title.
        2) Designate applicable system, equipment, material, or finish.
        3) Identity of separate structure as applicable.
        4) Identify volume number if more than one volume.
        5) Identity of general subject matter covered in manual.
        6) Identity of equipment number and Specification section.
4. Spine:
    a. Project title.
    b. Identify volume number if more than one volume.
5. Title Page:
    a. Contractor name, address, and telephone number.
    b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
        1) Identify area of responsibility of each.
        2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
    a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
    b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

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C. Data Compilation Format:

1. Compile all Engineer-accepted preliminary O&M data into a hard-copy, hard-bound set.
2. Each set shall consist of the following:
   a. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
   b. Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO. ___ OF ___," and list:
      1) Project title.
      2) Contractor's name, address, and telephone number.
      3) If entire volume covers equipment or system provided by one Supplier include the following:
         a) Identity of general subject matter covered in manual.
         b) Identity of equipment number and Specification section.
   c. Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
   d. Table of contents neatly typewritten, arranged in a systematic order:
      1) Include list of each product, indexed to content of each volume.
      2) Designate system or equipment for which it is intended.
      3) Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
   e. Section Dividers:
      1) Heavy, 80 pound cover weight, tabbed with numbered plastic index tabs.
      2) Fly-Leaf:
         a) For each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.
         b) List with Each Product:
            (1) Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.
            (2) Identify area of responsibility of each.
            (3) Provide local source of supply for parts and replacement.
         c) Identity of separate structure as applicable.
   f. Assemble and bind material, as much as possible, in same order as specified in the Contract Documents.

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D. Electronic Media Format:

1. Portable Document Format (PDF):
   a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
   b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
   c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.
2. Manufacturers' standard electronic format.

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit electronic copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Equipment Inventory Data:
   a. See Supplement Equipment Inventory Template. Owner will use this data to populate Owner's computerized maintenance management system.
   b. Obtain digital (MS Excel) version of this template from Owner.
   c. Prepare and submit digital (MS Excel) data for all equipment, valves, and instruments.
   d. Continuously maintain current Equipment Inventory Data, following receipt of approved submittals for each equipment.
   e. Submit final Equipment Inventory Data for each unit process concurrent with Manufacturer's Certificate of Proper Installation (as applicable) and prior to Functional Testing Part 1 for the related unit process.
3. Preliminary Data:
   a. Submit for Engineer's review.
   b. If data meets conditions of the Contract, Engineer will respond noting such conditions.
   c. If data does not meet conditions of the Contract:
      1) Submittal will be returned to Contractor with Engineer's comments for revision.
      2) Resubmit revised in accordance with Engineer's comments.
4. Final Data: Submit two copies and two CDs or DVDs in format specified herein.

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1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.
   h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings:
   a. Supplement product data with the Drawings as necessary to clearly illustrate:
      1) Format:
         a) Provide reinforced, punched, binder tab; bind in with text.
         b) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
         c) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
         d) Identify Specification section and product on the Drawings and envelopes.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
   d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.

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5. Instructions and Procedures: Within text, as required to supplement product data.
    a. Format:
        1) Organize in consistent format under separate heading for each different procedure.
        2) Provide logical sequence of instructions for each procedure.
        3) Provide information sheet for Owner's personnel, including:
            a) Proper procedures in event of failure.
            b) Instances that might affect validity of guarantee or Bond.
    b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
    c. Operating Procedures:
        1) Startup, break-in, routine, and normal operating instructions.
        2) Test procedures and results of factory tests where required.
        3) Regulation, control, stopping, and emergency instructions.
        4) Description of operation sequence by control manufacturer.
        5) Shutdown instructions for both short and extended duration.
        6) Summer and winter operating instructions, as applicable.
        7) Safety precautions.
        8) Special operating instructions.
    d. Maintenance and Overhaul Procedures:
        1) Routine maintenance.
        2) Guide to troubleshooting.
        3) Disassembly, removal, repair, reinstallation, and re-assembly.
6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
    a. Function, normal operating characteristics, and limiting conditions.
    b. Performance curves, engineering data, nameplate data, and tests.
    c. Complete nomenclature and commercial number of replaceable parts.
    d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
    a. Electrical service.
    b. Control requirements and interfaces.
    c. Communication requirements and interfaces.
3. List of electrical relay settings, and control and alarm contact settings.

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4. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
5. As-installed control diagrams by control manufacturer.
6. Operating Procedures:
    a. Routine and normal operating instructions.
    b. Startup and shutdown sequences, normal and emergency.
    c. Safety precautions.
    d. Special operating instructions.
7. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
8. Manufacturer's printed operating and maintenance instructions.
9. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
    a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
    b. Each Maintenance Summary may take as many pages as required.
    c. Use only 8-1/2-inch by 11-inch size paper.
    d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
    a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
    b. "Unit" is the unit of measure for ordering the part.
    c. "Quantity" is the number of units recommended.
    d. "Unit Cost" is the current purchase price.

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D. Equipment Inventory Data:

1. Compile individual Equipment Inventory Data for each applicable equipment item, respective unit, or system, and for components or sub-units.
2. Format:
   a. See attached supplement.
   b. Complete digitally using MS Excel 2010 or newer.
3. Coordinate with Owner to review required data format prior to initial submittal.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.
   c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Maintenance Summary Form.
2. Equipment Inventory Template.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____
2. MANUFACTURER _____
3. EQUIPMENT/TAG NUMBER(S) _____
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____
5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____
6. MANUFACTURER'S LOCAL REPRESENTATIVE _____
   a. Name_____ Telephone No. _____
   b. Address _____
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

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8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobil	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

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EQUIPMENT INVENTORY TEMPLATE																				
Field Title	**Equipment Classification**	**Equipment Type**	**Operating Status**	**Plant**	**Area**	**System**	**Make**	**Model**	**Serial Number**	**Model Year**	**Size**	**Valve Operator**	**As-Built Drawing**	**As-Built ID**	**Purchase Amount**	**Purchase Date**	**Warranty Number / Description**	**Installed By**	**Start Date**	**Service Life**	**General Comments**
EXAMPLE	Pumps	Centrifugal	Operational	Tri-City	Aeration Basins	Aeration	ABS Pumps, Inc.	ABC123	923874	2021	100 HP	Not Applicable	X-XX-123	Pump-101	$1,234	11/18/2025	No. 1234: 1-year from startup	Contractor	11/19/2025	15 Years	

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SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2024 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be the Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Component Important Factor:

1. Ip shall be taken as more than 1.0, unless noted otherwise.
2. Ip shall be taken as 1.5 if any of the following conditions apply:
   a. Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
   b. Component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where quantity of material exceeds threshold quantity established by the AHJ and is sufficient to pose threat to the public is released.
   c. Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.

1.03 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Oregon.

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2. Design anchorage into concrete including embedment in accordance with ACI 318-19; Chapter 17 (or other industry standard approved by the Engineer), and the Project Specifications.
    a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of mechanical and electrical components and systems in accordance with this section, unless a design is specifically provided within the Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential mechanical or electrical equipment.
6. Distribution Systems: Includes, but are not limited to, piping and conduit.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. Design anchorage and bracing for equipment and components for seismic loads except those exempted below. Include other loads as applicable in the design load combinations.
    a. Excepted equipment and components include the following:
        1) SDC D, SDC E, and SDC F:
            a) Mechanical and electrical components positively attached to the structure, provided that either:
                (1) For discrete mechanical and electrical components, component weighs 400 pounds or less, center of mass is located 4 feet or less above adjacent floor level, flexible connections are provided between component and associated ductwork, piping, and conduit, and Component Importance Factor, Ip, is equal to 1.0.
                (2) For discrete mechanical and electrical components, components weigh 20 pounds or less.
10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.

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2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on the Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment.
3. Operational:
    a. For loading supplied by equipment manufacturer for IBC required load cases.
    b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, pipe thrust, and other load-inducing conditions.
    c. Locate braces to minimize vibration to or movement of structure.
4. Seismic:
    a. In accordance with 2024 IBC, Section 1613, and Chapter 13 of ASCE 7.
    b. Design anchorage and bracing for design criteria listed on General Structural Notes on the Drawings.
    c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2, or IBC Section 1905.1.8 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip is equal to 1.5.
2. Provide support drawings and calculations for mechanical and electrical systems in accordance with Section 13.6 of ASCE 7.
3. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new architectural, mechanical and electrical components, systems, or equipment.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. List of mechanical and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
    b. Manufacturers' engineered seismic and non-seismic hardware product data.
    c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.

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d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on the Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil or structural engineer registered in the State of Oregon.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

1. Submitted anchorage drawings and calculations are identified as IBC deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment, or distribution system to be anchored to structure.

1.05 SOURCE QUALITY CONTROL

A. The Contractor and supplier responsibilities to accommodate the Owner-furnished shop fabrication related special inspections and testing are provided in General Structural Notes on the Drawings.

B. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in accordance with Section 01 45 16.13, Contractor Quality Control.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on the Drawings and nationally recognized standards.

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B. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 hp.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide distribution system anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

D. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by the Engineer.

E. Do not attach mechanical or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by the Engineer and AHJ.

B. Notify the Engineer upon completion of installation of seismic restraints.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan on the Drawings.

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B. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

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SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 STARTUP

A. The goal of this startup activity is to verify proper performance and operation of the Aeration Basins 1 to 4 area system and other unit processes modified under this Contract.

B. Testing integration and startup are complex portions of the Work required for satisfactory completion and require thorough planning and proper execution.

C. The startup shall be developed in conjunction with the Project phasing as described in Section 01 31 13, Project Coordination.

D. This section and related sections intend to present the overall expectations for executing testing and startup of the Work. Testing not needed or not possible may be waived through the submittal review process.

1.02 DEFINITIONS

A. Acceptance: The acceptance of a unit process by the Owner shall mean that the unit process or Facility has been deemed to have beneficial use for the Owner and will occur after the completion of the commissioning of the unit process or Facility.

B. Application Software Programming Engineer (ASPE): Entity, contracted directly by the Owner, who is responsible for the development and programming of the Facility PIC System. The Engineer is the ASPE for this Project.

C. Clean Water Functional Testing on Unit Processes: Testing where specified requirements are verified by operating unit processes with clean water prior to being placed into service.

D. Components: Individual items of equipment or portions of the Work that when combined with other components make up subsystems or systems. Components may be minor items such as pressure gauges, or they may be significant items, such as pump motors.

E. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

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F. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

G. Factory Demonstration Testing (FDT): All testing required to be conducted at the fabricators'/manufacturers'/vendors' offsite locations, witnessed or unwitnessed. Includes all such testing, regardless of the specific descriptive title used for said testing in the Contract Documents.

H. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

I. Instrumentation and Control Functional Test Part 1: See Section 40 90 00, Instrumentation and Control for Process Systems.

J. Instrumentation and Control Functional Test Part 2: See Section 40 90 00, Instrumentation and Control for Process Systems.

K. Manufacturer's Installation Inspection: Preliminary inspection conducted by Manufacturer or Manufacturer's accepted representative to confirm proper installation of components, systems, and subsystems.

L. Mechanical/Electrical Functional Testing: Testing performed to confirm general proper performance of mechanical and electrical systems in preparation for future integrated testing steps. Hydrostatic leak testing of pipes is an example of a mechanical functional test. Electrical functional testing specified in Division 26, Electrical, shall be considered Mechanical/Electrical Functional Testing.

M. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

N. PIC System Integrator: Entity provided by the Contractor to plan and execute the installation, interconnection, integration, and startup of the PIC System devices, panels, components, systems, and subsystems required for the Work.

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O. Process Instrumentation and Control (PIC) System: Computer-based system whose purpose is to control and supervise the overall Facility operation.

P. Software Factory Demonstration Testing: Startup phase during which the ASPE performs an FDT to test the proper communication and action of the ASPE-developed software system. This testing will be conducted offsite.

Q. Startup: Startup shall begin with the development of startup testing plans and meetings at the beginning of the Project and shall be completed upon acceptance of the Facility by the Owner.

R. Training: Classroom and equipment area instruction by Manufacturer or Manufacturer accepted representative intended to educate the Owner on the proper operation and maintenance of components, systems, and subsystems.

S. Unit Process: Portion of the Facility that perform a specific process function, such as Aeration Basins.

1.03 SUBMITTALS

A. Action Submittals:

1. Factory Demonstration Test Plans.
2. Functional Test Plans.
3. Performance Test Plans.
4. Facility Startup and Performance Demonstration Plan.

B. Informational Submittals:

1. Testing Results Submittal:
    a. Include the following:
        1) Results documentation from all Factory Demonstration Testing.
        2) Completed test plans.
        3) Record of all Training:
            a) Training requests.
            b) Agendas.
            c) Sign in sheets.
            d) Handouts.
            e) Electronic copy of all training presentations.
        4) Record of all Manufacturer Services/Inspections.

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1.04 ORGANIZATION OF STARTUP PHASES

A. The following table summarizes the various phases of startup:

Description	Article	Preceding Constraints	Comments
Submittals	As specified elsewhere.		
Factory Demonstration Testing	40 90 00	Approved submittals including Factory Demonstration Test plan required prior to testing.	
Factory Software Acceptance Testing	40 90 00	Delivery of instrumentation and control components to Engineer's facility if specified. Completion of all PLC and HMI application software. Approved submittals required prior to testing (including O&Ms).	Managed by Engineer.
Mechanical/ Electrical Functional Testing	26 05 01 40 27 00 40 27 02 40 80 01	Complete all FDTs. Complete equipment and piping installation. Receive Completed Manufacturer's Certificate of Proper Installation. Approved submittals required prior to testing (including O&Ms).	Includes hydrostatic testing, control circuit continuity testing, insulation resistance testing, independent electrical system testing.
Instrumentation and Control Functional Test Part 1	40 90 00	Manufacturer's installation assistance and inspection. Approved submittals required prior to testing (including O&Ms).	
Clean Water Functional Testing on Aeration Basins	3.03	Completion of Instrumentation and Control Functional Test Part 1. Approved submittals required prior to testing (including O&Ms).	

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Description	Article	Preceding Constraints	Comments
Instrumentation and Control Functional Test Part 2	40 90 00	Completion of Instrumentation and Control Functional Test Part 1. Submittal by Contractor and approval by Engineer of Instrumentation and Control Functional Test Part 1 test documentation confirming successful testing as described in the approved Instrumentation and Control Functional Test Part 1 test plan. Completion of Software Demonstration Testing and loading of application software by the Engineer. Approved submittals required prior to testing (including O&Ms).	
Functional Testing on Equipment and Systems	3.03	Approved submittals required prior to testing (including O&Ms).	
Training	As specified elsewhere.	Initiation of functional testing. Training will overlap with functional testing.	
Wastewater Performance Testing on Aeration Basins	3.04	Completion of clean water functional testing (if applicable). Completion of Instrumentation and Control Functional Test Part 2. Approved submittals required prior to testing (including O&Ms).	This effort will commence with the placing of a unit process into service.

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Description	Article	Preceding Constraints	Comments
Facility Performance Demonstration	3.06	Completion of Performance Testing where required. Completion of Wastewater Functional Testing.	This Facility Performance Demonstration shall be used to determine the suitability of a unit process for acceptance by the Owner and determination of Beneficial Use.

1.05 CONTRACTOR STARTUP PERSONNEL

A. Contractor shall provide personnel, both supervisory and from the applicable trades, who are experienced in startup, testing, and commissioning for the execution of the Work described in these Contract Documents.

1.06 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following: Step-by-step instructions for startup of each unit process and the complete facility.

B. For startup and testing purposes, the following designations are made:

1. Unit Processes:
   a. Aeration Basins 1-2:
      1) Major Equipment Systems: Process aeration.
   b. Aeration Basins 3-4:
      1) Major Equipment Systems: Process aeration.
2. Unit Process Startup Form (sample attached), to minimally include the following:
   a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
   b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
   c. Startup requirements for each unit process, including water, power, chemicals, etc.
   d. Space for evaluation comments.

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3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    a. Description of unit processes included in the facility startup.
    b. Sequence of unit process startup to achieve facility startup.
    c. Description of computerized operations, if any, included in the facility.
    d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
    e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

B. Contractor's Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing Work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.
3. Provide labor and materials as required for laboratory analyses.

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3.02 ALP NEW AND EXISINTG PIPING LEAK TESTING

A. The Owner has requested, as part of the leak testing of the new ALP piping being installed as part this Contract's Work, that the entire ALP piping system from the Blower room to the Basins be tested. Any leaks in the existing ALP piping not having been replaced as part of this Contract's Work be identified, and recommendation be provided for correction of existing ALP pipe leakage.

1. The ALP piping system can be broken down into five separate section tests, one test for each basin (which can include new and existing piping), and one test from the blowers to the basins section of piping (all existing).
2. Basin ALP Piping Leak Testing:
    a. Each basin ALP piping system is to be tested as part of the basin reconditioning when the basin is off-line. This testing can be done as part of the required new piping leak testing for each basin being re-piped. The piping tested will be from the abandoned control valves in the east gallery which have been converted from pneumatically control to manual hand wheel operators as part of this project. Each Basin has a single east gallery abandoned control valve.
    b. To perform the ALP piping leak test, a blind flange needs to be installed at diffuser header connection in zones 1A, 1B, 2, 3, and 4; and in the zone 5 and blind flange with an air connection for testing. The old control valve in east gallery is to be closed, while each new zone flow control butterfly valve needs to be locked in the 100 percent open position.
        1) Once the basic ALP system has been isolated from the gallery header and zone diffuser headers the ALP piping can be pressurized to the test pressure listed on the Piping Schedule on the Drawings. Test the ALP piping as per requirements listed in Section 40 80 01, Process Piping Leakage Testing for pneumatic testing.
    c. If after following the testing specification and confirming that all new piping is leak free, and the system of new and existing piping does not pass the leak test the existing piping will need to be re-tested and inspected.
        1) Repeat the leak test, but this time remove the four expansion joint inspection hatches on the walkway between the basins and soap test the expansion joints and all other joints accessible from the inspection hatches. Additionally, conduct soap tests of the east gallery isolation valve. If any of the existing piping shows leakage document the leakage and report the leakage to the Owner.

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d. Report all test results and corrective actions taken relative to the new piping repaired to pass soap/leak testing.
e. Once the Basin ALP piping leak testing is complete, then proceed to the perform the pneumatic testing for diffuser membranes in basins where the diffuser membranes have been replaced.

3. Blower to Basins ALP piping leak testing:
   a. To test the ALP piping between the blowers and the basins, all four aeration basins must be off-line, therefore this test must be scheduled for a specific time with the Owner and the test during will be limited.
   b. The test leak test will be testing the ALP piping from the blowers, underground into the north gallery and up to the 4 abandoned basin control valves in the east gallery.
   c. Upon Owner's Approval:
      1) Shutdown the blowers servicing the aeration basins, then close the blower discharge valve on all but one blower.
      2) Next make sure all four of the basin isolation valves (the abandoned control valves) are completely closed.
      3) Re-start the one blower which has its discharge valve open, allow the piping system to fully pressurize, then slowly close the operating blower isolation valve and just as the valve is closed shut down the blower.
      4) Once the ALP piping system between the blowers and the basins is charged, monitor the piping for loss of pressure, also monitor the basins to see if ALP air is leaking past the four basin isolation valves.
      5) Report test results to Owner. If the leak test shows indication of ALP leaks between the blowers and basin coordinate with Owner for additional testing, which may include removal of ALP pipe insulation to inspect piping connections in the Blower room or galleries, which is to be determined by the Owner.

3.03 CLEAN WATER FUNCTIONAL AND PERFORMANCE TESTING ON UNIT PROCESSES

A. Basin equipment shall be tested with clean water to confirm specified requirements are met.

B. Clean water is available for testing.

1. For the purposes of this section, clean water is meant to differentiate potable and reclaimed water from wastewater. Clean water may be potable or reclaimed water at the discretion of the Owner. Contractor shall take necessary precautions when handling clean water.

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C. The Contractor is responsible for furnishing and installing all required temporary piping, appurtenances, facilities, required to conduct functional and performance testing. Contractor shall remove and dispose of all temporary piping, appurtenances, facilities, after they are no longer required. Contractor shall repair all permanent elements of the Work affected by the temporary piping, appurtenances, facilities.

3.04 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form:
    a. Provide written test report for each item of equipment to be tested, to include the minimum information:
        1) Owner/Project Name.
        2) Equipment or item tested.
        3) Date and time of test.
        4) Type of test performed (Functional or Performance).
        5) Test method.
        6) Test conditions.
        7) Test results.
        8) Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking:
    a. Prior to beginning functional testing:
        1) Calibrate testing equipment in accordance with manufacturer's instructions.
        2) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
        3) Lubricate equipment in accordance with manufacturer's instructions.
        4) Turn rotating equipment by hand when possible to confirm that equipment is not bound.
        5) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
        6) Check power supply to electric-powered equipment for correct voltage.
        7) Adjust clearances and torque.
        8) Test piping for leaks.

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6. Ready-to-test determination will be by Engineer based at least on the following:
    a. Acceptable Operation and Maintenance Data.
    b. Notification by Contractor of equipment readiness for testing.
    c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
    d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
    e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
    f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
    g. Equipment and electrical tagging complete.
    h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

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3.05 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Startup sequencing of unit processes shall be in the order specified in Section 01 31 13, Project Coordination.

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

E. Significant Interruption:

1. May include any of the following events:
    a. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
    b. Failure to meet specified functional operation for more than 2 consecutive hours.
    c. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
    d. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
    e. As determined by Engineer.

F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.06 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

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D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility including its computer system until all unit processes are operable and under control of computer system.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic and computerized operation.

3.07 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION

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UNIT PROCESS STARTUP FORM

OWNER:_____ PROJECT:_____

Unit Process Description: (Include description and equipment number of all equipment and devices):

_____

_____

_____

_____

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/close order of equipment startup, etc.):

_____

_____

_____

_____

_____

Startup Requirements (Water, power, chemicals, etc.):_____

_____

_____

Evaluation Comments:_____

_____

_____

_____

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FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ PROJECT:_____

Unit Processes Description (List unit processes involved in facility startup):

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ Date: _____, 20____

Engineer: _____ Date: _____, 20____
(Authorized Signature)

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SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 82—Protection of Stratospheric Ozone.
   c. Part 273—Standards for Universal Waste Management.
4. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

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F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped.
4. Submit a shipping receipt or bill of lading for all containers of ACM shipped.
5. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this renovation project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

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1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation.
2. The Contractor's planned sequence of operations, including coordination with other work in progress.
3. Procedures for removal and disposition of materials specified to be salvaged.
4. Disconnection schedule of utility services.

B. Include statements affirming Contractor inspection of the existing roof deck, floors, walls, and framing members, and their suitability to perform as a safe working platform or, if inspection reveals a safety hazard to workers, state provisions for securing the safety of the workers throughout the performance of the Work.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

C. Areas in which the Work is to be accomplished will be available in accordance with Section 01 31 13, Project Coordination.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Tanks and Vessels: Remove two polymer storage tanks next to the RAS pump station building. Salvage mixers in accordance with 3.05.

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B. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on the Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16-inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on the Drawings.
4. At submerged locations not to receive new concrete, paint exposed rebar or metal embed ends with System No. 19a at wastewater surfaces per Section 09 90 00, Painting and Coating.

C. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include:
    a. Fill holes and depressions caused by previous physical damage or left as a result of removals in existing concrete walls with an approved patching material, applied in accordance with the manufacturer’s printed instructions.

D. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4-inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.

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3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
    a. Demolish conductors back to source.
    b. Demolish exposed conduit back to source or first junction box where existing conductors share conduit.
    c. Provide cover plate or cap over raceway opening exposed from demolition work.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

E. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

A. Dust and Debris Control:

1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Vacuum and dust the Work area daily.
3. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

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C. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.

D. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

E. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner’s personnel and the general public from injury due to demolition Work.

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3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.04 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 TITLE TO MATERIALS

A. With the exception of the following listed salvaged equipment, all items designated to be removed shall become the property of Contractor:

1. Polymer tank mixers.

B. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's Demolition/Renovation Plan, and the resulting authorization by Engineer to begin demolition.

3.06 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.

3.07 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Owner.

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3.08 SPECIALIZED SALVAGE

A. Ozone Depleting Substances (ODS):

1. Class I and Class II ODS are defined in Section 602(a) and Section (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling.
2. Dispose of all Class I and Class II ODS refrigerants in accordance with the Clean Air Act Amendment of 1990.
3. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g., residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82.

3.09 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of in accordance with federal, state, and local laws at permitted disposal facilities.

B. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.10 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

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SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

PART 1 GENERAL

1.01 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: Surface defect such as honeycomb, rock pockets, indentations and surface voids greater than 3/16-inch deep, surface voids greater than 3/4-inch diameter, cracks in liquid containment structures and belowgrade habitable spaces 0.005-inch wide and wider, cracks in other structures 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances which include but are not limited to fins, form pop-outs, and other projections, and at exposed concrete which includes texture irregularities, stains, and other color variations that cannot be removed by cleaning.

C. High-Pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. Low-Pressure Spray Mortar: Mortar suitable to be applied by low-pressure spraying, and in small areas may be applied by hand troweling.

E. Rebound: Shotcrete material, mostly aggregates, that bounce off a surface against which shotcrete was projected.

F. Shotcrete: Mortar pumped through hose and projected at high velocity.

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1.02 SUBMITTALS

A. Action Submittals:

1. Product data sheets for each material supplied.
2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar for each repair location in existing concrete.
3. Drawings indicating results of sounding for hollow areas including location, size, and estimated quantity of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
   a. Shotcrete Nozzleman: Current ACI Certification for each proposed nozzleman.
   b. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on vertical and overhead surfaces that are exposed to wastewater.
   c. Mortar Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
   a. Repair mortar system applicator.
   b. Repair mortar system manufacturer's representative.
   c. Independent Testing Laboratory.
5. Repair mortar system manufacturer's proposed modified test procedures for ASTM C109/C109M, ASTM C882/C882M, and ASTM C157/C157M test methods.
6. Field and laboratory test reports.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: For Repair System B – Low-Pressure Spray Mortar, in lieu of recognition or certification, demonstrate application of repair mortar manufacturer's system and obtain Certification of Proper Installation, in accordance with Article Manufacturer's Services.

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2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Pre-repair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Technical representative for repair material manufacturer.
   d. Engineer.
2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
   a. Review of field conditions. Conduct field observations of Work to be performed.
   b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project-specific repair method recommendations.
   c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
   d. Other specified requirements requiring coordination.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR

A. One-component or two-component, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.

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B. Cured materials mixed in accordance with manufacturer's instructions shall conform to the following criteria:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 6,000 pounds per square inch minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,100 pound per square inch minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 pounds per square inch minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 pounds per square inch minimum.
5. Drying Shrinkage, ASTM C157/C157M Modified at 28 Days or ASTM C531: 0.1 percent maximum.
6. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 1,000 coulombs maximum.
7. System shall not produce a vapor barrier.
8. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only addition of water.
9. Free of chlorides and other chemicals causing corrosion.

C. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 488CI.
2. Sika Corp., Lyndhurst, NJ; SikaRepair 224.
3. Euclid Chemical Co., Cleveland, OH; Tamms Structural Mortar.

2.02 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

A. Polymer-modified, one-component or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.

B. Cured Mortar Properties:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 7,000 pounds per square inch minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,200 pounds per square inch minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 pounds per square inch minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 pounds per square inch minimum.

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5. Drying Shrinkage, ASTM C596 at 28 Days: 0.12 percent maximum. Not required for small repair areas approximately 1 square foot in area or less.
6. Freeze Thaw Resistance, ASTM C666/C666M, at 300 Cycles: 90 percent RDM.
7. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum for liquid holding and belowgrade repairs.

C. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco N 300CI.
2. Sika Corp., Lyndhurst, NJ; SikaTop 123 PLUS.
3. Euclid Chemical Co., Cleveland, OH; DuralTop Gel.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.04 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
   c. Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 pounds per square inch minimum.
   b. Flexural Strength, ASTM C348: 1,000 pounds per square inch minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M at 14 Days:
      1) 2-Hour Open Time: 2,500 pounds per square inch minimum.
      2) 24-Hour Open Time: 2,000 pounds per square inch minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with and from same manufacturer as the repair system used.

B. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.

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2. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH: Dural Prep AC.

2.05 EVAPORATION RETARDANT

A. As required by manufacturer.

2.06 CURING COMPOUND

A. Per manufacturer's requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Existing Concrete Work:

1. Make provisions for repair of existing structure for the following:
   a. 1,400 square feet of Repair System B.
   b. 400 square feet of Repair System C.

3.02 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer, and review proposed extent of repair with Engineer.

B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.

1. Use 8,000 pounds per square inch minimum high-pressure water blasting machine as required for Site conditions.
2. Remove concrete to abrade substrate concrete surfaces to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
3. Where final surface is required to be flush with existing adjacent surface remove existing concrete depth as required for application of minimum thickness of repair mortar.

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C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Engineer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.

I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

J. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer’s printed instructions.

K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

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3.03 PROTECTION

A. Protect adjacent surfaces, and equipment, from being damaged by overshooting, rebound, and dust, as applicable for repair mortar system used, from low-pressure spray mortar.

3.04 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. After priming prepared substrate concrete surface per manufacturer's recommendations, apply mortar by low-pressure spraying equipment, unless noted otherwise.

C. Bonding Agent:

1. Use bonding agent when manufacture required for hand applied areas, in accordance with repair mortar manufacturer's instructions.
2. Application of repair mortar over bonding agent shall be completed within time frame recommended by bonding agent manufacturer.
3. Consult with manufacturer for optimum and minimum acceptable degrees of surface tackiness of coat.

D. Work mortar firmly and quickly into repair area.

E. Finish repair mortar to match adjacent concrete surface.

F. Cure as specified in Article Curing.

3.05 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. Bond Coat: Apply to prepared substrate concrete surface before application of mortar in accordance with repair mortar manufacturer's printed instructions. Do not apply more bond coat than can be covered with mortar before bond coat dries. Do not retemper bond coat.

C. Place mortar by hand or low-pressure spray and trowel to specified surface finish, in accordance with requirements of repair material's printed instructions.

D. Finish repair mortar to smooth even surface to match adjacent concrete surface.

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E. Cure as specified in Article Curing, and in accordance with manufacturer's printed instructions.

3.06 CURING

A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer's printed instructions.

B. Cure in accordance with repair mortar manufacturer's printed instructions.

C. Where permitted by repair mortar manufacturer's printed instructions, continue water fog curing after repair mortar system application and when curing will not cause erosion of mortar.

D. Continuously water fog cure repair mortar system for a period of 7 days.

E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer's printed instructions and approval is obtained from Engineer.

F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer's printed instructions.

G. Where curing compound is permitted by repair mortar system manufacturer, apply curing compound per manufacturer's requirements.

3.07 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed wet mortar materials from nozzle, or mixer, during construction for compliance with Specifications for testing at 7 days, and 28 days.
3. Provide a minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

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C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Owner will provide the following:

1. Compression Strength Test:
   a. Testing will follow a “modified” ASTM C109/C109M.
   b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
   c. Record location where repair mortar is being applied at time production samples are obtained.
2. Direct Tension Bond Test:
   a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
   b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
   c. Bond Strength of Repair Mortar to Substrate Concrete: 300 pounds per square inch minimum in direct tension without failure or movement.
   d. Record locations of Bond Tests on each type of applied repair mortar tested.

E. Retest mortar repairs that do not meet test requirements.

F. Repair and fill holes using same repair mortar where core samples have been removed.

3.08 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge. Remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

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D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.09 MANUFACTURER'S SERVICES

A. Provide repair mortar system manufacturer's representative at Site to review acceptability of surface preparation, mixing and installation assistance, training of repair mortar system applicators, inspection, and Certification of Proper Installation.

3.10 CLEANING

A. Remove overshot repair mortar and rebound materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas, finishing, and curing, and dispose offsite at an approved disposal site.

END OF SECTION

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SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in crack or joint.

C. Joint: Planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements, and may contain embedded waterstops.

D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to touch, or continuous flow of liquid.

E. Narrow Cracks: Width equal to or less than 0.015-inch.

F. Wide Crack: Wider than 0.015-inch.

1.02 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.
3. Submit .
    a. Marked up drawings showing locations of proposed polyurethane injection work, including the following:
        1) Exact locations for injection.
        2) Depth of penetration or crack.
        3) Width of crack measured every 4 feet minimum.
        4) Length of penetration or crack.
    b. Proposed materials.
    c. Injection procedure, including the following:
        1) Preparation of penetration for polyurethane.
        2) Fittings for installation for injection.
        3) Temperature of installation.
        4) Measurement and monitoring of injection pressure.
        5) Surface cleaning and repair.

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B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Statements of Qualification for Polyurethane Resin Injection:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
3. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
4. Installation instructions for repairing core holes with repair mortar.
5. Polyurethane resins injection pressure test records for concrete crack and joint injection work.

1.03 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
   a. Licensed or certified by polyurethane resin manufacturer.
   b. Minimum 3 years' experience in successful polyurethane injection.

1.04 PERFORMANCE REQUIREMENTS

A. Injected polyurethane resin shall fill cracks, and in no case shall depth of penetration of injection material be less than 90 percent of:

1. Full thickness of the concrete section for cracks.
2. Depth between the waterstop and the inside face of the structure for joints.

B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.

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C. Notwithstanding the foregoing, injected cracks which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package adhesive material in new sealed containers and label with following information:
   a. Manufacturer's name.
   b. Product name and lot number.

B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.

B. Euclid Chemical Co., Cleveland, OH; DURAL Aqua-Fil.

C. Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.02 POLYURETHANE RESIN

A. Single-component, water-activated, hydrophilic polyurethane injection resin.

B. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

C. Tensile Strength: Minimum 150 pounds per square inch, in accordance with ASTM D3574 or ASTM D638 test method.

2.03 SURFACE SEAL

A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

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2.04 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.05 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

A. Use of polyurethane injection shall be limited to locations as determined by Structural Engineer.

B. Carry out polyurethane injection of cracks in existing concrete structures:

1. Assume 176 linear feet of crack injection for bidding. Confirmation of actual cracking shall occur once basin is empty and available for inspection by the Engineer.

C. Do not proceed with injection work until action submittals have been reviewed and approved by the Structural Engineer of Record.

D. Perform injection work after performing surface preparation.

E. Width of the cracks shown may vary along the length and through the thickness of the concrete section.

F. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack.

B. Pumps: Positive displacement type pump.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer’s printed instructions, and able to maintain such pressure.

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D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks alignment, to intersect the cracks at the midpoint of the concrete section and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of the crack where possible, unless orientation of the crack is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.

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6. Adjust location and angle of drill holes to suit orientation of crack and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection.
7. Take measures to prevent drilling holes for injection too shallow, or too deep and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

B. Application of Surface Seal:

1. Apply surface seal along the length of the cracks designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.

C. Polyurethane Injection of Cracks:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks in a sequential manner, and reinjection as required, to meet the performance requirements.
2. Start injection into each crack at lowest elevation entry port for vertical or diagonal cracks and at one end for horizontal cracks in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack in a sequential manner until the full length of the crack has been injected. At no time inject more than 6 feet length of vertical crack before verifying that the first 12 inches of injected crack is set and cured.

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3. Prior to commencing the injection work along a crack in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack has been injected.

D. Finishing:

1. Cure polyurethane resins after crack has been completely filled without draining or runback of polyurethane resin material from crack.
2. Remove surface seal and injection packers or ports from along the crack.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Engineer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 pounds per square inch.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 pounds per square inch within 3 minutes.
5. Run pressure Test for Each Injection Equipment Unit:
   a. Beginning and end of each injection work day.
   b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

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B. Visual Inspection:

1. Confirm injection of polyurethane has stopped the leaking material.
2. Confirm installation of material is in accordance with manufacturers' requirements.
3. Confirm installation of material is not damaging concrete.

END OF SECTION

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SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
   e. C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP 0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Brush-Off Blast Cleaning.
   i. SP 10, Near-White Metal Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.

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l. SP 13, Surface Preparation of Concrete.
m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PPDS: Paint Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Paint Product Data Sheet (PPDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PPDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
   b. Detailed chemical and gradation analysis for each proposed abrasive material.

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2. Samples:
    a. Paint:
        1) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
        2) Furnish additional samples as required until colors, finishes, and textures are approved.
        3) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements: Meet federal, state, and local requirements limiting the emission of volatile organic compounds.

C. Surface Preparation and Application:

1. Perform surface preparation and painting in accordance with recommendations of the following:
    a. Paint manufacturer's instructions.
    b. SSPC PA 10.
    c. Federal, state, and local agencies having jurisdiction.

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1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

1.07 EXTRA MATERIALS

A. Provide small quantity kits for coating repairs, touchup painting and for painting small areas.

B. Provide appropriate liquid repair kits for repairing fusion bonded epoxy coating in the field.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

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C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Akzo Nobel (Devoe; International).
2. Carboline.
3. PPG.
4. Sherwin-Williams.
5. Tnemec.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Bituminous Paint	Single-component, coal-tar pitch based
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments.
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated.
High Build Epoxy	Polyamidoamine epoxy, minimum 69 percent volume solids, capability of 4 to 8 MDFT per coat.
Phenolic Epoxy	Phenolic epoxy, suitable for continuous wet exposure to temperatures of 250°F minimum.

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Product	Definition
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish.
TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

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D. Pipe:

1. Ductile Iron Pipe:
   a. Use NAPF standards as a guide for desired prepared surface.
   b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
   c. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
2. Steel Pipe:
   a. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.
   b. For pipe with epoxy lining, do not place end cap seals until pipe lining material has sufficiently dried.

2.06 PIPE IDENTIFICATION LABELS

A. Pipe Labels:

1. Small Piping Below 4-Inch: Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
   a. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
   b. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
2. Large Piping 4-Inch and Larger without Insulation: Provided stencil painted pipe labels.
3. Large Piping 4-Inch and Larger with Insulation: Provide Strap on labels.
   a. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
   b. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
4. Pipe labels shall have both message lettering and flow arrows with colors as shown on Piping Schedule on the Drawings.
5. Color Field and Letter Height: Meet ASME A13.1.
6. Message lettering: Piping system flow stream identification as indicated on Piping Schedule on the Drawings.
7. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers.

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B. Pipe Band (Color Identification):

1. For Stainless steel piping or piping with insulation and aluminum jacket (not painted) provide color banding with color identified on Piping Schedule on the Drawings.
2. Banding shall be painted or strap on type of heavy-duty vinyl or polyester, suitable for exterior use, long lasting and resistant to moisture, grease and oils and designed to firmly grip pipe so banding remain fixed in vertical pipe runs.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

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B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Saltsor approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.

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d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
g. SP 10, Near-White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
i. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steel, Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).

2. The words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” and “blast cleaning,” or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.

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4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
    a. Prepare such that there is:
        1) No undercutting or reverse ridges on weld bead.
        2) No weld spatter on or adjacent to weld or any area to be painted.
        3) No sharp peaks or ridges along weld bead.
    b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Preblast Cleaning Requirements:
    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

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D. Ductile Iron Surface Preparation

1. Provide ductile iron pipe to be painted without asphalt coating.
2. Grind smooth surface imperfections, including delaminating metal and annealing oxide that is not tightly adhered.
3. Remove oil, grease, and other surface contaminants in accordance with NAPF 500-03-01, Solvent Cleaning.
4. Abrasive blast clean in accordance with the following:
   a. Ductile Iron Pipe: NAPF 500-03-04.
   b. Cast Ductile Iron Fittings: NAPF 500-03-05.
   c. Exposed surfaces of metal at small coating defects may be prepared by Hand Tool Cleaning NAPF 500-03-02 or Power Tool Cleaning NAPF 500-03-03. Small coating defects are defined as a defect that exposes two square inches or less of bare metal.

E. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer’s recommendations for additional preparation that may be required.

F. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer’s recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

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G. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

H. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
   a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
   b. Check compatibility by application to a small area prior to starting painting.
   c. If lifting or other problems occur, request disposition from Engineer.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, and procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

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B. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
3. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
4. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
5. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
7. Keep paint materials sealed when not in use.
8. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

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C. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with specification.
   c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, nonferrous metal, and plastic to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. As shown in Finish Schedule on the Drawings. Additional requirements are included in the Piping Schedule.

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C. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning Ductile Iron: NAPF 500-03-04, Abrasive Blast Cleaning	High Build Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Submerged metal surfaces, including items below top of basin wall but above the water line.

D. System No. 4 Exposed Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
Ductile Iron: NAPF 500-03-04, Abrasive Blast Cleaning	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces.

E. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning Ductile Iron: NAPF 500-03-04, Abrasive Blast Cleaning	High Build Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles.

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F. System No. 9 Special Coatings—Heat Resistant:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steel, Non-Ferrous Metals	Phenolic Epoxy	1 coat, 4 – 6 MDFT
	Phenolic Epoxy	1 coat, 4 – 6 MDFT

1. Use on the following items or areas:
   a. Where existing stainless steel piping insulation is disturbed, coat existing stainless steel piping if existing stainless steel piping is coated and that coating is damaged.
   b. As shown in the Piping Schedule and on the Drawings.

G. System No. 19a Concrete Exposed Metal Repair Coating—Wastewater:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush blast concrete in accordance with Paragraph Concrete Surface Preparation; blast exposed reinforcing steel to Near White Metal, SSPC SP10. See Note 1.	Amine-cured epoxy, suitable for exposure to primary wastewater, finish color gray.	2 coats, 8 MDFTPC, see Note 2.
Note 1. Surface Preparation Alternative: Mechanical abrade concrete surfaces to meet International Concrete Restoration Association standard 37/32, Concrete Surface Profile No. 3. Mechanically abrade exposed ends of reinforcing steel in accordance with SSPC SP-11. Note 2. Brush out surface voids and irregularities to provide a monolithic film.		

1. Use on the following items or areas:
   a. Saw-cut concrete surfaces that will not receive new concrete to cover exposed ends of rebar and metal embeds. Or alternately, where approved, over ends of and minimum two inches around ends of exposed metal and rebar in lieu of entire surface.

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H. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex (Semigloss)	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All UV-exposed PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.
   b. As shown in the Piping Schedule and on the Drawings.

I. System No. 27 Aluminum in Contact with Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint –OR– High Build Epoxy	1 coat, 10 MDFT 1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete, and the following items or areas:
   a. Underside of aluminum checker plates installed over the aeration basin splitter box.

3.08 COLORS

A. Provide as selected by Owner.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Radiation Hazards: OSHA Purple.

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d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: As selected by Owner.
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, or as selected by Owner.
5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.

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2. Holiday Testing:
    a. a. Thin Film Coatings:
        1) Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
        2) Equipment: Tinker and Rasor Model M 1, TQC Low Voltage Pinhole Detector, “or-equal.”
    b. Thick Film Coatings:
        1) Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
        2) Equipment: As recommended by coating manufacturer.
    c. After repaired and recoated areas have dried sufficiently, retest each repaired area.
3. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.

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4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.10 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. As required to resolve field problems attributable to or associated with manufacturer's product.
4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.11 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.12 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Paint System Data Sheet (PSDS).
2. Paint Product Data Sheet (PPDS).

END OF SECTION

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PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

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PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:_____ max.:_____

Surface Temperature Limitations: min.:_____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

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SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
4. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
5. Occupational Safety and Health Act (OSHA).
6. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Samples: One full size for each type of nameplate, sign, valve tag, and label specified.

B. Informational Submittals: Manufacturer’s installation instructions.

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PART 2 PRODUCTS

2.01 GRAPHIC DISPLAY PANEL

A. Design and Construction: As detailed on the Drawings.

B. Fabricate in accordance with reviewed Shop Drawings and Samples.

2.02 DOOR NAMEPLATES

A. Material: Plastic with square corners.

B. Thickness: 1/8 inch.

C. Height: 2 inches.

D. Finish: Nondirectional matte.

E. Background: Black.

F. Letters: Raised.

1. Size: 1 inch high.
2. Color: White.
3. Style: Helvetica Regular upper case.
4. Message Text: As shown on the Panel Drawings.

G. Manufacturers and Products:

1. Best Sign Systems, Montrose, CO; Graphic Blast.
2. Andco Industries Corp., Greensboro, NC; 1400 series.

2.03 SIGN TYPES

A. Plastic Sign (Type A):

1. Exterior: Laminated plastic subsurface image type, 3/16 inch thick with high-gloss finish.
2. Interior: Plastic, 1/8 inch thick with nondirectional matte finish and raised letters.
3. Rounded corners.

B. Metal Sign (Type B):

1. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.

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2. Manufacturers:
   a. Seton Identification Products.
   b. Nutheme Illustrated Safety Co.

C. Fiberglass Sign (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8 inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.
2. Manufacturers:
   a. Best Sign Systems.
   b. Brady Signmark.

2.04 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.
5. Message: Piping system name as indicated on Piping Schedule.
6. Manufacturers and Products:
   a. Brady Signmark; B-946 Self-Sticking Vinyl Pipe Markers and Directional Flow Arrow Tape.
   b. Seton Identification Products; Opti-Code Markers and Directional Arrows.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: White engraved**,** 3/4-inch minimum high.
3. Background: Black**.**
4. Materials:
   a. Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
   b. Multi-layered acrylic.
5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
6. Size:
   a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
   b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.

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8. Manufacturers:
   a. Brady Signmark.
   b. Seton Identification Products.

2.05 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.

C. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

D. Manufacturer's standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer's recommendations.

B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors with self-sticking adhesive. See Panel Drawings for locations and messages.

B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

3.03 SIGNS

A. General:

1. Fasten to walls or posts, or hang as scheduled.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

3.04 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.

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3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
6. Install in accordance with manufacturer's instructions.

B. Equipment Labels: Locate and install on equipment.

END OF SECTION

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SECTION 26 05 01
ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway Transportation Officials (AASHTO).
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. Electronic Industries Association (EIA/TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Electrical Contractor's Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
6. National Electrical Manufacturers Association (NEMA):
   a. C80.1, Rigid Steel Conduit-Zinc-Coated.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   c. PB 1, Panelboards.
   d. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   e. ST 20, Dry Type Transformers for General Applications.
   f. WC 55, Instrumentation Cables and Thermocouple Wire.
   g. WC 70, Standard for Non-Shielded Power Cables Rated 2,000 V or Less for the Distribution of Electrical Energy.
   h. WC 71, Standard for Non-Shielded Cables Rated 2,001-5,000 Volts for use in the Distribution of Electrical Energy.
7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

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8. UL:
    a. 6, Electrical Rigid Metal Conduit—Steel.
    b. 62, Flexible Cord and Fixture Wire.
    c. 67, Panelboards.
    d. 360, Liquid-Tight Flexible Steel Conduit.
    e. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
    f. 486C, Splicing Wire Connectors.
    g. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
    h. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
    i. 514B, Fittings for Cable and Conduit.
    j. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fibre Members.
    k. 1561, Dry-Type General Purpose and Power Transformers.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

1.03 SUBMITTALS

A. Action Submittals:

1. Junction and pullboxes: Manufacturer’s product literature and descriptive information.
2. Panelboards:
    a. Manufacturer’s product literature and descriptive information for the panelboard, and each type of protective device, accessory, and component.
    b. Shop drawings, including dimensional plan, section, elevation, and general arrangement.
    c. Tabulation of features including the following:
        1) Protective devices with factory settings.
        2) Provisions for future protective devices.
        3) Space for future protective devices.
        4) Voltage, frequency, and phase ratings.
        5) Enclosure type.
        6) Bus and terminal bar configurations and current ratings.
        7) Provisions for circuit terminations with wire range.
        8) Short circuit current rating of assembled panelboard at system voltage.
        9) Features, characteristics, ratings, and factory settings of auxiliary components.

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3. Transformers:
   a. Manufacturer's product literature and descriptive information.
   b. Dimensions and weight.
   c. Nameplate data, including efficiency.
   d. Schematic and connection diagram.
4. Circuit breakers.
   a. Manufacturer's product literature and descriptive information.
   b. Manufacturer's letter of approval for modification to existing equipment.
5. Support and framing channels: Manufacturer's product literature and descriptive information.
6. Nameplates:
   a. Manufacturer's product literature and descriptive information.
   b. Nameplate schedule.
7. Conduit, fittings, and accessories.
   a. Manufacturer's product literature and descriptive information.
   b. Equipment and machinery proposed for bending metal conduit.
   c. Proposed list of die heads, shows and tools for proper installation of PVC-coated conduit.
8. Conductors, cable, and accessories:
   a. Manufacturer's product literature and descriptive information.
   b. Size and Ratings.
   c. Cable pulling calculations for sizes that cannot be hand pulled.
9. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test reports.
3. Field test reports.
4. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
5. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
   c. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

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1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.

1.05 QUALIFICATIONS

A. PVC-Coated, Rigid Steel Conduit Installer: Must be certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

B. Testing Firm Qualifications: Professionally independent of manufacturers, suppliers, and installers, or electrical equipment and systems being tested.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall comply with all applicable provisions of NFPA 70.

B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s service.

C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature per Section 01 61 00, Common Product Requirements.

D. Equipment Finish:

1. Manufacturer’s standard finish color, except where specific color is indicated.
2. If manufacturer has no standard color, finish equipment in accordance with Section 09 90 00, Painting and Coating.

2.02 JUNCTION AND PULL BOXES

A. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

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B. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel, with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

2.03 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB 1, NFPA 70, and UL 67.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current as indicated on the Drawings.

E. Cabinet:

1. NEMA 250, Type 1.
2. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Wiring Gutter: Minimum 4-inch square; both sides, top, and bottom.
4. Front: Fastened with adjustable clamps.
   a. Trim Size: As required by mounting.
   b. Finish: Manufacturer’s standard.
5. Interior:
   a. Factory assembled; complete with circuit breakers.
   b. Spaces: Cover openings with easily removable metal cover.
6. Door Hinges: Concealed.
7. Locking Device:
   a. Flush type.
   b. Doors Over 30 Inches in Height: Multipoint.
   c. Identical keylocks, with two milled keys each lock.
8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

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F. Bus Bar:

1. Material: Copper full sized throughout length.
2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
4. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
   c. Subfeed or through-feed lugs as shown.

G. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.
4. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
5. Do not use tandem or dual circuit breakers in normal single-pole spaces.

H. Manufacturers:

1. Eaton.
2. ABB - General Electric Industrial.
3. Schneider Electric - Square D.

2.04 DRY TYPE POWER TRANSFORMERS (0-VOLT TO 600-VOLT PRIMARY)

A. Type: Self-cooled, two-winding.

B. UL 1561 and NEMA ST 20.

C. Insulation Class, Temperature Rise, and Impedance: Manufacturer’s standard.

D. Core and Coil: Encapsulated.

E. Enclosure: NEMA 250, Type 2, ventilated.

F. Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

G. Sound Level: Not to exceed NEMA ST 20 levels.

H. Vibration isolators to minimize and isolate sound transmission.

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I. Manufacturers:

1. ABB - General Electric Solutions.
2. Eaton.
3. Schneider Electric - Square D.
4. Siemens.

2.05 CIRCUIT BREAKER, 0-VOLT TO 600 VOLTS

A. UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: Matched to the equipment's rating that the breaker is installed within.

C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Manufacturers: Matched to existing equipment installed within.

2.06 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12 gauge, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

2.07 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment: Adhesive.

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C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
2. Equipment and Panelboards: 1/4 inch.

2.08 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
   a. Meet requirements of NEMA C80.1 and UL 6.
   b. Exterior Finish: PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2 mils nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to either interior or exterior coating.

C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

D. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized.

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3. PVC-Coated Rigid Galvanized Steel Conduit:
   a. Meet requirements of UL 514B.
   b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
   c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
   d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
   e. Overlapping pressure sealing sleeves.
   f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
   g. Manufacturers:
      1) Robroy Industries.
      2) Ocal.
   h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
4. Flexible Metal, Liquid-Tight Conduit:
   a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
   b. Insulated throat and sealing O-rings.

2.09 CONDUIT ACCESSORIES

A. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.

B. Raceway Band:

1. Slip-on Type:
   a. Provide heat-shrinkable, black, medium-wall polyolefin tubing with factory-applied adhesive/sealant. Select product size based upon raceway outside diameter.
   b. Manufacturer and Product: 3M; Type IMCSN, medium wall cable sleeve.
2. Wrap-around Type:
   a. Provide 4-inch width, 20-mil thickness, nonprinted black PVC corrosion protection tape with primer.
   b. Manufacturer and Product: 3M; Type Scotchrap 51 with Scotchrap Pipe Primer.

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C. Penetration Sealant:

1. General:
   a. Uniform, homogeneous.
   b. Free from lumps, skins, and coarse particles when mixed.
   c. Nonstaining, nonbleeding.
   d. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
   e. Unless specifically noted, match the color of the wall.
2. Type 5—One-part Polyurethane, Immersible:
   a. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
   b. Capable of being continuously immersed in water.
   c. Manufacturers and Products for Nonsag:
      1) Sika Corp.; Sikaflex-1a.
      2) Tremco; Vulkem 116.
   d. Manufacturers and Products for Self-leveling:
      1) Master Builders Solutions Construction Systems US; MasterSeal SL-1.
      2) Tremco; Vulkem 45SSL.
      3) Sika Corp.; Sikaflex-1c SL.

2.10 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, NEMA WC 72, and NEMA WC 74.
2. Conductor Type:
   a. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
   b. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
   c. All Other Circuits: Stranded copper.
3. Insulation: Type XHHW-2.
4. Flexible Cords and Cables:
   a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.

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B. 600-Volt Rated Cable:

1. General:
   a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   c. Suitable for installation in open air, in cable trays, or conduit.
   d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
   e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
2. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   a. Outer Jacket: 45 mils nominal thickness.
   b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   c. Dimension: 0.31-inch nominal outside diameter.
   d. Conductors:
      1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
      2) 20 AWG, seven-strand tinned copper drain wire.
      3) Insulation: 15 mils nominal PVC.
      4) Jacket: 4 mils nominal nylon.
      5) Color Code: Pair conductors black and red.
   e. Manufacturer: Okonite Co.

C. Type 31 Shielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6A UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6A requirements.
2. Overall Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5e.
4. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and black PVC jacket.
5. NFPA 70 Riser (CMR) and Outdoor (CMX) rated.

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6. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
7. All cables shall be marked with a unique identifier at each end.
8. Manufacturer and Product: Belden; 2149A.

D. Accessories:

1. Tape:
   a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
   c. Arc and Fireproofing:
      1) 30 mils, elastomer.
      2) Manufacturers and Products:
         a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
         b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
2. Identification Devices:
   a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturer and Products: Raychem; Type D-SCE or Type ZH-SCE.
3. Connectors and Terminations:
   a. Nylon, Self-Insulated Crimp Connectors:
      1) Manufacturers and Products:
         a) Thomas & Betts; Sta-Kon.
         b) Burndy; Insulug.
         c) ILSCO.
4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Product:
      1) Thomas & Betts.
      2) Ideal; Twister.
5. Cable Lugs:
   a. In accordance with NEMA CC 1.
   b. Rated 600 volts of same material as conductor metal.
   c. Uninsulated Crimp Connectors and Terminators:
      1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

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2) Manufacturers and Products:
a) Thomas & Betts; Color-Keyed.
b) Burndy; Hydent.
c) ILSCO.

d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
1) Manufacturers and Products:
a) Thomas & Betts; Locktite.
b) Burndy; Quiklug.
c) ILSCO.

6. Cable Ties:
a. Nylon, adjustable, self-locking, and reusable.
b. Manufacturer and Product: Thomas & Betts; TY-RAP.

7. Heat Shrinkable Insulation:
a. Thermally stabilized, crosslinked polyolefin.
b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.11 GROUNDING

A. Ground Conductors: As specified in Article Conductors and Cable.

PART 3 EXECUTION

3.01 GENERAL

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

B. Work shall comply with all applicable provisions of NECA 1.

C. Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.

D. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 DEMOLITION

A. General Demolition:

1. Where shown, de-energize and disconnect nonelectrical equipment for removal by others.
2. Where shown, de-energize, disconnect, and remove electrical equipment.

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3. Remove affected circuits and raceways back to serving panelboard or control panel. Where affected circuits are consolidated with others, remove raceways back to first shared condulet or box. Where underground or embedded raceways are to be abandoned, remove raceway to 1 inch below surface of structure or 12 inches belowgrade and restore existing surface.

3.03 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

B. Cap conduit runs during construction with manufactured seals.

C. Close openings in boxes or equipment during construction.

D. Energize space heaters furnished with equipment.

E. Box NEMA Type: as shown on the Drawings.

3.04 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

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J. At or Belowgrade:

1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

K. Mounting Hardware Material: as shown on the Drawings.

L. NEMA Type: as shown on the Drawings.

M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.05 PANELBOARDS

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor, unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard, new and modified.

3.06 DRY TYPE POWER TRANSFORMERS (0-VOLT TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture-proof flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets where required.

3.07 SUPPORT AND FRAMING CHANNELS

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Material Type: as shown on the Drawings.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

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3.08 NAMEPLATES

A. Provide identifying nameplate on all equipment.

3.09 CONDUIT AND FITTINGS

A. General:

1. Crushed or deformed raceways not permitted.
2. Maintain raceway entirely free of obstructions and moisture.
3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
6. Group raceways installed in same area.
7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
10. Install watertight fittings in outdoor, underground, or wet locations.
11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
13. Do not install raceways in concrete equipment pads, foundations, or beams.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and data cables in strict conformance with the requirements of EIA/TIA 569.
17. Columns and Beams:
    a. Trade size of conduit not to exceed one-fourth of beam thickness.
    b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross-section.

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B. Conduit Application:

1. Diameter:
   a. Interior Minimum: 3/4 inch.
   b. Exterior Minimum: 3/4 inch.
2. Material: as shown on the Drawings.

C. Connections:

1. For motors-mounted, wall-mounted, or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
   a. General: Flexible metal, liquid-tight conduit.
   b. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
2. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
3. Transition From Underground or Concrete Embedded to Exposed: PVC coated rigid steel.

D. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
4. Vertical installations shall use nonsag (Grade NS) joint sealant.
5. Horizontal installations shall use self-leveling (Grade P) joint sealants.
6. Entering Structures:
   a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
   c. Heating, Ventilating, and Air Conditioning Equipment:
      1) Penetrate equipment in area established by manufacturer.
      2) Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
      3) Seal penetration with Type 5 sealant.

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d. Corrosive-Sensitive Areas:
   1) Seal all conduit passing through corrosive environment walls.
   2) Seal conduit entering equipment panelboards and field panels containing electronic equipment.
   3) Seal penetration with Type 5 sealant.
e. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
f. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.
   2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.
g. Handholes:
   1) Metallic Raceways: Provide insulated grounding bushings.
   2) Nonmetallic Raceways: Provide bell ends flush with wall.

E. Support:

1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.
2. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 20 percent extra space for future conduit.
3. Application/Type of Conduit Strap:
   a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
   b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
   c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
4. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   a. Wood: Wood screws.
   b. Hollow Masonry Units: Toggle bolts.
   c. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
   d. Steelwork: Machine screws.
   e. Location/Type of Hardware: as shown on the Drawings.

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F. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
3. Install with symmetrical bends or cast metal fittings.
4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
7. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

G. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.

H. PVC-Coated Rigid Steel Conduit:

1. Install in accordance with manufacturer's instructions.
2. All tools and equipment used in the cutting, bending, threading, and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
3. Provide PVC boot to cover all exposed threading.

I. Termination at Enclosures:

1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
3. Sheet Metal Boxes, Cabinets, and Enclosures:
    a. Rigid Galvanized Conduit:
        1) Provide one lock nut each on inside and outside of enclosure.
        2) Install grounding bushing.
        3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.

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4) Install insulated bushing on ends of conduit where grounding is not required.
5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
6) Terminate conduits with threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.

b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
c. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.

4. Free-Standing Enclosures:
a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
b. Terminate PVC conduit entering bottom with bell end fittings.

J. Empty Raceways:

1. Provide permanent, removable cap over each end.
2. Provide PVC plug with pull tab for underground raceways with end bells.
3. Provide nylon pull cord.
4. Identify, as specified in Paragraph Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

K. Identification Devices:

1. Raceway Tags:
a. Identify Raceway Schedule designation. Where Raceway tag is not provided, identify by the origin and destination.
b. Install at each terminus, each penetration, near midpoint, and at minimum intervals of every 50 feet of exposed raceway, whether in ceiling space or surface mounted.
c. Provide corrosion-resistant wire for attachment.

L. Raceway Band: Install wherever metallic conduit emerges from concrete slabs. Not required with PVC-coated RGS conduit. Center band at slab surface and install according to manufacturer’s instructions.

1. Slip-on Type: Clean conduit surface at installation location. Cut tubing to 4-inch minimum lengths and slip onto raceway prior to slab placement and termination of conduit. Heat-shrink onto conduit.

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2. Wrap-around Type: Use where slip-on access to conduit is not possible. Clean conduit surface at installation location. Apply primer. Apply wraps to provide two layers of tape. Neatly finish tape end to prevent unraveling.

3.10 CONDUCTORS AND CABLES

A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.

B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.

D. Terminate all conductors and cables, unless otherwise shown.

E. Do not splice conductors, unless specifically indicated or approved by Engineer.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.

H. Power Conductor Color Coding:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
    a. Neutral Wire: White.
    b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
    c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
    d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
    e. Ground Wire: Green.

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I. Circuit Identification:

1. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
2. Circuits Not Appearing in Circuit Schedules: Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.11 GROUNDING

A. Grounding shall be in compliance with NFPA 70 and as shown.

B. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

C. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

D. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

E. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

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3.12 FIELD QUALITY CONTROL

A. Tests shall be performed in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. General:

1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
2. Test instrument calibration shall be in accordance with NETA ATS.
3. Perform inspection and electrical tests after equipment has been installed.
4. Perform tests with apparatus de-energized whenever feasible.
5. Inspection and electrical tests on energized equipment are to be:
    a. Scheduled with Engineer prior to de-energization.
    b. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

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K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
5. Replace missing or damaged hardware.

O. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.

P. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.

Q. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

R. Balance electrical load between phases on panelboards after installation.

END OF SECTION

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SECTION 35 20 16.25
FABRICATED SLIDE GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. There are no new slide gates being provided or installed as part of this scope of work. This scope of work is limited to the refurbishment of existing gates, and replacement of damaged or in-operable parts, specifically:

1. Basin side wall slide gates.
2. Channel flow isolation gate.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA): C561, Fabricated Stainless Steel Slide Gates.
2. ASTM International (ASTM):
   a. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.

1.03 DEFINITIONS

A. Self-Contained: The arrangement of gate operator, supported by gate frame, such that operating thrust loads are not applied external to the assembly.

B. Submersible: The ability to exclude water when submerged under a 20-foot head of fresh water for 24 hours and still maintain electrical integrity.

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1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction, specifically for any new materials provided such as guides or seal materials.
   b. Product Data sheets for each model or repair kit.

B. Informational Submittals:

1. Service records for maintenance performed during construction.
2. Manufacturer's written/printed installation instructions.
3. Functional and performance testing documents.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Leakage shall not exceed 0.1 gallon per minute per foot of gate periphery under either seating or unseating head conditions.

2.02 BASIN SIDE WALL SLIDE GATES

A. The Basin Side Wall Slide Gates are located in the Aeration Basins as identified on the Drawings.

B. The existing gates are stainless steel, upward-acting wall surface mounted.

C. Replace the slide seals with EPDM resilient neoprene or UHMW polyethylene bearing strip in a retainer slot on the downstream side (unseating head side) of the gate.

D. Clean hardware and lubricate operators.

E. See Drawings for size and number of gates.

2.03 CHANNEL FLOW ISOLATION GATES

A. The Channel Flow Isolation Gates are located in the mixed liquor channel between the Aeration Basins and Secondary Clarifiers.

B. The existing gates are stainless steel, upward-acting channel mounted gates.

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C. Replace slide gate seals with UHMW polyethylene bearing strip in a retainer slot on the downstream side (unseating head side) of the gate.

D. Replace manual geared crank-operator and pedestal.

1. Mount actuator on high strength cast iron pedestal, torque tube, or baseplate, machined and drilled ready for bolting to the operating floor, top wall mounting bracket, or gate yoke as required.
2. Sealed, ball thrust or tapered roller bearings, located above and below operating nut flange to support opening and closing thrusts, equipped with bronze lift nut internally threaded with Acme threads.
3. Gears: Accurately machined steel, with cut teeth to provide smooth and proper operation. Stainless steel pinion shaft.
4. Furnish mechanical seals at housing penetrations and input pinions with needle or ball bearings and grease lubrication fittings for bearings.
5. Crank and Gear Housing:
    a. Material: Cast iron.
    b. Maximum Crank Radius: 15 inches.
    c. Manual Effort: Not to exceed 40 pounds.
    d. Suitable for operation by portable electric drill after removal of crank.

E. Clean and lubricate gate assembly.

F. See Drawings for size and number of gates.

G. Provide new Identification Tags for each gate:

1. For each gate operator, 1-1/2-inch minimum diameter heavy brass tag, bearing the gate tag number shown in the schedule.
2. Attach the tags to the operator by soldered split key rings to that ring and tag cannot be removed. Use block type numbers and letters with 1/4-inch minimum high numbers and letters stamped on and filled with black enamel.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with the manufacturer’s written instructions.

B. Lubricate stems before operating.

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3.02 FIELD QUALITY CONTROL

A. Provide a repair and maintenance report for each slide gate identifying parts replace, parts refurbished, adjustments made and ware parts lubricated.

B. Perform Functional Tests: Conduct on each slide gate.

C. Performance Test:

1. Conduct on each slide gate.
2. Perform under actual or approved simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Adjust, realign, or modify units and retest if necessary.

END OF SECTION

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SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping; B31.3, Process Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
   a. International Building Code (IBC).
   b. International Mechanical Code (IMC).
5. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1-foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Calculations for each type of pipe support, attachment and anchor.

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3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Maintenance information on piping support system.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Post-Installed Concrete Anchors:
   a. See Structural Notes on the Drawings for the following information:
      1) Manufacture product description and installation instructions.
      2) Current ICC-ES Report for each type to be used.
      3) Adhesive anchor installer certification.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a registered professional engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems for pipes 30 inches and smaller throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required, and shall be designed by the Contractor; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.3 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on the Structural General Drawings.

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3. Wind loads in accordance with governing codes and as shown on the Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
    a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
    b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
5. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Material Classification Table on the Drawings for pipe support materials of construction based upon function area.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

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B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1-inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Figure 2000.

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B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. B-Line; Figure B3095, sizes 1 inch through 36 inches with Figure B3088S base.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

2.06 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

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2.07 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.08 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.09 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.10 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

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2.11 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.

2.12 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.
   b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

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E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts:
   a. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, styrofoam fillers, and end caps.
   b. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer's standard to match insert.
   c. Manufacturers and Products:
      1) Power-Strut, Wayne, MI; PS 349 Series.
      2) B-Line Systems, Inc., Highland, IL; B32 Series.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.

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4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3 inches.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:
      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.
   b. Floor Mounted Channel Supports:
      1) Use for pipe smaller than 3 inches running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.
   c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

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4. Insulated Pipe:
    a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
    b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
    c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
    a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
    a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

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E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 SUPPLEMENTS

A. There are no supplements listed as part of this specification. See Materials Classification Table on the Drawings for pipe support materials of construction based upon function area.

END OF SECTION

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SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
3. American Society of Mechanical Engineers (ASME):
    a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
    b. B1.20.1, Pipe Threads, General Purpose (Inch).
    c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Class 25, Class 125, and Class 250.
    d. B16.3, Malleable Iron Threaded Fittings Class 150 and Class 300.
    e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
    f. B16.9, Factory-Made Wrought Buttwelding Fittings.
    g. B16.11, Forged Fittings, Socket-Welding and Threaded.
    h. B16.15, Cast Copper Alloy Threaded Fittings Class 125 and Class 250.
    i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
    j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
    k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, Class 300, Class 600, Class 900, Class 1500, and Class 2500.
    l. B16.25, Buttwelding Ends.
    m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Class 150 and Class 300.
    n. B31.1, Power Piping.
    o. B31.3, Process Piping.
    p. B31.9, Building Services Piping.
    q. B36.10M, Welded and Seamless Wrought Steel Pipe.
4. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

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5. American Water Works Association (AWWA):
    a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
    b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
    c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
    d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
    f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
    g. C153/A21.53, Ductile-Iron Compact Fittings.
    h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inches Through 144 Inches (100 mm Through 3,600 mm).
    i. C606, Grooved and Shouldered Joints.
6. American Welding Society (AWS):
    a. Brazing Handbook.
    b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
    c. D1.1/D1.1M, Structural Welding Code - Steel.
    d. QC1, Standard for AWS Certification of Welding Inspectors.
7. ASTM International (ASTM):
    a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
    b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
    d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
    e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
    g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
    h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
    j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.

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l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
n. A197/A197M, Standard Specification for Cupola Malleable Iron.
o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
r. A276, Standard Specification for Stainless Steel Bars and Shapes.
s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 pounds per square inch Tensile Strength.
u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

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gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
hh. B32, Standard Specification for Solder Metal.
ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
jj. B61, Standard Specification for Steam or Valve Bronze Castings.
kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
ll. B75/B75M, Standard Specification for Seamless Copper Tube.
mm. B88, Standard Specification for Seamless Copper Water Tube.
nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
ww. D1330, Standard Specification for Rubber Sheet Gaskets.
xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, Schedule 80, and Schedule 120.
zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
aaa. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

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bbb. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ccc. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ddd. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
eee. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
fff. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
ggg. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
hhh. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
iii. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
jjj. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
kkk. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
lll. F436, Standard Specification for Hardened Steel Washers.
mmm. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
nnn. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ooo. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedule 40 and Schedule 80.
ppp. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
qqq. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
rrr. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

8. FM Global (FM).
9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP 43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
10. NSF International (NSF): 61 Drinking Water System Components—Health Effects.
11. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
12. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

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1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Top face of channel walls and cover slabs.
   b. Top face of aeration basin walkways.
   c. Liquid surface or within 2 feet above top of liquid surface.
   d. Top of tank wall or under tank cover.
   e. Or other damp locations.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
4. Pipe Corrosion Protection: Product data.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.
4. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
5. Nondestructive inspection and testing procedures.
6. Test logs.
7. Pipe coating applicator certification.
8. CWI inspection records and NDE test records.
9. Torquing requirements and procedures, including torque values, for flanged piping assemblies.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Form QW-482 and Form QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).

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4. Contractor's CWI: Certified in accordance with AWS QC1 and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.

1. The presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

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2.02 PIPING

A. As specified on Piping Data Sheet(s) and on Piping Schedule located on the Drawings.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 JOINTS

A. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on the Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher-pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

D. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 pounds per square inch minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1-degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

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E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Fernco Joint Sealer Co.
   b. "Or-equal."

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. Insulating Flanges, Couplings, and Unions:

1. Materials:
   a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
   a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   b. Bolt insulating sleeves shall be provided full length between insulating washers.
   c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
   d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
   e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.

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4. Flange Insulating Kits:
    a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
    b. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA LI-1, G-10 grade).
    c. Insulating Washers: Fiberglass-reinforced epoxy (NEMA LI-1, G-10 grade)
    d. Washers:
        1) General Service: Hardened steel, ASTM F436, 1/8-inch thick.
        2) Immersion Service: Type 316 stainless steel, 1/8-inch thick.
        3) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
        4) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.
5. Manufacturers and Products:
    a. Dielectric Flanges and Unions:
        1) PSI, Houston, TX.
        2) Advance Products and Systems, Lafayette, LA.
    b. Insulating Couplings:
        1) Dresser; STAB-39.
        2) Baker Coupling Company, Inc.; Series 216.

2.06 VENT AND DRAIN VALVES

A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.07 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.
2. Manufacturer’s identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

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2.08 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Piping Schedule, and Section 09 90 00, Painting and Coating.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions, except for damaged glass-lined pipe that is to be promptly removed from Site.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.

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C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1-inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Post-welding Treatment of Stainless Steel: Examine welding area for any iron deposits and remove them. Clean welding area from any impurities other than iron deposits and remove heat tint. Re-passivate the welding area per ASTM A380 and per ASTM A967. Repeat for external and internal surfaces.

J. Weld Quality: Meet requirements of governing welding codes.

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3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but, if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. Manufacturer: Same as pipe manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer's latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer's standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer's latest published installation instructions.

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F. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

H. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

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E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1-inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

G. Provide stainless steel bird screen on open pipe ends connected to process piping (such as, vent piping), unless otherwise indicated on the Drawings. Attach bird screen with ring flange, threaded connection or other applicable pipe fitting.

3.06 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Submerged or Embedded: As specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

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B. Stainless Steel Pipe:

1. Exposed: No additional corrosion protection required.
2. Submerged: No additional corrosion protection required.
3. Under Insulation: As listed on Piping Schedule on the Drawings and specified in Section 09 90 00, Painting and Coating.

C. Copper Pipe:

1. Exposed: As listed on Piping Schedule on the Drawings and specified in Section 09 90 00, Painting and Coating.

D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Connections to existing metallic iron and steel pipe.
   c. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   b. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

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3.07 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.08 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.09 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.10 PIPE IDENTIFICATION

A. As specified in Section 10 14 00, Signage, and in Section 09 90 00, Painting and Coating.

3.11 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.

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4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code ASME B31.3 for Normal Fluid Service.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.12 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. Immediately after cleaning service piping, dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.

D. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

F. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

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3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings—General Service
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings
40 27 00.20	Stainless Steel Pipe and Fittings—Thin Wall

END OF SECTION

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SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Buried Liquid Service Using Mechanical or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 3 and Table 5 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-Mortar: AWWA C104/A21.4 with asphaltic seal coat. Use only for liquid service.

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SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Fittings	Lined and coated same as pipe. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face or ASME B16.1, Class 250 raised face. Gray cast iron will not be allowed.
Joints	Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 250 psi minimum working pressure. American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex or HP Lok. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic. Flange: Dimensions per AWWA C110/A21.10 flat face, or ASME B16.1, Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.
Couplings	Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.

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SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436, Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Mechanical, and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. Flanged, Water, Sewage and Hot Air Services: Full face, 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D1330. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

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SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints.
	Threaded: 2" & smaller	Standard weight.
	Welded: 2" thru 20"	Standard weight.
	Grooved: 2-1/2" thru 12"	Standard weight.
Lining (where indicated on Piping Schedule)	2" & larger	Ceramic Epoxy: Pipe and fittings to be ceramic-epoxy lined shall not have been previously lined. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line with a total dry film thickness of 40 mils of ceramic epoxy. Ceramic epoxy shall be amine-cured Novolac epoxy with 20 percent minimum volume ceramic quartz pigment, Protecto 401 by Induron Coating, “or-equal”, for sewer service. Ceramapure by Induron Coating, “or-equal”, for NSF 61 and potable water service. Lining shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining thickness shall be tested using a magnetic film thickness gauge. Lining integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test.

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SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Joints	2" & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
	2" & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
Fittings	2" & smaller	Threaded: 150-pound or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed.
	2" & larger	Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47/A47M, ductile iron ASTM A536, forged steel ASTM A234/A234M, or factory fabricated from ASTM A53/A53M pipe. Grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products.
Branch Connections	1-1/2" & smaller	For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet.
	2" & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.

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SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Flanges	1-1/2" & smaller	Forged carbon steel, ASTM A105/A105M, ASME B16.5, Class 150 socket-weld or threaded, raised face. When mating flange is flat face, provide flat face.
	2" & larger	Butt-Welded Systems Standard Flange (RFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5, Class 150 slip-on or welding neck, raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Butt-Welded Systems Standard Flange (FFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5, Class 150 slip-on or welding neck, flat face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Use when mating flange is plastic. Butt-Welded Systems Blind Flange: Forged carbon steel, ASTM A105/A105M, ASME B16.5, Class 150 or Class 300, facing to match mating flange. Grooved End Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment. Cast Iron Mating Flange: AWWA C207, Class D or E, to mate with ASME B16.1, Class 125 cast-iron flange. AWWA C207 Class F or ASTM A105/A105M, ASME B16.5, Class 300 flat face to mate with ASME B16.1, Class 250 cast-iron flange.

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SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Unions	1-1/2" & smaller	Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150-pound or 300-pound WOG, meeting the requirements of ASME B16.3.
Couplings	2" & larger	Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products. Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M.
Bolting	All	Flanges: Carbon steel ASTM A307, Grade B heavy hex or stud bolts; ASTM A563, Grade A heavy hex head nuts. Torque bolts per gasket manufacturer recommendations. When mating flange on equipment is cast iron or plastic, provide ASTM A307, Grade B hex head or stud bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.

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SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Gaskets	All flanges	Water, Steam, and Air Services: Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D1330, NSF 61. Use only with raised face flanges. Use full-face or ring type gasket for raised-face flange. Fuel Gas Service: Full face, 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated 250 degrees F continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade. Use only with flat face flanges. Mating Flange: Cast iron or plastic. Full face, 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D1330. NSF 61 approved for potable water service. Insulating Gasket: ASME B16.21 and ASME 16.5, fabric reinforced phenolic neoprene faced gasket, sleeves, washers, CL150, 1/8-inch thick, 175 degrees F Step-Ko Type E DW, or approved equal. Grooved Couplings: EPDM per coupling manufacturer standard.
Thread Lubricant	1-1/2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

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SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	4" & smaller	Buttwelded Pipe, Schedule 40S: ASTM A312/A312M, Grade TP316/316L dual marked, seamless, pickled and passivated. Threaded Pipe, Schedule 80S: ASTM A312/A312M, Grade TP316/316L dual marked, seamless, pickled and passivated.
	6" thru 24"	Schedule 10S: ASTM A312/A312M, Grade TP316/316L, dual marked, seamless or welded pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	4" & smaller	Threaded, socket weld or flanged at equipment as required or shown.
	6" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting.
Fittings	1-1/2" & smaller	Threaded or socket weld: Forged ASTM A182/A182M, Grade F316, conforming to MSS SP-114 Class 1000.
	2" & 4"	Butt Welded: ASTM A403/A403M, Grade WP316/316L-S dual marked, conforming to ASME B16.9, annealed, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	6" thru 24"	Butt-Welded: ASTM A403/A403M, Grade WP316/316L dual marked, conforming to ASME 16.9, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.

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SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.
Branch Connections	4" & smaller	Tee or reducing tee in conformance with fittings above.
	6" & larger	Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	Stainless Steel: AWWA C228, Class SD, 316/316L. or ASTM A182/A182M, Grade F316/316L, ASME B16.5 Class 150, flat face, weld neck, threaded, blind, or slip-on. Weld slip-on flanges inside and outside. Weld neck bore to match internal pipe diameter.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, CL 3000, integral ground seats, AAR design meeting the requirements of MSS SP-83.
Bolting/Nuts	All	Flanges: AWWA C228, Type 316 stainless steel, ASTM A193/A193M Grade B8M, Class 2 heavy hex head or stud bolts and ASTM A194/A194M Grade 8M nuts. Torque bolts per gasket manufacturer recommendations.

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SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Gaskets	All Flanges	Flanged, Water, Hot Air, and Sewage Services: Full face, 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade.
Thread Lubricant (fittings)	1 1/2" & smaller	General Service: Nickel pigmented PTFE, designed for stainless steel pipe, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

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SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	Seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 as follows: Water (buried) .....Type K, soft or hard temper Water (exposed) .....Type L, hard drawn Domestic hot water.....Type L, hard drawn Compressed air service.....Type L, hard drawn P-Trap priming service.....Type L, soft temper Sample line service.....Type L, hard drawn
Fittings	ASTM B75/B75M commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Class 150, ASTM B75/B75M commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	Copper hex head bolts, hex head nuts and washers per ASTM F467 and/or ASTM F468 be used. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	1/16-inch-thick nonasbestos compression type, full face, Cranite, John Manville.
Solder	Joints 2-1/2-Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger Than 2-1/2-Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or Grade HN. Do not use cored solder.

END OF SECTION

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SECTION 40 27 00.20
STAINLESS STEEL PIPE AND FITTINGS—THIN WALL

Item	Size	Description
Pipe	12" & smaller	Schedule 10S Roll Groove: ASTM A778, "as-welded" grade, Type 316/316L, pickled, and passivated.
	14" & larger	Schedule 10S Wedge Groove: ASTM A778, "as-welded" grade, Type 316/316L, pickled, and passivated.
Joints	All	Butt welded or Flanged
Fittings	All	Fabricated, Butt-Welded: ASTM A774/A774M Grade 316L conforming to MSS SP 43, "as-welded" grade, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise. Wedge groove ends.
Flanges	All	Van Stone type with stainless-steel, butt-welded stub ends with raised face, lapped joint, ANSI Class 150, ASTM A240/A240M, Type 316L "as-welded grade," conforming to ASME B16.9, pickled, and passivayed, wall thickness same as pipe. Backing flange red primer epoxy same material as pipe. Blind flanges, exposed to atmosphere and not buried nor immersed in liquid, shall be stainless steel.
Bolting/Nuts	All	Flanges: AWWA C228, Type 316 stainless steel, ASTM A193/A193M Grade B8M, Class 2 heavy hex head or stud bolts and ASTM A194/A194M Grade 8M nuts. Torque bolts per gasket manufacturer recommendations.

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SECTION 40 27 00.20
STAINLESS STEEL PIPE AND FITTINGS—THIN WALL

Item	Size	Description
Gaskets	Flanges	Flanged, Water and Sewage Service: 1/8-inch thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D1330, Grade 1 and Grade 2. Flanged, Hot Air and Fuel Gas Service: 1/8-inch thick, unless otherwise specified, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 300 degrees F, conforming to ASME B16.21 and ASTM D1330 Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

END OF SECTION

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SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Class 25, Class 125, and Class 250.
   b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 pounds per square inch.
2. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 Inches (75 mm) Through 72 Inches (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-Inch Through 24-Inch (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   k. C542, Electric Motor Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

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e. B61, Standard Specification for Steam or Valve Bronze Castings.
f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

4. FM Global (FM).
5. Manufacturers Standardization Society (MSS):
   a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
   b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   d. SP-88, Diaphragm Valves.
   e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. UL.
8. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

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c. Power and control wiring diagrams, including terminals and numbers.
d. For each actuator provided, manufacturer's standard data sheet, with application specific features and options clearly identified.
e. Sizing calculations for open-close/throttle and modulating valves.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
   a. Butterfly valves; full compliance with AWWA C504.
3. Tests and inspection data.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on the Drawings.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

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2.02 VALVE SCHEDULES

A. Additional requirements relative to this section are shown on Pneumatically-Actuated Valve Schedule, Self-Regulated Valve Schedule, Phase 1 Manual Valve Schedule and Phase 2 Manual Valve Schedule located on the Drawings.

2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

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2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
2. Type V151 Bonneted Knife Gate Valve with Resilient Seats 24 Inches and Smaller:
   a. Full bonneted wafer body type, carbon steel body, stainless steel bonnet with carbon steel exterior stiffeners, outside stem and yoke, rated for 150 pounds per square inch cold water, ASME B16.1 flanged ends, self-cleaning, uni-direction flow, with flush and drain ports, resilient neoprene seat.
   b. Wetted metal parts and stem, Type 316 stainless steel, metal seat, yoke sleeve carbon steel, stem nut bronze, gate finish ground both sides with a sharp knife edge.
   c. Packing system leak-tight seal around gate, valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual or power actuator.
   d. In compliance with MSS SP-81.
   e. Manufacturers and Products:
      1) DeZurik; Hilton H-200-B.
      2) "Or approved equal."

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B. Ball Valves:

1. Type V306 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 pounds per square inch gauge CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
2. Type V309 Instrument Air Shutoff Valve 1/8-Inch to 3/4-Inch:
   a. For Stainless Steel Tubing: Stainless steel body and ball, nylon handle, tube fitting ends stainless steel, PTFE seats and seals, stainless steel panel nut, rated 1,500 pounds per square inch minimum.
   b. For Copper Tubing: Brass body and ball, nylon handle, tube fitting ends brass, PTFE seats and seals, brass panel nut, rated 1,500 pounds per square inch minimum.
   c. Manufacturers and Products:
      1) Swagelok; 40 Series.
      2) Parker Hannifin; B Series.

C. Plug Valves:

1. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
   a. Nonlubricated type rated 175 pounds per square inch gauge CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
   b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.
   c. Epoxy coating and lining per AWWA C550.

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d. Operators:
   1) 3-Inch to 4-Inch Valves: Wrench lever manual.
   2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.

e. Manufacturers and Products:
   1) Pratt; Ballcentric.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 600.

D. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on the Drawings or specified herein.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on the Drawings or specified herein.

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2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, EPDM rubber seat, and stainless steel seating surface.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Triton XR-70.
      2) DeZurik; AWWA Valve.
3. Type V501 Butterfly Valve Water Works Service 30 Inches to 72 Inches:
   a. AWWA C504, Class 25 A.
   b. Short body type, flanged ends.
   c. Cast-iron body, ductile iron disc with Type 316 stainless steel seating edge, Type 316 stainless steel shafts, EPDM rubber seat.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Model Triton XR-70.
      2) DeZurik; BAW AWWA Valve.
4. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 12 Inches for Low Pressure Process Air Service:
   a. Lug style stainless steel body, stainless steel discs, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 pounds per square inch working pressure rating, bubble-tight at 50 pounds per square inch differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 21.
      2) “Or approved equal.”
5. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
   a. ASME B16.1 Class 150 lug style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, RTFE seat, PTFE stem packing, stainless steel with RTFE thrust washer.
   b. Manufacturers and Products:
      1) Bray Series 41 lugged style high performance butterfly valve.
      2) “Or approved equal.”

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E. Self-Regulated Automatic Valves:

1. Type V706 Controls Air Pressure-Reducing Valve 1/2 Inches valve body:
   a. Direct-operated regulator, spring controlled, stainless steel body with filter and internal relief, with drain valve and optional valve body mounted pressure gauge.
   b. NPT threaded ends, 250 pounds per square inch gauge rated minimum.
   c. Size/Rating: 1/2-inch, as shown in Valve Schedule**.**
   d. Manufacturers and Products:
      1) Fisher; Type 67DFSR.
      2) "Or approved equal."

F. Miscellaneous Valves:

1. Type V916 Cast Stainless Steel Mud Valve 4 Inches to 20 Inches:
   a. Heavy-duty CF8M stainless steel yoke, flange, guides, and gate; SBR rubber seat mechanically retained with Type 316 stainless steel fasteners, nonrising stem. Stainless steel casting to be passivated per ASTM A380. Type 316 stainless steel one-piece stem with integral thrust collar and coated with antigalling compound.
   b. 2-inch operating nut**.** Stem guides Type 316 stainless steel with bronze bushings for L/R of 200 maximum. Cast top and bottom stem couplings Type 316 stainless steel.
   c. Manufacturers:
      1) Troy Valve.
      2) Trumbull Industries, Inc.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.

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e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.

2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.

B. Pneumatic Actuators:

1. General:
   a. Actuator complete with air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories.
   b. Suitable for full operation range of valve at air supply pressure indicated.
   c. Position indication and stop limiting devices on all actuators.
2. Vane Style Actuator:
   a. In compliance with AWWA C541.
   b. Air supply of 80 pounds per square inch gauge.
   c. Pressure die-cast aluminum housing with corrosion resistant fusion bonded epoxy finish, stainless steel bolting, stainless steel adjustable end stops.
   d. Electroless nickel-plated steel shaft and vane, single-component machined or cast part.
   e. Dual-opposed polyurethane lip seals with stainless steel expander.
   f. Double Acting:
      1) Fail last position.
      2) Complete with mounting hardware.
      3) Suitable for non-lubrication air.
   g. Spring Return: None required, actuators to fail last position on loss of air.
   h. Geared Manual Override: Geared type with de-clutchable handwheel, torque rated for application.
   i. Visual Indicator: High visibility, OPEN-CLOSED indication, color coded, chemical resistant, clear polycarbonate cover.
   j. Manufacturers:
      1) Kinetrol.
      2) "Or approved equal."

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k. Accessories:
   1) Air Set: Pressure regulator with internal relief, 5 micron filter, outlet pressure gauge, and adjustable reduced pressure range as required by valve actuator.
      a) Stainless Steel body and handwheel.
      b) Safety vented lockout isolation valve.
      c) Gauge range 1-1/3 to 2 times maximum operating pressure.
      d) Manufacturers and Products:
         (1) Bray series 55.
         (2) "Or approved equal."
   2) Air Exhaust Muffler:
      a) In the exhaust port of actuator pilot solenoid valves.
      b) Manufacturers and Products:
         (1) Barry Wright Corp.
         (2) Allied Witan Co.
   3) Limit Switch:
      a) Single-pole, double-throw (SPDT) type, rated 10 amps at 120V ac.
      b) Housed in NEMA 4X enclosure.
      c) Adjustable for OPEN and CLOSED valve positions.
   4) Positioner:
      a) For modulating actuators, shall be pneumatic force balance instruments to control valve position as a function of input signal. Accomplish positive positioning of valve by a mechanical feedback connection from valve actuating mechanism. Position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Positioner suitable for double acting or spring return actuator.
      b) Positioner to have zero and span adjustment and be field reversible for direct or reverse action.
      c) Gauges for supply and output pressure and for input signal pressure.
      d) Positioner for 4 mA to 20 mA dc input signal as indicated. Hold valve in last position on loss of signal below 3.8 mA.
      e) Positioner for dc input signal with transducers shall convert electrical signal to appropriate pneumatic signal. Transducer integral with positioner or separate component. If separate, factory mount transducer on pneumatic operator. Line electric power not required for transducer.

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f) Positioner to provide 4 mA to 20 mA dc isolated output valve position signal, capable of driving into loads of up to 500 ohms as 24V dc.
g) Corrosion-resistant enclosures for positioners and transducers to be splash-proof and moisture-proof with gasketed covers.
h) Manufacture and Products:
(1) Bray series 6A electro-pneumatic positioner.
(2) "Or approved equal."

5) Pilot Solenoid Valve:
a) Solenoid valve shall pilot control actuator in appropriate configuration for type of open-close actuator being controlled. Double acting actuator shall have four-way solenoid valve, and spring return actuator shall have three-way solenoid valve. Dual coil valve shall not change position unless one coil is energized while the other is de-energized.
b) Pilot operated diaphragm type solenoid valve with brass body and resilient seat. Valve with minimum operating pressure differential no greater than 10 pounds per square inch gauge and maximum operating pressure differential no less than 150 pounds per square inch gauge. Internal parts corrosion-resistant. Solenoid valve to have Class F molded coils for operation on 120V ac, 60 Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.
c) Manufacturers and Products:
(1) Asco Red Hat.
(2) C. A. Norgren Co.

l. Open-Close and Throttling Valve:
1) Double Acting Cylinders: Four-way solenoid with dual coils.
2) Spring Return Cylinders: Three-way solenoids, spring return.

m. Modulating Valve: Positioner with 4 mA to 20 mA input signal, unless otherwise indicated.
n. Control Features: Pneumatic actuators with features noted in the Pneumatic Actuated Valve Schedule.

3. Diaphragm Actuator:
a. Spring return with steel or aluminum diaphragm case and spring barrel, steel spring and actuator stem, and fabric-reinforced neoprene diaphragm.

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b. Actuators used on quarter-turn valves to include a totally enclosed valve actuating mechanism. Actuating mechanism to be factory lubricated and sealed.
c. Diaphragm actuators sized and configured for service indicated and air supply pressure of 35 pounds per square inch gauge.
d. Manufacturers and Products:
    1) Fisher Controls; Type 1051.
    2) "Or approved equal."
e. Accessories:
    1) Air Set: Pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by valve actuator.
        a) Stainless Steel body and handwheel.
        b) Safety vented lockout isolation valve.
    2) Gauge range 1-1/3 to 2 times maximum operating pressure.
        a) Manufacturers and Products:
            (1) Fisher Controls; Type 67 CSFR.
            (2) "Or approved equal."
    3) Air Exhaust Muffler:
        a) In the exhaust port of actuator pilot solenoid valves.
        b) Manufacturers and Products:
            (1) Barry Wright Corp.
            (2) Allied Witan Co.
    4) Limit Switch:
        a) Single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac.
        b) Housed in NEMA 4X enclosure.
        c) Adjustable for OPEN and CLOSED valve positions.
    5) Positioner:
        a) For modulating actuators, shall be pneumatic force balance instruments to control valve position as a function of input signal. Accomplish positive positioning of valve by a mechanical feedback connection from valve actuating mechanism. Position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Positioner suitable for double acting or spring return actuator.
        b) Positioner to have zero and span adjustment and be field reversible for direct or reverse action.
        c) Gauges for supply and output pressure and for input signal pressure.
        d) Positioner for 3 pounds per square inch gauge to 15 pounds per square inch gauge pneumatic input signal or 4 mA to 20 mA dc input signal as indicated.

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e) Positioner for dc input signal with transducers shall convert electrical signal to appropriate pneumatic signal. Transducer integral with positioner or separate component. If separate, factory mount transducer on pneumatic operator. Line electric power not required for transducer.

f) Corrosion-resistant enclosures for positioners and transducers to be splash-proof and moisture-proof with gasketed covers.

6) Pilot Solenoid Valve:

a) Solenoid valve shall pilot control actuator in appropriate configuration for type of open-close actuator being controlled. Double acting actuator shall have four-way solenoid valve, and spring return actuator shall have three-way solenoid valve. Dual coil valve shall not change position unless one coil is energized while the other is de-energized.

b) Pilot operated diaphragm type solenoid valve with brass body and resilient seat. Valve with minimum operating pressure differential no greater than 10 pounds per square inch gauge and maximum operating pressure differential no less than 150 pounds per square inch gauge. Internal parts corrosion-resistant. Solenoid valve to have Class F molded coils for operation on 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.

c) Manufacturers and Products:

(1) Asco Red Hat.

(2) C. A. Norgren Co.

f. Open-Close and Throttling Valve:

1) Double Acting Cylinders: Four-way solenoid with dual coils.

2) Spring Return Cylinders: Three-way solenoids, spring return.

g. Modulating Valve: Positioner with 4 mA to 20 mA input signal, unless otherwise indicated.

h. Control Features: Pneumatic actuators with features noted in the Pneumatic Actuated Valve Schedule.

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2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy stainless steel tag attached with No. 16 stainless steel jack chain for each valve operator and valve, bearing valve tag number shown on Pneumatic Actuated Valve Schedule, Self-Regulated Valve Schedule, and Manual Valve Schedule on the Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 10 amps, 120 volts ac.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound or thread tape.

C. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer’s recommendations.
   d. Where replacing existing valve install in same orientation as valve being replaced, and re-use existing valve operator unless directed otherwise on the Drawings.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

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3. Eccentric Plug Valves:
    a. Unless otherwise restricted or shown on the Drawings, install valve as follows:
        1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
        2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
        3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).
4. Butterfly Valves:
    a. Unless otherwise restricted or shown on the Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
    b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
    c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
    d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
    e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
5. Check Valves:
    a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
    b. Install valve in vertical flow (up) piping only for gas services.
    c. Install swing check valve with shaft in horizontal position.
    d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
6. Solenoid Valves: Install in accordance with manufacturer's instructions.

D. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

E. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

F. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

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G. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

H. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

I. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 FIELD FINISHING

A. Field finish per Section 09 90 00, Painting and coating.

3.03 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1-gpm per foot of seat periphery.

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3.04 MANUFACTURER'S SERVICES

A. Valve(s) as listed below require manufacturer's field services: Pneumatically controlled valves.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

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SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. UL.

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1.02 SUBMITTALS

A. Action Submittals: Manufacturer's descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02-perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

2.02 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

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2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
    a. Knauf Insulation; Proto 1000.
    b. Johns Manville; Zeston 2000 or 300.
    c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
    a. Manufacturer and Product: Armacell; WB Armaflex finish.
2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, Alloy 5005, Alloy 1100, or Alloy 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
    a. RPR Products; Insul-Mate.
    b. ITW, Pabco-Childers.

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PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

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D. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

E. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.
2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
   a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

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3.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Service and Insulation Thickness Table.

END OF SECTION

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Service and Insulation Thickness								
					Finish Systems			
Service Type	**Pipe Legend**	**Thickness**	**Fluid Temperature (degrees F)***	**Insulation**	**Concealed from View**	**Indoors Exposed**	**Outdoors**	**Buried**
Air Low Pressure	ALP	Pipe Size: Insulation Thickness Inches:* 0.5 to 3: 1 3.5 to 10: 1.5 12 to 20: 2 Or ASHRAE 90.1, whichever results in thickest insulation requirement.	40 - 250	Type 2 Insulate exposed indoor and outdoor piping, where applicable.	None	Match existing if not available then F1.	F3	None
PE–Personnel Exposure		ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish	F3 below 8'	F3	NA
Use these fluid temperatures unless otherwise noted in the Piping Schedule. Inches: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding.								

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SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Certifications of Calibration: Testing equipment.
2. Certified Test Report.
3. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

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4. New Piping Connected to Existing Piping:
    a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
    b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
6. Test Pressure: As indicated on Piping Schedule on the Drawings.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25-foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection**.**

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C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 pounds per square inch gauge maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

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3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 PNUEMATIC TESTING FOR DIFFUSER MEMBRANES

A. Test each basin diffuser zone individually.

1. Fill basin with enough water to cover the diffusers with at least 1-foot of water, but not more than 2-foot of water.
2. Confirm all diffuser zones in the basin are isolated by having manual ALP manifold valves closed on all zones.
3. Then for the single zone being tested open the manual ALP isolation valve, followed by slowly opening the ALP control valve to provide an ALP flow rate of about 2 SCFM per diffuser in the zone being tested.
4. Visually inspect each leg of the diffuser manifold in the basin looking for air leaks at manifold joints and membrane holders. Also visually inspect for air leaks around edges of diffuser holders and membranes.
5. If leaks are identified, note on piping plan or tag in basin with flagging before moving on to test other zones in the same basin.
    a. Once all zones in a basin have been leak tested, and if leaks are found drain basin enough to gain dry access to leaks and repair.
    b. Once all leaks have been repaired, refill basin to water testing level and retest all zones in a basin, repeat until all zones in a single basin pass with no leaks identified.
6. Once all zones in a basin have passed the leak testing, then submit a report documenting the testing, leaks which were identified and corrective actions taken.

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3.05 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace, and retest as specified.

3.06 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by third party at start of each testing day. Engineer will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 pounds per square inch or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

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B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 pounds per square inch greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 pounds per square inch to 2.5 pounds per square inch greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

Table 1*

A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

Example: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace, and retest as specified.

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3.07 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer or Engineer's agent to represent that test has been satisfactorily completed.

END OF SECTION

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SECTION 40 90 00
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 01 91 14, Equipment Testing and Facility Startup.
2. Section 01 31 13, Project Coordination.
3. Section 40 91 00, Instrumentation and Control Components.
4. Section 40 95 80, Fiber Optic Communication System.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Drawings, including but not limited to, loop wiring diagrams, network diagrams, detailed panel drawings, and others specified hereinafter.
3. New Analyzer Control Panels, and new Control Panels, reference Analyzer Control Panel Schedule and Control Panel Schedule in Article Supplements. Finalize design and fabrication of analyzer and control panels.
4. Network installation and testing including: Fiber optic communications network between control panel CP-3B in the RAS building and the Aeration Basin Remote Input/Output panels including fiber cables, patch panels, and network switches.
5. Coordination with Applications Software:
    a. The Engineer will provide Application Software for PLC programming, and SCADA HMI displays and functions. Work related to supporting this activity includes:
        1) Early delivery of programming equipment to Engineer’s office.
        2) Coordinating PLC input and output assignments, scheduling, testing, and startup.
        3) Assist with onsite software testing to verify proper equipment operation.

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6. Applications Software:
    a. Provided by Engineer for the following:
        1) New RAS PLC: PLC3B, CP-3B-RIO-1, CP-3B-RIO-2, and CP-3B-RIO-3.
        2) Modifications to PLC3A, for communications to PLC-3B.
        3) Modifications to the Plantwide HMI for work included under this Contract, specifically the Aeration Basin improvements and RAS flow control modifications. As defined in the loop descriptions and herein.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and other PIC subsections:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
    a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
    b. A276, Standard Specification for Stainless Steel Bars and Shapes.
    c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
    d. B32, Standard Specification for Solder Metal.
    e. B88, Standard Specification for Seamless Copper Water Tube.
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. International Society of Automation (ISA):
    a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
    b. S5.1, Instrumentation Symbols and Identification.
    c. S5.4, Instrument Loop Diagrams.
    d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
    e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
    f. TR18.2 Management of Alarm Systems for the Process Industries
    g. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
    h. TR101.01 HMI Philosophy.

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6. International Conference on Energy Conversion and Application (ICECA).
7. National Electrical Code (NEC).
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.
9. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
10. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
11. UL: 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. ACP: Analyzer Control Panel.
2. CP: Control Panel
3. FDT: Factory Demonstration Test.
4. FSAT: Factory Software Acceptance Test.
5. FT: Functional Test.
6. HMI: Human-Machine Interface.
7. HVAC: Heating, Ventilating, and Air Conditioning.
8. I&C: Instrumentation and Control.
9. I/O: Input and Output.
10. LCP: Local Control Panel.
11. MCC: Motor Control Center.
12. NIP: Network Interface Panel.
13. O&M: Operation and Maintenance.
14. P&ID: Process and Instrument Diagram.
15. PC: Personal Computer.
16. PIC: Process Instrumentation and Control.
17. PLC: Programmable Logic Controller.
18. POE: Power over Ethernet.
19. PT: Performance Test.
20. RIO: Remote Input and Output.
21. RTU: Remote Terminal Unit.
22. SCADA: Supervisory Control and Data Acquisition.
23. UPS: Uninterruptible Power Supply.

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B. Application Software:

1. Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:
   a. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
   b. Programming in any programming or scripting language.

C. Enclosure: Control panel, console, cabinet, or instrument housing.

D. Instructor Day: Eight hours of actual instruction time.

E. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

F. Signal Types:

1. Analog Signal, Current Type:
   a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signal, Voltage Type: 1-volt to 5 volts dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Industrial Ethernet — PROFINET Communication Signals:
   a. PROFINET communication signal is used for digital data exchange between PLCs, distributed I/O, motor control centers, VFDs, and intelligent field devices.
   b. Conform to IEC 61158, IEC 61784-2, and PI (PROFIBUS & PROFINET International) implementation guidelines.

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c. Use industrial grade, shielded twisted-pair copper cabling rated Category 5e or better, installed per manufacturer and PI installation standards.

6. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.
   a. HART.
   b. Memosens.
   c. Modbus TCP.

G. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, and fieldbus devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware for PIC.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

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B. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
   e. Verify readiness for operation.
   f. Verify correctness of final power and signal connections (lugging and connecting).
   g. Adjusting and calibrating.
   h. Starting up.
   i. Testing and coordination of testing.
   j. Training.
   k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.
2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Motor control centers.
      3) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

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1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01 33 00, Submittal Procedures, and this section.

B. General:

1. Submit proposed submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
    a. Hard Copy: Not required, unless otherwise noted for specific items.
    b. Electronic Copies: Required for all submittals.
        1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
        2) Documents created specifically for Project:
            a) Text and Graphics: Microsoft Word.
            b) Lists: Microsoft Excel, unless otherwise noted for specific items.
            c) Drawings:
                (1) Preliminary: Adobe Acrobat PDF.
                (2) As-built record Drawings: Adobe Acrobat PDF and AutoCAD in DWG format. All external references shall be bound, and all custom fonts and plot style tables (CTB/STB) shall be included to ensure proper plotting.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
    a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
    b. Use identical abbreviations in PIC subsections.
    c. Submit updated versions as they occur.
6. Activity Completion:
    a. Action Submittals: Completed when reviewed and approved.
    b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

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7. For each submittal pertaining to instrumentation provide a list of instruments being covered by the submittal, this list to include the following information:
   a. Instrument's name.
   b. Instrument's description.
   c. Instrument's component code.
   d. Instrument's calibrated range or setpoint(s).
   e. Standard detail used for installation.
8. Furnish the submittals with the information required by each section of this specification.

Submittal Requirements	Topic/Title	Additional Information
1.05.B.1	Submittal Breakdown	Schedule for and breakdown of proposed submittals to be submitted.
1.05.C.1	Bill of Material	Complete schedule of materials and equipment used in the manufactured design (Bill of Materials).
1.05.C.2	Catalog Cuts	Product Selection and Information Sheets (Datasheets or manufacturer cutsheets).
1.05.C.3	Component Data Sheets	ISA Compliant datasheets, fully completed electronic and hard copy version for each instrument or component.
1.05.C.4	Panel Construction Drawings	Panel dimensional drawings including mounting, lifting, finished data, legend (BOM included), nameplates, and general equipment layout.
1.05.C.5	Panel Wiring Diagrams	Panel wiring diagrams for discrete control and power circuits.
1.05.C.6	Panel Power Requirements and Heat Dissipation	Control panel calculations for power consumption and heat dissipation.
1.05.C.7	Panel Plumbing Diagrams	Plumbing Diagrams for each panel containing piping and tubing.
1.05.C.8	Installation Details	Additional details required for adequate installation of I&C components.

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Submittal Requirements	Topic/Title	Additional Information
1.05.C.9	Spares and expendables	List of spares and recommend equipment.
1.05.C.10	PLC I/O List	Updated I/O list to reflect actual equipment provided.
1.05.D.1	Statements of Qualification	PICS contractor qualifications.
1.05.D.2	O&M Manuals	Operation and Maintenance Manuals.
1.05.D.3	MCOPI	Manufacturer's Certificate of Proper Installation
1.05.D.4	Testing	PICS test forms: Preliminary and final forms. Completed test reports.
1.05.D.5	Training	General Training plan & schedule.

C. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: PDF and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.

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c. External power and signal connections.
d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

3. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content: Specific features and configuration data for each component, including but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Setpoints.
      8) Materials of construction.
      9) Options included.
      10) Power requirements.
      11) Signal interfaces.
      12) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.
   c. Electronic Copies: PDF and Microsoft Excel.
4. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
   f. Submittal Format: Electronic copies for all intermediate submittals. Refer to Article Submittals, heading Submittal Format
      1) Approved final as-built drawings to be provided to the Owner in both electronic and hard copies. A set of hard copies to be kept in control panel.

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2) Final electronic copies to be submitted in both AutoCAD and PDF formats.

5. Panel Wiring Diagrams:
   a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.
   c. Diagram Type:
      1) Ladder diagrams where applicable in a format similar to those shown on the Drawings. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
      2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.
   d. Item Identification: Identify each item with attributes listed.
      1) Wires: Wire number and color. Cable number if part of multiconductor cable.
      2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
      3) Components:
         a) Tag number, terminal numbers, and location ("FIELD," enclosure number, or MCC number).
         b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
      4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
      5) Relay Coils:
         a) Tag number and its function.
         b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
      6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
      7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
   e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.

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f. Ground wires, surge protectors, and connections.
g. Wire and Cable Names: Show names for circuits entering and leaving a panel. Refer to Division 26, Electrical.

6. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
   a. Required voltages, currents, and phases(s).
   b. Maximum heat dissipations Btu per hour.
   c. Calculations.
   d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 110 degrees F.
7. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
   a. Pipes and Tubes: Thickness, pressure rating, and materials.
   b. Components: Valves, regulators, and filters.
   c. Connections to panel-mounted devices.
   d. Panel interface connections.
   e. Submittal Format: Electronic copies for all intermediate submittals. Refer to Article Submittals, heading Submittal Format
      1) Approved final as-built drawings to be provided to the Owner in both electronic and hard copies.
      2) Final electronic copies to be submitted in both AutoCAD and PDF formats.
8. Installation Details: Include modifications or further details required and define installation of I&C components.
9. Spares, expendables, and test equipment.
10. Electronic Copies: Microsoft Excel.
11. PLC I/O List:
    a. Managed by Engineer:
       1) During construction Engineer will maintain PLC I/O List and give electronic Microsoft Excel copies to PIC System Integrator.
       2) Engineer will assign PLC I/O points to specific chassis, slot, and point addresses.
    b. PLC I/O List Changes: Changes to PLC I/O List reflecting actual equipment and instrumentation provided.
       1) Mark up electronic file of latest PLC I/O List from Engineer. Highlight changed cells with yellow, new rows with red, and rows to be deleted with green.
       2) Submit marked up copies changes at 30-day intervals.

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D. Informational Submittals:

1. Statements of Qualification:
   a. PIC System Integrator.
   b. PIC System Integrator's site representative.
   c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
2. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
   a. General:
      1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
      2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
   b. Final versions of Legend and Abbreviation Lists.
   c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
   d. Provide the following items as defined under heading Action Submittals:
      1) Bill of materials.
      2) Catalog cuts.
      3) Instrument list.
      4) Component data sheets.
      5) Detailed Wiring Diagrams: As-built drawings.
         a) Panel wiring diagrams.
      6) Panel plumbing diagrams.
   e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
      1) Content for Each O&M Manual:
         a) Table of Contents.
         b) Operations procedures.
         c) Installation requirements and procedures.
         d) Maintenance requirements and procedures.
         e) Troubleshooting procedures.
         f) Calibration procedures.
         g) Internal schematic and wiring diagrams.
         h) Component and I/O Module Calibration Sheets from field quality control calibrations.
      2) Provide PDF file will linked index to all manuals.

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f. List of spares, expendables, test equipment and tools provided.
g. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

3. Provide Manufacturer's Certificate of Proper Installation where specified.
4. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed off test results.
   b. Functional Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation:
         a) Copy of signed-off test results.
         b) Completed component calibration sheets.
   c. Performance Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results.
5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers' Field Services.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.

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2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by Engineer:
   a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
   b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
2. Test Prerequisite: Associated test procedures Submittals completed.
3. Training Prerequisite: Associated training plan Submittal completed.
4. PLC Equipment Delivered to Engineer's office:
   a. Refer to PIC subsections for a definition of this equipment.
   b. Prerequisite: Approved Bill of Materials.
   c. Duration: 6 weeks.

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5. PLC3B and HMI Applications Software Configuring and Testing by Engineer:
    a. Prerequisite: PLC Input and Output assignments complete and documented.
    b. Duration: 6 weeks.
6. Panels CP-3B, CP-3B-RIO-1, CP-3B-RIO-2, and CP-3B-RIO-3 Shipment to Site:
    a. General Prerequisites:
        1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
        2) FDT completed.
7. CP-3B, CP-3B-RIO-1, and CP-3B-RIO-3 Panel Installations Prerequisite:
    a. Equipment received at Site.
8. CP-3B-RIO-2 Panel Installation Prerequisite:
    a. Equipment received at Site.
    b. Upgrades to first two Aeration Basins complete
9. Functional Test Part 1 Prerequisite:
    a. Phase 1: CP-3B, CP-3B-RIO-1, and CP-3B-RIO-3 Panel installations complete.
    b. Phase 2: CP-3B-RIO-2 Panel installation complete.
10. Functional Test Part 2 Prerequisite:
    a. Phase 1 Functional Test Part 1 complete.
    b. Phase 2 Functional Test Part 1 complete.
11. Performance Test Prerequisite:
    a. Phase 1 Functional Test Part 2 complete.
    b. Phase 2 Functional Test Part 2 complete.
    c. Phase 3: Complete testing of entire system once both phase 1 and phase 2 FT2 tests are completed.

1.09 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

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C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	1
Fuses	20	10
Relays	20	3
Terminal Blocks	10	10
Surge Suppressors	10	1
Component (Code)	**Quantity**	**Options**
Dissolved Oxygen Element, Luminescent (A20)	2	Range: 0.0 - 5.0 mg/L
Flow Element and Transmitter, Thermal Mass Flow(F51)	1	Range: 0.0 – 1,200.0 SCFM
Pressure Gauge (P04)	1	Range: 0-15 PSI

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Corrosion-inhibiting vapor capsules.
2. DO probe overhaul kits: Two.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on the Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software (except for Engineer provided applications software), whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals."

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2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC Equipment List in Article, Supplements, and PLC components in Section 40 91 00, Instrumentation and Control Components.

2.04 FIELD BUS, NETWORK, AND HMI COMPONENTS

A. Reference PIC subsections.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions:

1. The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
   a. Inside:
      1) Temperature: 40 degrees F to 95 degrees F.
      2) Relative Humidity: 10 percent to 95 percent noncondensing.
      3) NEC Classification: Nonhazardous.

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b. Outside:
   1) Temperature: Minus 10 degrees F to 110 degrees F.
   2) Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
   3) NEC Classification: Nonhazardous.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, in Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside: NEMA 12.
   b. Smaller Panels and Assemblies (that are not freestanding):
      1) Inside: NEMA 12.
      2) All Other Locations: NEMA 4X.
   c. Field Elements: Outside.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: Refer to Example Control Panel Layouts and Control Panel Schedule drawings.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

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D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on the Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch-high, imposed.
4. Mounting: Affix to component with 16-guage or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on the Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

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2.09 LOOP SPECIFICATIONS

A. See Article Supplements located at End of Section.

B. Organization: By unit process and loop number.

C. Loop Subheadings:

1. Local: Clarifies functional performance of loop for local and hardwired control, for example in MCCs and control panels.
2. Auto: Specifies nonstandard PLC functions.
3. HMI: Specifies nonstandard HMI functions.

2.10 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 01, Electrical.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 01, Electrical.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
   b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: No. 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer’s standard cables.

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5. Wire Identification: Numbered and tagged at each termination.
    a. Wire Tags: Machine printed, heat shrink.
    b. Manufacturers:
        1) Brady Perma Sleev.
        2) Tyco Electronics (TE Connectivity).

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with requirements in Section 26 05 01, Electrical.

F. Terminal Blocks for Enclosures:

1. Quantity:
    a. Accommodate present and spare indicated needs.
    b. Wire spare PLC I/O points to terminal blocks.
    c. One wire per terminal for field wires entering enclosures.
    d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
    e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on the Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
    a. Locate signal ground at dc power supply for loop.
    b. Use to ground wire shields for loop.
    c. Group and ground wire shields in following locations: Ground Bar.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

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I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from nonintrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

J. Wiring Interface: Terminate and identify wiring entering or leaving enclosures.

1. Analog and Discrete Signal Wires: Terminate at numbered terminal blocks as shown on the approved wiring diagrams.
2. Wiring for Special Signals: Terminate communications, digital data, and multiplexed signals using manufacturer’s standard connectors for the device to which the signals terminate.

K. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Provide, install, coordinate, and inspect grounding of surge suppressors at connection of AC power to PIC control panels.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.11 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements for maximum external dimensions allowed for individual control panels.
2. Equipment Arrangements: Refer to Drawings Typical Local Control Panel Layout and Typical Local Control Panel Schedule drawings.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.

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4. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
5. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.
      5) Ventilation Fans:
         a) Furnish where required to provide adequate cooling.
         b) Create positive internal pressure within panel.
         c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
      6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
   b. Minimum Thickness: 12-gauge, unless otherwise noted.

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2. Panel Front:
    a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
    b. No seams or bolt heads visible when viewed from front.
    c. Panel Cutouts: Smoothly finished with rounded edges.
    d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
    a. Structural steel for instrument support and panel bracing.
    b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
    a. Full height, fully gasketed access door where shown on the Drawings.
    b. Latch: Three-point.
    c. Handle: keylocking/padlocking type.
    d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
    e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
    f. Front and Side Access Doors: As shown on the Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
    a. Panels listed as inside:
        1) Enclosure Type: NEMA 12.
        2) Materials: Steel.
    b. Other Panels:
        1) Enclosure Type: NEMA 4X.
        2) Materials: Type 304 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
    a. Rubber-gasketed with continuous hinge.
    b. Stainless steel lockable quick-release clamps.
4. Manufacturers:
        1) Saginaw Control and Engineering.
        2) nVent Hoffman.
        3) Rittal Corp.

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E. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

F. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
      2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
         a) Branch Circuit Breakers: 15 amps at 250V ac.
      3) Breaker Manufacturers and Products:
         a) Allen-Bradley, 1489-A.
         b) Eaton, FAZ-NA.
   c. Circuit Wiring:
      1) P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
         a) Devices on Single Circuit: 20, maximum.
         b) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
         c) Branch Circuit Loading: 12 amperes continuous, maximum.
         d) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
         e) Provide 120V ac plugmold for panel components with line cords.
2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.

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e. RTD and Thermocouple Extension Cable:
   1) Continuous field to panel with no intermediate junction boxes or terminations.
   2) RTDs in motor windings are considered a 600-volt circuit.
   3) Terminate thermocouple extension wire directly to loop instrument.

3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4mA dc to 20mA dc Signals: 0.2 mA, maximum.
      2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched LED lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched LED light.
   b. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in Instrument List:
      1) EMERGENCY STOP: Red.
      2) All Others: Black.
   b. Lettering Color:
      1) Black on white and yellow buttons.
      2) White on black, red, and green buttons.

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10. Standard Light Colors and Inscriptions:
    a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in Instrument List:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

    b. Lettering Color:
        1) Black on white and amber lenses.
        2) White on red and green lenses.

G. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
    a. Locking-fork-tongue or ring-tongue lugs.
    b. Use manufacturer’s recommended tool with required sized anvil to make crimp lug terminations.
    c. Wires terminated in a crimp lug, maximum of one.
    d. Lugs installed on a screw terminal, maximum of two.

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6. Connections to Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Wiring: Provide wiring in accordance with the wire color code, conductor sizes, and overall control-panel wiring practices indicated in the table below, unless otherwise noted.

System	Color	Conductor	Comment
Ground	Green	As Req	
AC Power	Black	As Req	Note 1
AC Neutral	White	As Req	Note 1
Foreign Voltage (ac)	Yellow	As Req	Note 1
Foreign Voltage (dc)	Purple	As Req	Note 1
DC Positive	Blue	14 AWG	With appropriate fusing
DC Negative	White/Blue	14 AWG	With appropriate fusing
DC Digital Input	Brown	18 AWG	
AC Digital Input	Red	18 AWG	
Digital Output	Orange	18 AWG	
Analog Input	White/Clear	18 AWG	Note 2

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System	Color	Conductor	Comment
Analog Output	Red	18 AWG	Note 2
Analog Common	Black	18 AWG	
Note 1: 1) Primary Power Distribution: 12 AWG. 2) Secondary Power Distribution: 14 AWG. 3) Control: 16 AWG.			
Note 2: Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.			

12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with yellow (ac) or purple (dc) insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with yellow (ac) or purple (dc) insulation for any other purpose.
13. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
14. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.
16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

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I. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Nonmetallic Panels: Not painted.
5. Steel Panels: Painted Manufacturer's standard color.

2.12 CONTROL PANELS

A. General: Reference the concept drawing on the Contract Drawings, Control Panel Schedule, and Instrument List in the Article Supplements.

B. Design, coordinate, furnish, and install the following control panels with all components required for a complete and functional system including, but not limited to, components listed in the PLC Equipment List and Instrument List in, Article Supplements:

1. CP-3B.
2. CP-3B-RIO-1.
3. CP-3B-RIO-2.
4. CP-3B-RIO-3.
5. ACP-3261.
6. ACP-3262.
7. ACP-3263.
8. ACP-3264.

2.13 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
   a. Northern Instruments; Model Zerust VC.
   b. Hoffmann Engineering; Model A-HCI.

2.14 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.

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4. Procedures, Forms, and Checklists:
    a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
    b. Describe each test item to be performed.
    c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
    a. Provide special testing materials and equipment.
    b. Wherever possible, perform tests using actual process variables, equipment, and data.
    c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
    d. Define simulation techniques in test procedures.
    e. Test Format: Cause and effect.
        1) Person conducting test initiates an input (cause).
        2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
    a. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator’s facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
    a. Simulate each discrete signal at terminal strip.
    b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O.
6. Correct deficiencies found and complete prior to shipment to Site.
7. Failed Tests:
    a. Repeat and witnessed by Engineer.
    b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
8. Make following documentation available to Engineer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.

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d. Approved hardware Shop Drawings for equipment being tested.
e. Approved preliminary software documentation Submittal.

9. Daily Schedule for FDT:
   a. Begin each day with meeting to review day's test schedule.
   b. End each day with each meeting to review day's test results and to review or revise next day's test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 01, Electrical.

C. Electrical Raceways: As specified in Section 26 05 01, Electrical.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on the Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
   a. Tool-formed without flattening, and of same radius.
   b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
   c. Slope instrument connection tubing in accordance with installation details.

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d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
g. Blow debris from inside of tubing.
h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
k. Provide separate support for components in tubing runs.
l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
m. Keep tubing and conduit runs at least 12 inches from hot pipes.
n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
o. Securely attach tubing raceways to building structural members.

5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

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B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During Functional Test Part 1, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.
2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation. Divide Functional Test for each facility into two parts.
2. Functional Test Part 1: Performed by PIC System Integrator to test and document PIC, excluding Engineer provided applications software, is ready for operation. For PIC Subsystems for which Engineer provides applications software, provide sufficient temporary software configuring to allow testing of these subsystems.
    a. Loop/Component Inspections and Tests:
        1) These inspections and tests do not require witnessing.
        2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
        3) Provide space on forms for signoff by PIC System Integrator.

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4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
   a) Project name.
   b) Loop number.
   c) Tag number for each component.
   d) Checkoffs/Signoffs for Each Component:
      (1) Tag/identification.
      (2) Installation.
      (3) Termination wiring.
      (4) Termination tubing.
      (5) Calibration/adjustment.
   e) Checkoffs/Signoffs for the Loop:
      (1) Panel interface terminations.
      (2) I/O interface terminations with PLCs.
   f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
   g) Total loop operational.
   h) Space for comments.
5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLC I/O module and include the following:
   a) Project name.
   b) Loop number.
   c) Component tag number or I/O module number.
   d) Component code number for I&C elements.
   e) Manufacturer for I&C elements.
   f) Model number/serial number for I&C elements.
   g) Summary of Functional Requirements; For Example:
      (1) Indicators scale and ranges.
      (2) Transmitters/converters, input and output ranges.
      (3) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
      (4) I/O Modules: Input or output.
   h) Calibrations, for example, but not limited to:
      (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
      (2) Discrete Devices: Actual trip points and reset points.
      (3) Controllers: Mode settings (P&ID).

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(4) I/O Modules: Actual inputs or outputs of 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
(5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.
c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.
d. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.

3. Functional Test Part 2: Combined effort between Contractor, PIC System Integrator, and Engineer to confirm PIC, including applications software, is ready for operation.
a. Prerequisite: Completion of Functional Test Part 1.
b. Joint test with Engineer, using real field sensors and equipment. Plant interlocking and communications with PLCs and HMI tested on loop-by-loop basis.
c. Test procedures provided by Engineer based on Functional Test Part 1 and on FSAT tests.
d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

F. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform jointly with Engineer a Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a loop-by-loop, basis.
2. Entire installed PIC system to be tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or

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measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Determination of Ready for Operation: When Functional Test has been completed.
8. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

B. Specialty Equipment: For certain components or systems provided under this section, but not manufactured by PIC System Integrator, provide services of qualified manufacturer's representative during installation, startup, demonstration testing, and training. Provide original equipment manufacturer's services for:

1. Air Flow Meters.
2. Flume Flow Transmitters.
3. Analytical Transmitters.

C. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 TRAINING

A. General:

1. Provide an integrated training program for Owner's personnel.
2. Perform training to meet specific needs of Owner's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.
5. Owner reserves the right to reuse recordings of training sessions.

B. Operations and Maintenance Training:

1. General:
   a. Include review of O&M data.
   b. Use equipment similar to that provided.

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2. Operations Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: One instructor day.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, LOCAL/REMOTE control transfer, LOCAL and REMOTE control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.
3. Maintenance Training:
   a. Training Session Duration: One instructor day.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) I&C components removal and replacement.
      6) Periodic preventive maintenance.

3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

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3.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification.

1. Control Loop Descriptions.
2. Control Panel Schedule.
3. Instrument List.
4. PLC Input/Output List.
5. PLC Equipment List.
6. Preparation for Testing and Functional Test Forms:
    a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
    b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
    c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
7. Performance Test Sheet: Describe Performance Test for a given loop.
    a. List requirements of the loop.
    b. Briefly describe test.
    c. Cite expected results.
    d. Provide space for checkoff by witness.

END OF SECTION

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Control Loop Description	Aeration Basin Air Distribution
Overview:	
Process Description:	

Each of the four aeration basins control air distribution into each of four basin zones. Each zone includes an air flow meter to measure flow to the zone diffusers. The dissolved oxygen is measured in each zone.
Air flow is modulated to maintain a setpoint dissolved oxygen in each zone.

Reference Drawing(s):	P&IDs: 008-N-3201, 008-N-3202, 008-N-3203, 008-N-3204		
Last Update/Review:		**Approved By:**	

Equipment

Unit Equipment:

Equipment Tag No.	Description	Notes
560-3251B	AB1 Zone 2 Control Valve	Pneumatic Actuator
560-3251C	AB1 Zone 3 Control Valve	Pneumatic Actuator
560-3251D	AB1 Zone 4 Control Valve	Pneumatic Actuator
560-3251E	AB1 Zone 5 Control Valve	Pneumatic Actuator
560-3252B	AB2 Zone 2 Control Valve	Pneumatic Actuator
560-3252C	AB2 Zone 3 Control Valve	Pneumatic Actuator
560-3252D	AB2 Zone 4 Control Valve	Pneumatic Actuator
560-3252E	AB2 Zone 5 Control Valve	Pneumatic Actuator
560-3253B	AB3 Zone 2 Control Valve	Pneumatic Actuator
560-3253C	AB3 Zone 3 Control Valve	Pneumatic Actuator
560-3253D	AB3 Zone 4 Control Valve	Pneumatic Actuator
560-3253E	AB3 Zone 5 Control Valve	Pneumatic Actuator
560-3254B	AB4 Zone 2 Control Valve	Pneumatic Actuator
560-3254C	AB4 Zone 3 Control Valve	Pneumatic Actuator
560-3254D	AB4 Zone 4 Control Valve	Pneumatic Actuator
560-3254E	AB4 Zone 5 Control Valve	Pneumatic Actuator

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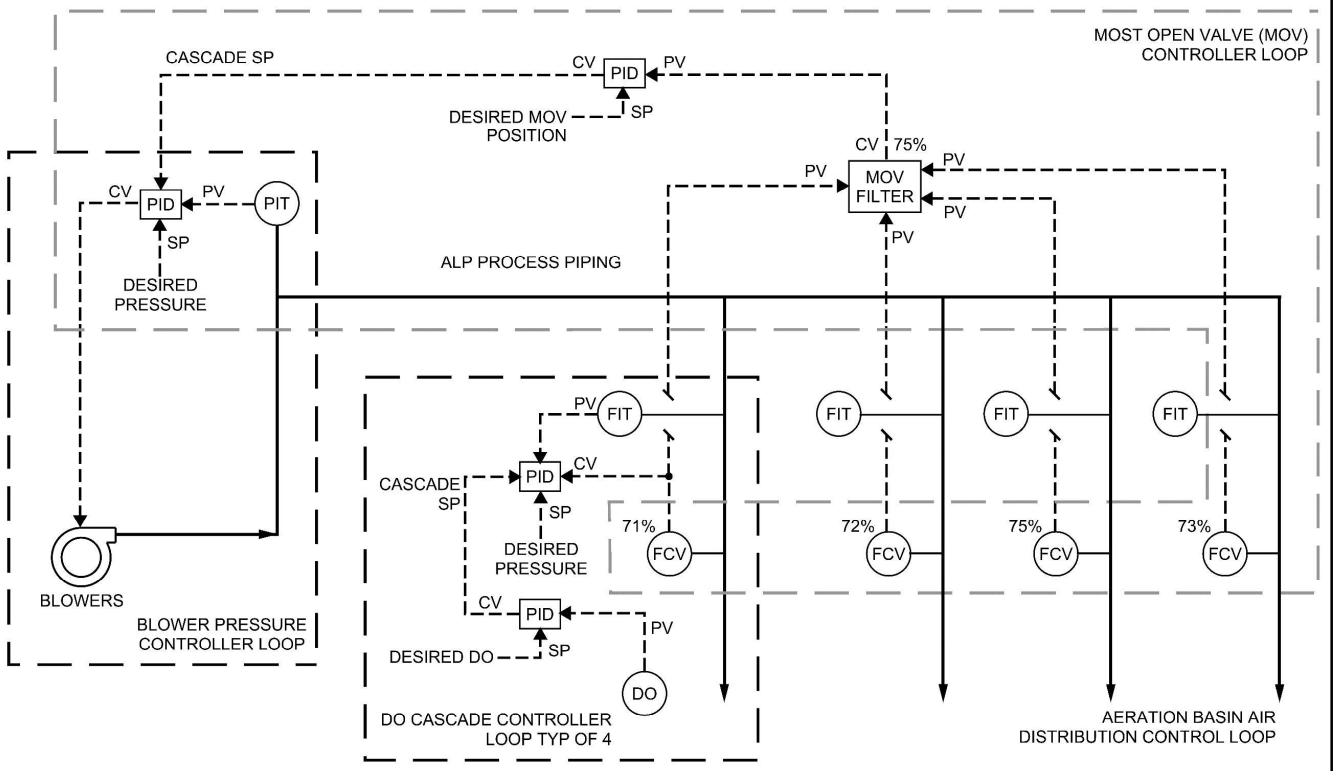
Instrumentation:			
	Instrument Tag No.	**Description**	**Notes**
	AE-3261B	AB1 Zone 2 Dissolved Oxygen Sensor	
	AE-3261C	AB1 Zone 3 Dissolved Oxygen Sensor	
	AE-3261D	AB1 Zone 4 Dissolved Oxygen Sensor	
	AE-3261E	AB1 Zone 5 Dissolved Oxygen Sensor	
	FIT-3251B	AB1 Zone 2 Air Flow Meter	
	FIT-3251C	AB1 Zone 3 Air Flow Meter	
	FIT-3251D	AB1 Zone 4 Air Flow Meter	
	FIT-3251E	AB1 Zone 5 Air Flow Meter	
	AE-3262B	AB2 Zone 2 Dissolved Oxygen Sensor	
	AE-3262C	AB2 Zone 3 Dissolved Oxygen Sensor	
	AE-3262D	AB2 Zone 4 Dissolved Oxygen Sensor	
	AE-3262E	AB2 Zone 5 Dissolved Oxygen Sensor	
	FIT-3252B	AB2 Zone 2 Air Flow Meter	
	FIT-3252C	AB2 Zone 3 Air Flow Meter	
	FIT-3252D	AB2 Zone 4 Air Flow Meter	
	FIT-3252E	AB2 Zone 5 Air Flow Meter	
	AE-3263B	AB3 Zone 2 Dissolved Oxygen Sensor	
	AE-3263C	AB3 Zone 3 Dissolved Oxygen Sensor	
	AE-3263D	AB3 Zone 4 Dissolved Oxygen Sensor	
	AE-3263E	AB3 Zone 5 Dissolved Oxygen Sensor	
	FIT-3253B	AB3 Zone 2 Air Flow Meter	
	FIT-3253C	AB3 Zone 3 Air Flow Meter	
	FIT-3253D	AB3 Zone 4 Air Flow Meter	
	FIT-3253E	AB3 Zone 5 Air Flow Meter	
	AE-3264B	AB4 Zone 2 Dissolved Oxygen Sensor	
	AE-3264C	AB4 Zone 3 Dissolved Oxygen Sensor	
	AE-3264D	AB4 Zone 4 Dissolved Oxygen Sensor	
	AE-3264E	AB4 Zone 5 Dissolved Oxygen Sensor	
	FIT-3254B	AB4 Zone 2 Air Flow Meter	
	FIT-3254C	AB4 Zone 3 Air Flow Meter	
	FIT-3254D	AB4 Zone 4 Air Flow Meter	
	FIT-3254E	AB4 Zone 5 Air Flow Meter	

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Control Strategies

For each zone (cell), a PID controller for dissolved oxygen (D.O.) controls air flow to the zone. The output of the controller is a flow setpoint used for cascade control to a PID controller for air flow. The air flow controller modulates the control valve for that zone. As the D.O. increases, the air flow is reduced, and as D.O. drops, the air flow is raised.

The positions of each control valve in all online basins are monitored and compared. The highest percent open (most open) valve is compared to a most open valve setpoint. If the most open valve is above the setpoint (indicating more air needed) then the blower pressure setpoint is raised a small amount. If the most open valve is below the setpoint minus deadband (indicating less air needed) then the blower pressure setpoint is lowered a small amount After each adjustment to pressure setpoint the system is given time to stabilize before another adjustment is made.



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Local Control Operation and Alarm Reset
VFD Control Panel
NA
Motor Control Center
NA
MFR Control Center
NA
Local Control Station
TBD
SCADA Control Operation and Alarm Reset
SCADA Manual
For each basin air control valve: 1. SCADA adjustment of valve position.
SCADA Auto
For each zone (cell), a PID controller for dissolved oxygen (D.O.) controls air flow to the zone. The output of the controller is a flow setpoint used for cascade control to a PID controller for air flow. The air flow controller modulates the control valve for that zone. As the D.O. increases, the air flow is reduced, and as D.O. drops, the air flow is raised. The positions of each control valve in all online basins are monitored and compared. The highest percent open (most open) valve is compared to a most open valve setpoint. If the most open valve is above the setpoint (indicating more air needed) then the blower pressure setpoint is raised a small amount. If the most open valve is below the setpoint minus deadband (indicating less air needed) then the blower pressure setpoint is lowered a small amount After each adjustment to pressure setpoint the system is given time to stabilize before another adjustment is made.
SCADA Display
Status and Process Display
The HMI will use new face plate HMI graphics and corresponding PLC function blocks. For Each Basin Zone: 1. Dissolved Oxygen. 2. Dissolved Oxygen Controller. 3. Air Flow. 4. Air Flow Controller. 5. Valve Position 6. Most Open Valve Position
Operator Entries
For Each Basin Zone: 1. D.O. Setpoint Most Open Valve Control: 1. ENABLE/DISABLE selection. 2. Most Open Valve Setpoint

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SCADA Alarms and Resets

ALARMS
For Each Basin Zone (disable when basin is offline):
1. LOW Dissolved Oxygen
2. LOW Air Flow
3. Valve Failed to Position

Hard-Wired Interlocks

NA

Software Interlocks

NA

Historical Trending and Run-time Counters

For Each Basin Zone:
1. Dissolved Oxygen
2. Air Flow
3. Air Control Valve Position
4. Valve Position Setpoint
Most Open Valve Control:
1. Most Open Valve Position
2. Most Open Valve Setpoint

Equipment (Auto/Manual) Restart After Power Interruption

NA

Equipment Automatic Failover Sequence

NA

Equipment (Auto/Manual) Restart After Power Interruption

NA

PLC I/O Points

Tag No.	Description	Notes
TC03B_320_AIT_3261B_IN	AB1 Zone 2 Dissolved Oxygen	
TC03B_320_AIT_3261C_IN	AB1 Zone 3 Dissolved Oxygen	
TC03B_320_AIT_3261D_IN	AB1 Zone 4 Dissolved Oxygen	
TC03B_320_AIT_3261E_IN	AB1 Zone 5 Dissolved Oxygen	
TC03B_320_TIT_3261B_IN	AB1 Zone 2 DO Temperature	
TC03B_320_TIT_3261C_IN	AB1 Zone 3 DO Temperature	
TC03B_320_TIT_3261D_IN	AB1 Zone 4 DO Temperature	
TC03B_320_TIT_3261E_IN	AB1 Zone 5 DO Temperature	
TC03B_320_FIT_3251B_IN	ALP Flow to Aeration Basin 1 Zone 2	
TC03B_320_FIT_3251C_IN	ALP Flow to Aeration Basin 1 Zone 3	
TC03B_320_FIT_3251D_IN	ALP Flow to Aeration Basin 1 Zone 4	
TC03B_320_FIT_3251E_IN	ALP Flow to Aeration Basin 1 Zone 5	
TC03B_320_ZT_3251B_IN	AB1 Zone 2 FCV Position Feedback	
TC03B_320_ZT_3251C_IN	AB1 Zone 3 FCV Position Feedback	
TC03B_320_ZT_3251D_IN	AB1 Zone 4 FCV Position Feedback	
TC03B_320_ZT_3251E_IN	AB1 Zone 5 FCV Position Feedback	

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Tag No.	Description	Notes
TC03B_320_ZC_3251B_OUT	AB1 Zone 2 FCV Position Command	
TC03B_320_ZC_3251C_OUT	AB1 Zone 3 FCV Position Command	
TC03B_320_ZC_3251D_OUT	AB1 Zone 4 FCV Position Command	
TC03B_320_ZC_3251E_OUT	AB1 Zone 5 FCV Position Command	
TC03B_320_AIT_3262B_IN	AB2 Zone 2 Dissolved Oxygen	
TC03B_320_AIT_3262C_IN	AB2 Zone 3 Dissolved Oxygen	
TC03B_320_AIT_3262D_IN	AB2 Zone 4 Dissolved Oxygen	
TC03B_320_AIT_3262E_IN	AB2 Zone 5 Dissolved Oxygen	
TC03B_320_TIT_3262B_IN	AB2 Zone 2 DO Temperature	
TC03B_320_TIT_3262C_IN	AB2 Zone 3 DO Temperature	
TC03B_320_TIT_3262D_IN	AB2 Zone 4 DO Temperature	
TC03B_320_TIT_3262E_IN	AB2 Zone 5 DO Temperature	
TC03B_320_FIT_3252B_IN	ALP Flow to Aeration Basin 2 Zone 2	
TC03B_320_FIT_3252C_IN	ALP Flow to Aeration Basin 2 Zone 3	
TC03B_320_FIT_3252D_IN	ALP Flow to Aeration Basin 2 Zone 4	
TC03B_320_FIT_3252E_IN	ALP Flow to Aeration Basin 2 Zone 5	
TC03B_320_ZT_3252B_IN	AB2 Zone 2 FCV Position Feedback	
TC03B_320_ZT_3252C_IN	AB2 Zone 3 FCV Position Feedback	
TC03B_320_ZT_3252D_IN	AB2 Zone 4 FCV Position Feedback	
TC03B_320_ZT_3252E_IN	AB2 Zone 5 FCV Position Feedback	
TC03B_320_ZC_3252B_OUT	AB2 Zone 2 FCV Position Command	
TC03B_320_ZC_3252C_OUT	AB2 Zone 3 FCV Position Command	
TC03B_320_ZC_3252D_OUT	AB2 Zone 4 FCV Position Command	
TC03B_320_ZC_3252E_OUT	AB2 Zone 5 FCV Position Command	
TC03B_320_AIT_3263B_IN	AB3 Zone 2 Dissolved Oxygen	
TC03B_320_AIT_3263C_IN	AB3 Zone 3 Dissolved Oxygen	
TC03B_320_AIT_3263D_IN	AB3 Zone 4 Dissolved Oxygen	
TC03B_320_AIT_3263E_IN	AB3 Zone 5 Dissolved Oxygen	
TC03B_320_TIT_3263B_IN	AB3 Zone 2 DO Temperature	
TC03B_320_TIT_3263C_IN	AB3 Zone 3 DO Temperature	
TC03B_320_TIT_3263D_IN	AB3 Zone 4 DO Temperature	
TC03B_320_TIT_3263E_IN	AB3 Zone 5 DO Temperature	
TC03B_320_FIT_3253B_IN	ALP Flow to Aeration Basin 3 Zone 2	
TC03B_320_FIT_3253C_IN	ALP Flow to Aeration Basin 3 Zone 3	
TC03B_320_FIT_3253D_IN	ALP Flow to Aeration Basin 3 Zone 4	
TC03B_320_FIT_3253E_IN	ALP Flow to Aeration Basin 3 Zone 5	
TC03B_320_ZT_3253B_IN	AB3 Zone 2 FCV Position Feedback	
TC03B_320_ZT_3253C_IN	AB3 Zone 3 FCV Position Feedback	
TC03B_320_ZT_3253D_IN	AB3 Zone 4 FCV Position Feedback	
TC03B_320_ZT_3253E_IN	AB3 Zone 5 FCV Position Feedback	
TC03B_320_ZC_3253B_OUT	AB3 Zone 2 FCV Position Command	
TC03B_320_ZC_3253C_OUT	AB3 Zone 3 FCV Position Command	
TC03B_320_ZC_3253D_OUT	AB3 Zone 4 FCV Position Command	
TC03B_320_ZC_3253E_OUT	AB3 Zone 5 FCV Position Command	

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Tag No.	Description	Notes
TC03B_320_AIT_3264B_IN	AB4 Zone 2 Dissolved Oxygen	
TC03B_320_AIT_3264C_IN	AB4 Zone 3 Dissolved Oxygen	
TC03B_320_AIT_3264D_IN	AB4 Zone 4 Dissolved Oxygen	
TC03B_320_AIT_3264E_IN	AB4 Zone 5 Dissolved Oxygen	
TC03B_320_TIT_3264B_IN	AB4 Zone 2 DO Temperature	
TC03B_320_TIT_3264C_IN	AB4 Zone 3 DO Temperature	
TC03B_320_TIT_3264D_IN	AB4 Zone 4 DO Temperature	
TC03B_320_TIT_3264E_IN	AB4 Zone 5 DO Temperature	
TC03B_320_FIT_3254B_IN	ALP Flow to Aeration Basin 4 Zone 2	
TC03B_320_FIT_3254C_IN	ALP Flow to Aeration Basin 4 Zone 3	
TC03B_320_FIT_3254D_IN	ALP Flow to Aeration Basin 4 Zone 4	
TC03B_320_FIT_3254E_IN	ALP Flow to Aeration Basin 4 Zone 5	
TC03B_320_ZT_3254B_IN	AB4 Zone 2 FCV Position Feedback	
TC03B_320_ZT_3254C_IN	AB4 Zone 3 FCV Position Feedback	
TC03B_320_ZT_3254D_IN	AB4 Zone 4 FCV Position Feedback	
TC03B_320_ZT_3254E_IN	AB4 Zone 5 FCV Position Feedback	
TC03B_320_ZC_3254B_OUT	AB4 Zone 2 FCV Position Command	
TC03B_320_ZC_3254C_OUT	AB4 Zone 3 FCV Position Command	
TC03B_320_ZC_3254D_OUT	AB4 Zone 4 FCV Position Command	
TC03B_320_ZC_3254E_OUT	AB4 Zone 5 FCV Position Command	

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Control Loop Description	Secondary Clarifier 1 & 2 Mixed Liquor Flow

Overview:

Process Description:

The aeration basin effluent flow is split between two Parshall flumes where the flow is routed to secondary clarifiers 1 & 2.
During wet weather the effluent can surcharge causing the flow to increase. Flow transmitters monitoring the flume flow gives indication of surcharge conditions.

Reference Drawing(s):	P&IDs: 008-N-3200		
Last Update/Review:		**Approved By:**	

Equipment

Unit Equipment:

Equipment Tag No.	Description	Notes

Instrumentation:

Instrument Tag No.	Description	Notes
FIT-3274	Sec. Clarifier 1 Mixed Liquor Flow	Parshall Flume Flow
FIT-3275	Sec. Clarifier 2 Mixed Liquor Flow	Parshall Flume Flow

Control Strategies

Measure, scale, indicate, totalize, and trend the Aeration Basin Effluent flow on the HMI. Monitor for instruments BAD QUALITY and alarm on the HMI. Provide CALIBRATION MODE selection from the HMI, where the flow value is held while the instrument is calibrated. Provide alarm on the HMI, if the instrument is set in the CALIBRATION MODE for greater than two hours.
Monitor for Aeration Basin Effluent HIGH FLOW condition, set through the HMI, and alarm on the HMI. Provide ALARM DISABLE capability from the HMI.

Local Control Operation and Alarm Reset

VFD Control Panel

NA

Motor Control Center

NA

MFR Control Center

NA

Local Control Station

Indicate instantaneous flow

SCADA Control Operation and Alarm Reset

SCADA Manual

NA

SCADA Auto

NA

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SCADA Display

Status and Process Display

For Each Flow Meter:
1. In-Service / Out-Of-Service Status
2. Process Flow
3. Flow Totals

Operator Entries

For Each Flow Meter:
1. In-Service / Out-Of-Service
2. High Flow Alarm

SCADA Alarms and Resets

For Each Flow Meter:
1. Alarms
   a. Signal Bad Quality; Priority: TBD
   b. High Flow Alarm; Priority: TBD
   c. Calibration Mode Alarm; Priority: TBD
   d. TBD

2. Reset:
   a. Flow Totals

Hard-Wired Interlocks

NA

Software Interlocks

NA

Historical Trending and Run-time Counters

For Each Flow Meter:
1. Historize Process Flow
2. Calculate Flow Totals for:
   a. Today
   b. Yesterday
   c. Grand Total

Equipment (Auto/Manual) Restart After Power Interruption

NA

Equipment Automatic Failover Sequence

NA

Equipment (Auto/Manual) Restart After Power Interruption

NA

PLC I/O Points

	Tag No.	Description	Notes
	TC03B_320_FIT_3274_IN	Sec. Clarifier 1 Mixed Liquor Flow	
	TC03B_320_FIT_3275_IN	Sec. Clarifier 2 Mixed Liquor Flow	

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Control Loop Description	Secondary Clarifier RAS Flow Control Valves

Overview:

Process Description:

The Return Activated Sludge (RAS) flow is regulated as a percentage of the total Secondary Effluent flow (QSE). The PLC calculates the total RAS flow, QRAS, using an operator adjustable Target Ratio (TRRAS) that typically targets approximately 50% of QSE. This total RAS flow is the combined flow returned from Secondary Clarifiers 1 and 2, such that QRAS = QRAS1 + QRAS2. Using the Aearation Basin Effluent Mixed Liquor flows QML1 and QML2 adjust the percentage of RAS flow from each clarifier to reflect the percentage of the total flow into the clarifier.

Reference Drawing(s):	P&IDs: 008-N-3200, 008-N-3400		
Last Update/Review:		**Approved By:**	

Equipment

Unit Equipment:

Equipment Tag No.	Description	Notes
560-3421	Sec. Clarifier 1 RAS Flow Control Valve	
560-3422	Sec. Clarifier 2 RAS Flow Control Valve	

Instrumentation:

Instrument Tag No.	Description	Notes
FIT-3274	Sec. Clarifier 1 Mixed Liquor Flow	Flume Flow
FIT-3275	Sec. Clarifier 2 Mixed Liquor Flow	Flume Flow
FIT-3421	Sec. Clarifier 1 RAS Effluent Flow	
FIT-3422	Sec. Clarifier 2 RAS Effluent Flow	

Control Strategies

The PLC calculates the total RAS flow (QRAS) as a percentage of the total Secondary Effluent flow (QSE). Operators adjust this percentage as needed, and the PLC assigns individual RAS flow targets for each Secondary Clarifier so that the sum of the two RAS flows equals the total QRAS.

Instead of maintaining an equal 50 / 50 RAS flow split between Clarifier 1 and Clarifier 2, the control system distributes RAS flow in proportion to the Mixed Liquor flow entering each clarifier. The PLC receives the Mixed Liquor flow values (QML1 and QML2) and determines each clarifier's share of the total QRAS.

$QRAS1 = (QML1/ (QML2+QML1))\times(TRRAS\times QSE)$

$QRAS2 = (QML2/ (QML2+QML1))\times(TRRAS\times QSE)$

For each clarifier, a dedicated PID loop modulates the associated RAS Flow Control Valve to meet its assigned RAS flow setpoint. The PID output generates a valve position command that adjusts the valve to achieve the desired RAS flow.

The PLC monitors flow signals and valve position feedback for each control valve. Any deviation from expected performance—such as failure to achieve commanded position or poor signal quality—is alarmed through SCADA. Historical data for RAS flow, valve position, and valve setpoint are recorded for each clarifier.

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Local Control Operation and Alarm Reset
VFD Control Panel
NA
Motor Control Center
NA
MFR Control Center
NA
Local Control Station
Indicate valve position Adjust valve position
SCADA Control Operation and Alarm Reset
SCADA Manual
For Each Clarifier RAS Control Valve: 1. SCADA adjustment of valve position.
SCADA Auto
The PLC calculates the RAS flow setpoint from each Clarifier. QRAS1 = (QML1/ (QML2+QML1))×(TRRAS×QSE) QRAS2 = (QML2/ (QML2+QML1))×(TRRAS×QSE) For each clarifier, a dedicated PID loop modulates the associated RAS Flow Control Valve to meet its assigned RAS flow setpoint. The PID output generates a valve position command that adjusts the valve to achieve the desired RAS flow.
SCADA Display
Status and Process Display
For Each Flow Control Valve: 1. Local / Remote Status 2. Valve Position
Operator Entries
RAS Target Ratio (TRRAS): 1. Provide entry for target ratio in % of RAS to come from Secondary Clarifier efffluent flow . For Each Flow Control Valve: 1. In-Service / Out-Of-Service 2. Valve Position
SCADA Alarms and Resets
For Each Flow Control Vavle: 1. Alarms a. Signal Bad Quality; Priority: TBD b. Failed to Position; Priority: TBD c. TBD

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Hard-Wired Interlocks
NA
Software Interlocks
NA
Historical Trending and Run-time Counters
For Each Clarifier: 1. RAS Flow 2. Control Valve Position 3. Control Valve Position Setpoint
Equipment (Auto/Manual) Restart After Power Interruption
NA
Equipment Automatic Failover Sequence
NA
Equipment (Auto/Manual) Restart After Power Interruption
NA
PLC I/O Points

Tag No.	Description	Notes
TC03B_340_ZT_3421_IN	Sec. Clarifier 1 RAS FCV Position Feedback	
TC03B_340_ZT_3422_IN	Sec. Clarifier 2 RAS FCV Position Feedback	
TC03B_340_ZC_3421_OUT	Sec. Clarifier 1 RAS FCV Position Command	
TC03B_340_ZC_3422_OUT	Sec. Clarifier 2 RAS FCV Position Command	

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Control Loop Description	RAS Flow Control Valves

Overview:

Process Description:

The Return Activated Sludge is pumped from the secondary clarifiers via the RAS pump station where the flow is split between the online Aeration Basins. The RAS control valves are modulated to ensure an even flow split between the basins.

Reference Drawing(s):	P&IDs: 008-N-3205, 008-N-3206		
Last Update/Review:		**Approved By:**	

Equipment

Unit Equipment:

Equipment Tag No.	Description	Notes
560-3471	AB 1 RAS Flow Control Valve	
560-3472	AB 2 RAS Flow Control Valve	
560-3473	AB 3 RAS Flow Control Valve	
560-3474	AB 4 RAS Flow Control Valve	

Instrumentation:

Instrument Tag No.	Description	Notes
FIT-3471	AB 1 RAS Flow Meter	Existing, connected to PLC-3A
FIT-3472	AB 2 RAS Flow Meter	Existing, connected to PLC-3A
FIT-3473	AB 3 RAS Flow Meter	Existing, connected to PLC-3A
FIT-3474	AB 4 RAS Flow Meter	Existing, connected to PLC-3A

Control Strategies

For each basin, a PID controller monitors and adjusts the RAS flow to the basin where hand valves, adjusted by Operations, control the flow to the basin's zones. The output of the PID controller is a valve position setpoint used to modulate the RAS flow control valve's position.

Local Control Operation and Alarm Reset

VFD Control Panel

NA

Motor Control Center

NA

MFR Control Center

NA

Local Control Station

Indicate valve position
Adjust valve position

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SCADA Control Operation and Alarm Reset
SCADA Manual
For Each Basin RAS Control Valve: 1. SCADA adjustment of valve position.
SCADA Auto
NA
SCADA Display
Status and Process Display
For Each Flow Meter: 1. Use existing logic and graphics For Each Flow Control Valve: 1. Local / Remote Status 2. Valve Position
Operator Entries
For Each Flow Control Valve: 1. In-Service / Out-Of-Service 2. Valve Position
SCADA Alarms and Resets
For Each Flow Control Valve: 1. Alarms a. Signal Bad Quality; Priority: TBD b. Failed to Position; Priority: TBD c. TBD
Hard-Wired Interlocks
NA
Software Interlocks
NA
Historical Trending and Run-time Counters
For Each Basin: 1. RAS Flow 2. Control Valve Position 3. Control Valve Position Setpoint
Equipment (Auto/Manual) Restart After Power Interruption
NA
Equipment Automatic Failover Sequence
NA
Equipment (Auto/Manual) Restart After Power Interruption
NA

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PLC I/O Points			
	Tag No.	**Description**	**Notes**
	TC03B_340_ZT_3471_IN	AB1 RAS FCV Position Feedback	
	TC03B_340_ZT_3472_IN	AB2 RAS FCV Position Feedback	
	TC03B_340_ZT_3473_IN	AB3 RAS FCV Position Feedback	
	TC03B_340_ZT_3474_IN	AB4 RAS FCV Position Feedback	
	TC03B_340_ZC_3471_OUT	AB1 RAS FCV Position Command	
	TC03B_340_ZC_3472_OUT	AB2 RAS FCV Position Command	
	TC03B_340_ZC_3473_OUT	AB3 RAS FCV Position Command	
	TC03B_340_ZC_3474_OUT	AB4 RAS FCV Position Command	

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CONTROL PANEL SCHEDULE

Panel No.	Service	Mounting	NEMA	Dimensions H" W" D"	FDT	Space Heater	Service Lights	Environment	SST
CP-3B	Aeration Basins 1-4 Controls	Freestanding	12	60" x 60" x 18"	Yes	No	Yes	Inside/ Unconditioned	No
CP-3B-RIO-1	Aeration Basins 1-2 Remote I/O	Freestanding	4X	60" x 48" x 18"	Yes	Yes	Yes	Outside* [1]	Yes
CP-3B-RIO-2	Aeration Basins 3-4 Remote I/O	Freestanding	4X	60" x 48" x 18"	Yes	Yes	Yes	Outside* [2]	Yes
CP-3B-RIO-3	RAS Gallery Remote I/O	Freestanding	4	60" x 48" x 18"	Yes	Yes	Yes	Inside/ Unconditioned	No
ACP-3261	Aeration Basin 1 Controller for Dissolved Oxygen Analyzers	Stanchion	4X	36" x 36" x 12"	Yes	Yes	Yes	Outside*	Yes
ACP-3262	Aeration Basin 2 Controller for Dissolved Oxygen Analyzers	Stanchion	4X	36" x 36" x 12"	Yes	Yes	Yes	Outside* [1]	Yes
ACP-3263	Aeration Basin 3 Controller for Dissolved Oxygen Analyzers	Stanchion	4X	36" x 36" x 12"	Yes	Yes	Yes	Outside*	Yes
ACP-3264	Aeration Basin 4 Controller for Dissolved Oxygen Analyzers	Stanchion	4X	36" x 36" x 12"	Yes	Yes	Yes	Outside* [2]	Yes

Column Descriptions:

FDT: Factory Demonstration test required.

Dimensions: Maximum space available for panel.

SST: Stainless Steel.

Notes:

* Sun Shade Required

1. Sun Shade for CP-3B-RIO-1 and ACP-3262 to be combined

2. Sun Shade for CP-3B-RIO-2 and ACP-3264 to be combined

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A20 & A150 - DISSOLVED OXYGEN ANALYZER

INSTRUMENT TAG NO	DRAWING NO	INSTRUMENT DESCRIPTION	PROCESS FUILD	SENSOR RANGE	CALIBRATED RANGE	AIR CLEANING	STANDARD DETAIL	REMARKS
AIT-3261	008-N-3201	AB1 Dissolved Oxygen Analyzer						Mount Inside ACP Panel
AE-3261B	008-N-3201	AB1 Zone 2 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3261C	008-N-3201	AB1 Zone 3 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3261D	008-N-3201	AB1 Zone 4 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3261E	008-N-3201	AB1 Zone 5 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AIT-3262	008-N-3202	AB2 Dissolved Oxygen Analyzer						Mount Inside ACP Panel
AE-3262B	008-N-3202	AB2 Zone 2 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3262C	008-N-3202	AB2 Zone 3 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3262D	008-N-3202	AB2 Zone 4 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3262E	008-N-3202	AB2 Zone 5 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AIT-3263	008-N-3203	AB3 Dissolved Oxygen Analyzer						Mount Inside ACP Panel
AE-3263B	008-N-3203	AB3 Zone 2 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3263C	008-N-3203	AB3 Zone 3 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3263D	008-N-3203	AB3 Zone 4 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3263E	008-N-3203	AB3 Zone 5 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AIT-3264	008-N-3204	AB4 Dissolved Oxygen Analyzer						Mount Inside ACP Panel
AE-3264B	008-N-3204	AB4 Zone 2 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3264C	008-N-3204	AB4 Zone 3 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3264D	008-N-3204	AB4 Zone 4 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.
AE-3264E	008-N-3204	AB4 Zone 5 Dissolved Oxygen Sensor	ML	0 - 20 MG/L	0 - 5 MG/L	Yes	4091-159	Fixed Cable; M12 Plug.

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F22 - RADAR FLOW TRANSMITTER, PARSHALL FLUME

INSTRUMENT TAG NO	DRAWING NO	INSTRUMENT DESCRIPTION	PROCESS FUILD	INSTRUMENT RANGE	TRANSMIITER MOUNT	STANDARD DETAIL	REMARKS
FIT-3274	008-N-3200	Secondary Clarifier 1 Mixed Liquor Flow Transmitter	ML	0-21 MGD	Remote	4091-382	
FE-3274	008-N-3200	Secondary Clarifier 1 Mixed Liquor Flow Sensor	ML	0-4 FT		4091-203	Document and submit to the engineer the as found conditions and dimensions of the Parshall Flume.
FIT-3275	008-N-3200	Secondary Clarifier 2 Mixed Liquor Flow Transmitter	ML	0-21 MGD	Remote	4091-382	
FE-3275	008-N-3200	Secondary Clarifier 2 Mixed Liquor Flow Sensor	ML	0-4 FT		4091-203	Document and submit to the engineer the as found conditions and dimensions of the Parshall Flume.

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F51 - THERMAL MASS FLOWMETER

INSTRUMENT TAG NO	DRAWING NO	INSTRUMENT DESCRIPTION	PROCESS FUILD	MAX PRESSURE	INSTRUMENT RANGE	LINE SIZE	HOT TAP	TRANSMIITER MOUNT	FLOW CONDITIONER	STANDARD DETAIL	REMARKS
FIT-3251B	008-N-3201	AB1 Zone 2 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3251C	008-N-3201	AB1 Zone 3 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3251D	008-N-3201	AB1 Zone 4 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3251E	008-N-3201	AB1 Zone 5 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3252B	008-N-3202	AB2 Zone 2 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3252C	008-N-3202	AB2 Zone 3 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3252D	008-N-3202	AB2 Zone 4 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3252E	008-N-3202	AB2 Zone 5 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3253B	008-N-3203	AB3 Zone 2 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3253C	008-N-3203	AB3 Zone 3 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3253D	008-N-3203	AB3 Zone 4 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3253E	008-N-3203	AB3 Zone 5 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3254B	008-N-3204	AB4 Zone 2 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3254C	008-N-3204	AB4 Zone 3 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3254D	008-N-3204	AB4 Zone 4 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	
FIT-3254E	008-N-3204	AB4 Zone 5 Air Flow Meter	ALP	12	0-1,200 SCFM	6"	NO	INTEGRAL	YES	4091-217	

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P04 - PRESSURE GAUGE

INSTRUMENT TAG NO	DRAWING NO	INSTRUMENT DESCRIPTION	PROCESS FUILD	MAX PRESSURE	INSTRUMENT RANGE	LIQUID FILLED	DIAPHRAM SEAL	ISOLATION SEAL	STANDARD DETAIL	REMARKS
PI-3251BA	008-N-3201	AB1 Zone 2 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251BB	008-N-3201	AB1 Zone 2 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251CA	008-N-3201	AB1 Zone 3 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251CB	008-N-3201	AB1 Zone 3 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251DA	008-N-3201	AB1 Zone 4 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251DB	008-N-3201	AB1 Zone 4 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251EA	008-N-3201	AB1 Zone 5 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3251EB	008-N-3201	AB1 Zone 5 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252BA	008-N-3202	AB2 Zone 2 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252BB	008-N-3202	AB2 Zone 2 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252CA	008-N-3202	AB2 Zone 3 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252CB	008-N-3202	AB2 Zone 3 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252DA	008-N-3202	AB2 Zone 4 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252DB	008-N-3202	AB2 Zone 4 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252EA	008-N-3202	AB2 Zone 5 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3252EB	008-N-3202	AB2 Zone 5 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253BA	008-N-3203	AB3 Zone 2 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253BB	008-N-3203	AB3 Zone 2 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253CA	008-N-3203	AB3 Zone 3 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253CB	008-N-3203	AB3 Zone 3 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253DA	008-N-3203	AB3 Zone 4 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253DB	008-N-3203	AB3 Zone 4 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253EA	008-N-3203	AB3 Zone 5 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3253EB	008-N-3203	AB3 Zone 5 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254BA	008-N-3204	AB4 Zone 2 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254BB	008-N-3204	AB4 Zone 2 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254CA	008-N-3204	AB4 Zone 3 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254CB	008-N-3204	AB4 Zone 3 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254DA	008-N-3204	AB4 Zone 4 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254DB	008-N-3204	AB4 Zone 4 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254EA	008-N-3204	AB4 Zone 5 FCV Inlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	
PI-3254EB	008-N-3204	AB4 Zone 5 FCV Outlet Air Pressure	ALP	12	0-15 PSI	GLYCERIN	NO	NO	4091-301	

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PLC INPUT / OUTPUT LIST

Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3251B_IN	ALP Flow to Aeration Basin 1 Zone 2	0	1200	SCFM	AI	008-N-3201	1	6	0
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3251C_IN	ALP Flow to Aeration Basin 1 Zone 3	0	1200	SCFM	AI	008-N-3201	1	6	1
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3251D_IN	ALP Flow to Aeration Basin 1 Zone 4	0	1200	SCFM	AI	008-N-3201	1	6	2
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3251E_IN	ALP Flow to Aeration Basin 1 Zone 5	0	1200	SCFM	AI	008-N-3201	1	6	3
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3251B_IN	AB1 Zone 2 FCV Position Feedback	0	100	%	AI	008-N-3201	1	6	4
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3251C_IN	AB1 Zone 3 FCV Position Feedback	0	100	%	AI	008-N-3201	1	6	5
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3251D_IN	AB1 Zone 4 FCV Position Feedback	0	100	%	AI	008-N-3201	1	6	6
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3251E_IN	AB1 Zone 5 FCV Position Feedback	0	100	%	AI	008-N-3201	1	6	7
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3252B_IN	ALP Flow to Aeration Basin 2 Zone 2	0	1200	SCFM	AI	008-N-3202	1	7	0
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3252C_IN	ALP Flow to Aeration Basin 2 Zone 3	0	1200	SCFM	AI	008-N-3202	1	7	1
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3252D_IN	ALP Flow to Aeration Basin 2 Zone 4	0	1200	SCFM	AI	008-N-3202	1	7	2
CP-3B-RIO-1	PLC3B	TC03B_320_FIT_3252E_IN	ALP Flow to Aeration Basin 2 Zone 5	0	1200	SCFM	AI	008-N-3202	1	7	3
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3252B_IN	AB2 Zone 2 FCV Position Feedback	0	100	%	AI	008-N-3202	1	7	4
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3252C_IN	AB2 Zone 3 FCV Position Feedback	0	100	%	AI	008-N-3202	1	7	5
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3252D_IN	AB2 Zone 4 FCV Position Feedback	0	100	%	AI	008-N-3202	1	7	6
CP-3B-RIO-1	PLC3B	TC03B_320_ZT_3252E_IN	AB2 Zone 5 FCV Position Feedback	0	100	%	AI	008-N-3202	1	7	7
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3253B_IN	ALP Flow to Aeration Basin 3 Zone 2	0	1200	SCFM	AI	008-N-3203	2	6	0
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3253C_IN	ALP Flow to Aeration Basin 3 Zone 3	0	1200	SCFM	AI	008-N-3203	2	6	1
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3253D_IN	ALP Flow to Aeration Basin 3 Zone 4	0	1200	SCFM	AI	008-N-3203	2	6	2
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3253E_IN	ALP Flow to Aeration Basin 3 Zone 5	0	1200	SCFM	AI	008-N-3203	2	6	3
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3253B_IN	AB3 Zone 2 FCV Position Feedback	0	100	%	AI	008-N-3203	2	6	4
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3253C_IN	AB3 Zone 3 FCV Position Feedback	0	100	%	AI	008-N-3203	2	6	5
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3253D_IN	AB3 Zone 4 FCV Position Feedback	0	100	%	AI	008-N-3203	2	6	6
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3253E_IN	AB3 Zone 5 FCV Position Feedback	0	100	%	AI	008-N-3203	2	6	7
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3254B_IN	ALP Flow to Aeration Basin 4 Zone 2	0	1200	SCFM	AI	008-N-3204	2	7	0
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3254C_IN	ALP Flow to Aeration Basin 4 Zone 3	0	1200	SCFM	AI	008-N-3204	2	7	1
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3254D_IN	ALP Flow to Aeration Basin 4 Zone 4	0	1200	SCFM	AI	008-N-3204	2	7	2
CP-3B-RIO-2	PLC3B	TC03B_320_FIT_3254E_IN	ALP Flow to Aeration Basin 4 Zone 5	0	1200	SCFM	AI	008-N-3204	2	7	3
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3254B_IN	AB4 Zone 2 FCV Position Feedback	0	100	%	AI	008-N-3204	2	7	4
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3254C_IN	AB4 Zone 3 FCV Position Feedback	0	100	%	AI	008-N-3204	2	7	5
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3254D_IN	AB4 Zone 4 FCV Position Feedback	0	100	%	AI	008-N-3204	2	7	6
CP-3B-RIO-2	PLC3B	TC03B_320_ZT_3254E_IN	AB4 Zone 5 FCV Position Feedback	0	100	%	AI	008-N-3204	2	7	7

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Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
CP-3B	PLC3B	TC03B_320_FIT_3274_IN	Secondary Clarifier 1 Mixed Liquor Flow	0	21	MGD	AI	008-N-3200	0	6	0
CP-3B	PLC3B	TC03B_320_FIT_3275_IN	Secondary Clarifier 2 Mixed Liquor Flow	0	21	MGD	AI	008-N-3200	0	7	0
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3421_IN	SC 1 RAS FCV Position Feedback	0	100	%	AI	008-N-3400	3	3	1
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3422_IN	SC 2 RAS FCV Position Feedback	0	100	%	AI	008-N-3400	3	4	1
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3471_IN	AB1 RAS FCV Position Feedback	0	100	%	AI	008-N-3205	3	3	2
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3472_IN	AB2 RAS FCV Position Feedback	0	100	%	AI	008-N-3205	3	4	2
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3473_IN	AB3 RAS FCV Position Feedback	0	100	%	AI	008-N-3206	3	3	3
CP-3B-RIO-3	PLC3B	TC03B_340_ZT_3474_IN	AB4 RAS FCV Position Feedback	0	100	%	AI	008-N-3206	3	4	3
Count of I/O Type AI:							**40**				

Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3251B_OUT	AB1 Zone 2 FCV Position Command	0	100	%	AO	008-N-3201	1	9	0
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3251C_OUT	AB1 Zone 3 FCV Position Command	0	100	%	AO	008-N-3201	1	9	1
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3251D_OUT	AB1 Zone 4 FCV Position Command	0	100	%	AO	008-N-3201	1	9	2
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3251E_OUT	AB1 Zone 5 FCV Position Command	0	100	%	AO	008-N-3201	1	9	3
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3252B_OUT	AB2 Zone 2 FCV Position Command	0	100	%	AO	008-N-3202	1	10	0
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3252C_OUT	AB2 Zone 3 FCV Position Command	0	100	%	AO	008-N-3202	1	10	1
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3252D_OUT	AB2 Zone 4 FCV Position Command	0	100	%	AO	008-N-3202	1	10	2
CP-3B-RIO-1	PLC3B	TC03B_320_ZC_3252E_OUT	AB2 Zone 5 FCV Position Command	0	100	%	AO	008-N-3202	1	10	3
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3253B_OUT	AB3 Zone 2 FCV Position Command	0	100	%	AO	008-N-3203	2	9	0
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3253C_OUT	AB3 Zone 3 FCV Position Command	0	100	%	AO	008-N-3203	2	9	1
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3253D_OUT	AB3 Zone 4 FCV Position Command	0	100	%	AO	008-N-3203	2	9	2
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3253E_OUT	AB3 Zone 5 FCV Position Command	0	100	%	AO	008-N-3203	2	9	3
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3254B_OUT	AB4 Zone 2 FCV Position Command	0	100	%	AO	008-N-3204	2	10	0
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3254C_OUT	AB4 Zone 3 FCV Position Command	0	100	%	AO	008-N-3204	2	10	1
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3254D_OUT	AB4 Zone 4 FCV Position Command	0	100	%	AO	008-N-3204	2	10	2
CP-3B-RIO-2	PLC3B	TC03B_320_ZC_3254E_OUT	AB4 Zone 5 FCV Position Command	0	100	%	AO	008-N-3204	2	10	3
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3421_OUT	SC 1 RAS FCV Position Command	0	100	%	AO	008-N-3400	3	5	0
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3422_OUT	SC 2 RAS FCV Position Command	0	100	%	AO	008-N-3400	3	6	0
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3471_OUT	AB1 RAS FCV Position Command	0	100	%	AO	008-N-3205	3	5	1
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3472_OUT	AB2 RAS FCV Position Command	0	100	%	AO	008-N-3205	3	6	1
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3473_OUT	AB3 RAS FCV Position Command	0	100	%	AO	008-N-3206	3	5	2
CP-3B-RIO-3	PLC3B	TC03B_340_ZC_3474_OUT	AB4 RAS FCV Position Command	0	100	%	AO	008-N-3206	3	6	2
Count of I/O Type AO:							**22**				

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Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
CP-3B	PLC3B	TC03B_340_JA1_CP3B_IN	CP-3B Control Power Status	NORMAL	FAILED	-	DI	008-N-0101	0	3	0
CP-3B	PLC3B	TC3B_340_EA_CP3B_IN	CP-3B Surge Protection Status	NORMAL	FAILED	-	DI	008-N-0101	0	3	1
CP-3B	PLC3B	TC3B_340_YA_CP3B_IN	CP-3B UPS Fault	NORMAL	FAULT	-	DI	008-N-0101	0	3	2
CP-3B	PLC3B	TC3B_340_JA2_CP3B_IN	CP-3B Power Supply 1 Status	ALARM	NORMAL	-	DI	008-N-0101	0	3	3
CP-3B	PLC3B	TC3B_340_JA3_CP3B_IN	CP-3B Power Supply 2 Status	ALARM	NORMAL	-	DI	008-N-0101	0	3	4
CP-3B	PLC3B	TC3B_340_TSH_CP3B_IN	CP-3B Temperature Status	NORMAL	HIGH	-	DI	008-N-0101	0	3	5
CP-3B-RIO-1	PLC3B	TC03B_320_JA1_RIO1_IN	CP-3B-RIO-1 UPS Control Power Status	NORMAL	FAILED	-	DI	008-N-0105	1	5	0
CP-3B-RIO-1	PLC3B	TC03B_320_JA2_RIO1_IN	CP-3B-RIO-1 Utility Power Status	NORMAL	FAILED	-	DI	008-N-0105	1	5	1
CP-3B-RIO-1	PLC3B	TC3B_320_EA1_RIO1_IN	CP-3B-RIO-1 Surge Protection 1, UPS Status	NORMAL	FAILED	-	DI	008-N-0105	1	5	2
CP-3B-RIO-1	PLC3B	TC3B_320_EA2_RIO1_IN	CP-3B-RIO-1 Surge Protection 2, Utility Status	NORMAL	FAILED	-	DI	008-N-0105	1	5	3
CP-3B-RIO-1	PLC3B	TC3B_320_JA3_RIO1_IN	CP-3B-RIO-1 Power Supply 1 Status	ALARM	NORMAL	-	DI	008-N-0105	1	5	4
CP-3B-RIO-1	PLC3B	TC3B_320_JA4_RIO1_IN	CP-3B-RIO-1 Power Supply 2 Status	ALARM	NORMAL	-	DI	008-N-0105	1	5	5
CP-3B-RIO-1	PLC3B	TC3B_320_TSH_RIO1_IN	CP-3B-RIO-1 Temperature Status	NORMAL	HIGH	-	DI	008-N-0105	1	5	6
CP-3B-RIO-2	PLC3B	TC3B_320_JA1_RIO2_IN	CP-3B-RIO-2 UPS Control Power Status	NORMAL	FAILED	-	DI	008-N-0105	2	5	0
CP-3B-RIO-2	PLC3B	TC3B_320_JA2_RIO2_IN	CP-3B-RIO-2 Utility Power Status	NORMAL	FAILED	-	DI	008-N-0105	2	5	1
CP-3B-RIO-2	PLC3B	TC3B_320_EA1_RIO2_IN	CP-3B-RIO-2 Surge Protection 1, UPS Status	NORMAL	FAILED	-	DI	008-N-0105	2	5	2
CP-3B-RIO-2	PLC3B	TC3B_320_EA2_RIO2_IN	CP-3B-RIO-2 Surge Protection 2,Utility Status	NORMAL	FAILED	-	DI	008-N-0105	2	5	3
CP-3B-RIO-2	PLC3B	TC3B_320_JA3_RIO2_IN	CP-3B-RIO-2 Power Supply 1 Status	ALARM	NORMAL	-	DI	008-N-0105	2	5	4
CP-3B-RIO-2	PLC3B	TC3B_320_JA4_RIO2_IN	CP-3B-RIO-2 Power Supply 2 Status	ALARM	NORMAL	-	DI	008-N-0105	2	5	5
CP-3B-RIO-2	PLC3B	TC3B_320_TSH_RIO2_IN	CP-3B-RIO-2 Temperature Status	NORMAL	HIGH	-	DI	008-N-0105	2	5	6
CP-3B-RIO-3	PLC3B	TC03B_340_JA1_RIO3_IN	CP-3B-RIO-3 UPS Control Power Status	NORMAL	FAILED	-	DI	008-N-0105	3	2	0
CP-3B-RIO-3	PLC3B	TC03B_340_JA2_RIO3_IN	CP-3B-RIO-3 Utility Power Status	NORMAL	FAILED	-	DI	008-N-0105	3	2	1
CP-3B-RIO-3	PLC3B	TC3B_340_EA1_RIO3_IN	CP-3B-RIO-3 Surge Protection 1, UPS Status	NORMAL	FAILED	-	DI	008-N-0105	3	2	2
CP-3B-RIO-3	PLC3B	TC3B_340_EA2_RIO3_IN	CP-3B-RIO-3 Surge Protection 2, Utility Status	NORMAL	FAILED	-	DI	008-N-0105	3	2	3
CP-3B-RIO-3	PLC3B	TC3B_340_JA3_RIO3_IN	CP-3B-RIO-3 Power Supply 1 Status	ALARM	NORMAL	-	DI	008-N-0105	3	2	4
CP-3B-RIO-3	PLC3B	TC3B_340_JA4_RIO3_IN	CP-3B-RIO-3 Power Supply 2 Status	ALARM	NORMAL	-	DI	008-N-0105	3	2	5
CP-3B-RIO-3	PLC3B	TC3B_340_TSH_RIO3_IN	CP-3B-RIO-3 Temperature Status	NORMAL	HIGH	-	DI	008-N-0105	3	2	6
Count of I/O Type DI:							**27**				

Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
Count of I/O Type DO:							**0**				

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Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
ACP-3261	PLC3B	TC03B_320_AIT_3261B_IN	AB1 Zone 2 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_TIT_3261B_IN	AB1 Zone 2 Temperature *	0	100	Deg C	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_AIT_3261C_IN	AB1 Zone 3 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_TIT_3261C_IN	AB1 Zone 3 Temperature *	0	100	Deg C	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_AIT_3261D_IN	AB1 Zone 4 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_TIT_3261D_IN	AB1 Zone 4 Temperature *	0	100	Deg C	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_AIT_3261E_IN	AB1 Zone 5 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3201	1	-	-
ACP-3261	PLC3B	TC03B_320_TIT_3261E_IN	AB1 Zone 5 Temperature *	0	100	Deg C	PROFI	008-N-3201	1	-	-
ACP-3262	PLC3B	TC03B_320_AIT_3262B_IN	AB2 Zone 2 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_TIT_3262B_IN	AB2 Zone 2 Temperature *	0	100	Deg C	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_AIT_3262C_IN	AB2 Zone 3 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_TIT_3262C_IN	AB2 Zone 3 Temperature *	0	100	Deg C	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_AIT_3262D_IN	AB2 Zone 4 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_TIT_3262D_IN	AB2 Zone 4 Temperature *	0	100	Deg C	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_AIT_3262E_IN	AB2 Zone 5 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3202	1	-	-
ACP-3262	PLC3B	TC03B_320_TIT_3262E_IN	AB2 Zone 5 Temperature *	0	100	Deg C	PROFI	008-N-3202	1	-	-
ACP-3263	PLC3B	TC03B_320_AIT_3263B_IN	AB3 Zone 2 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_TIT_3263B_IN	AB3 Zone 2 Temperature *	0	100	Deg C	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_AIT_3263C_IN	AB3 Zone 3 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_TIT_3263C_IN	AB3 Zone 3 Temperature *	0	100	Deg C	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_AIT_3263D_IN	AB3 Zone 4 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_TIT_3263D_IN	AB3 Zone 4 Temperature *	0	100	Deg C	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_AIT_3263E_IN	AB3 Zone 5 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3203	2	-	-
ACP-3263	PLC3B	TC03B_320_TIT_3263E_IN	AB3 Zone 5 Temperature *	0	100	Deg C	PROFI	008-N-3203	2	-	-
ACP-3264	PLC3B	TC03B_320_AIT_3264B_IN	AB4 Zone 2 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_TIT_3264B_IN	AB4 Zone 2 Temperature *	0	100	Deg C	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_AIT_3264C_IN	AB4 Zone 3 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_TIT_3264C_IN	AB4 Zone 3 Temperature *	0	100	Deg C	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_AIT_3264D_IN	AB4 Zone 4 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_TIT_3264D_IN	AB4 Zone 4 Temperature *	0	100	Deg C	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_AIT_3264E_IN	AB4 Zone 5 Dissolved Oxygen *	0	5	mg/L	PROFI	008-N-3204	2	-	-
ACP-3264	PLC3B	TC03B_320_TIT_3264E_IN	AB4 Zone 5 Temperature *	0	100	Deg C	PROFI	008-N-3204	2	-	-
* Each DO sensor has multiple process values and diagnostic I/O, see specification section 40.91.00 for additional details.											
Count of I/O Type ProfiNet:							**32**				

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Panel No.	PLC No.	IO Tag	Loop Title	Zero State	One State	Eng Units	IO Type	PID No.	Rack	Slot	Point
LCP-3291A	PLC3B	TC03B_320_M_3291A_x	AB1 Zone 1A Mixer **	-	-	-	MB TCP	008-N-3201	1	-	-
LCP-3291B	PLC3B	TC03B_320_M_3291B_x	AB1 Zone 1B Mixer **	-	-	-	MB TCP	008-N-3201	1	-	-
LCP-3292A	PLC3B	TC03B_320_M_3292A_x	AB2 Zone 1A Mixer **	-	-	-	MB TCP	008-N-3202	1	-	-
LCP-3292B	PLC3B	TC03B_320_M_3292B_x	AB2 Zone 1B Mixer **	-	-	-	MB TCP	008-N-3202	1	-	-
LCP-3293A	PLC3B	TC03B_320_M_3293A_x	AB3 Zone 1A Mixer **	-	-	-	MB TCP	008-N-3203	2	-	-
LCP-3293B	PLC3B	TC03B_320_M_3293B_x	AB3 Zone 1B Mixer **	-	-	-	MB TCP	008-N-3203	2	-	-
LCP-3294A	PLC3B	TC03B_320_M_3294A_x	AB4 Zone 1A Mixer **	-	-	-	MB TCP	008-N-3204	2	-	-
LCP-3294B	PLC3B	TC03B_320_M_3294B_x	AB4 Zone 1B Mixer **	-	-	-	MB TCP	008-N-3204	2	-	-
x = Multiple tags are associated with this Modbus enabled device											
** Existing Owner supplied logic will be copied from the "Temporary PLC" to PLC-3B											
Count of I/O Type (Modbus) MB TCP:							**8**				

Totals for PLC3B:		
	AI	40
	AO	22
	DI	27
	DO	0
	PROFI	32
	MB TCP	8
	Total	**129**

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PLC EQUIPMENT LIST

Item	Product	Manufacturer	Description	Qty	Notes
CP-3B					
1	6ES7515-2AM02-0AB0	Siemens	CPU 1515-2 PN; 1 MB program, 4.5 MB data memory; dual PROFINET interfaces.	1	
2	6ES7954-8LL04-0AA0	Siemens	SIMATIC memory card (256 MB Flash EPROM); for S7-1x00 CPUs.	1	
3	6ES7590-1AE80-0AA0	Siemens	Mounting rail (482.6 mm) for S7-1500 modules; includes grounding screw.	1	Adjust rail length as required, provide space for future I/O moule expansion
4	6ES7531-7NF10-0AB0	Siemens	Analog input module (AI 8xU/I HS); 16-bit resolution, fast sampling.	2	
5	6ES7532-5HF00-0AB0	Siemens	Analog output module (AQ 8xU/I HS); 16-bit resolution, SIL2 safety support.	2	
6	6ES7521-1BH00-0AB0	Siemens	Digital input module DI 16x24 V DC HF, 16 channels in groups of 16	3	
7	6ES7522-1BH01-0AB0	Siemens	Digital output module DQ16x24 V DC/0.5A HF; 16 channels in groups of 8	2	
8	6ES7592-1AM00-0XB0	Siemens	40-pin front connector for 35 mm wide modules; includes potential bridges.	9	
CP-3B-RIO-1					
9	6ES7590-1AE80-0AA0	Siemens	Mounting rail (482.6 mm) for S7-1500 modules; includes grounding screw.	1	Adjust rail length as required.
10	6ES7155-5AA01-0AB0	Siemens	PROFINET IO interface module for ET 200MP; supports up to 30 I/O modules.	1	
11	6ES7531-7NF10-0AB0	Siemens	Analog input module (AI 8xU/I HS); 16-bit resolution, fast sampling.	3	
12	6ES7532-5HF00-0AB0	Siemens	Analog output module (AQ 8xU/I HS); 16-bit resolution, SIL2 safety support.	2	
13	6ES7521-1BH00-0AB0	Siemens	Digital input module DI 16x24 V DC HF, 16 channels in groups of 16	2	
14	6ES7522-1BH01-0AB0	Siemens	Digital output module DQ16x24 V DC/0.5A HF; 16 channels in groups of 8	1	
15	6ES7592-1AM00-0XB0	Siemens	40-pin front connector for 35 mm wide modules; includes potential bridges.	8	
CP-3B-RIO-2					
16	6ES7590-1AE80-0AA0	Siemens	Mounting rail (482.6 mm) for S7-1500 modules; includes grounding screw.	1	Adjust rail length as required.
17	6ES7155-5AA01-0AB0	Siemens	PROFINET IO interface module for ET 200MP; supports up to 30 I/O modules.	1	
18	6ES7531-7NF10-0AB0	Siemens	Analog input module (AI 8xU/I HS); 16-bit resolution, fast sampling.	3	
19	6ES7532-5HF00-0AB0	Siemens	Analog output module (AQ 8xU/I HS); 16-bit resolution, SIL2 safety support.	2	
20	6ES7521-1BH00-0AB0	Siemens	Digital input module DI 16x24 V DC HF, 16 channels in groups of 16	2	
21	6ES7522-1BH01-0AB0	Siemens	Digital output module DQ16x24 V DC/0.5A HF; 16 channels in groups of 8	1	
22	6ES7592-1AM00-0XB0	Siemens	40-pin front connector for 35 mm wide modules; includes potential bridges.	8	
CP-3B-RIO-3					
23	6ES7590-1AE80-0AA0	Siemens	Mounting rail (482.6 mm) for S7-1500 modules; includes grounding screw.	1	Adjust rail length as required, provide space for future I/O moule expansion
24	6ES7155-5AA01-0AB0	Siemens	PROFINET IO interface module for ET 200MP; supports up to 30 I/O modules.	1	
25	6ES7531-7NF10-0AB0	Siemens	Analog input module (AI 8xU/I HS); 16-bit resolution, fast sampling.	2	
26	6ES7532-5HF00-0AB0	Siemens	Analog output module (AQ 8xU/I HS); 16-bit resolution, SIL2 safety support.	2	
27	6ES7521-1BH00-0AB0	Siemens	Digital input module DI 16x24 V DC HF, 16 channels in groups of 16	1	
28	6ES7522-1BH01-0AB0	Siemens	Digital output module DQ16x24 V DC/0.5A HF; 16 channels in groups of 8	1	
29	6ES7592-1AM00-0XB0	Siemens	40-pin front connector for 35 mm wide modules; includes potential bridges.	6	

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JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.20**

Project Name: *Newport News WTP*	Project No. *WDC23456.C1*

FUNCTIONAL REQUIREMENTS:

1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-20 DWM*	*Jan-12-20 DWM*	*Feb-7-20 DWM*	*Mar-5-20 DWM*	*N.A.*	*May-6-20 VDA*	
FIC-10-2	*Jan-12-20 DWM*	*Jan-12-20 DWM*	*Mar-5-20 DWM*	*Apr-4-20 DWM*		*May-4-20 VDA*	
FSH-10-2	*Jan-12-20 DWM*	*Jan-12-20 DWM*	*Mar-5-20 DWM*	*Apr-4-20 DWM*		*May-7-20 VDA*	
FAH-10-2	*Jan-12-20 DWM*	*Jan-12-20 DWM*	*Mar-5-20 DWM*	*Apr-4-20 DWM*		*May-7-20 VDA*	
FCV-10-2	*Mar-2-20 DWM*	*Mar-2-20 DWM*	*Apr-20-20 DWM*	*Apr-30-20 DWM*		*May-16-20 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-20*	Loop No.: *10-2*

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JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER** Rev.06.05. 20

COMPONENT	MANUFACTURER		PROJECT
Code: *A7*	Name: *Leeds & Northrup*		Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Serial #: *11553322*	Name: *UOSA AWT PHASE 3*

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*	*1.*	*N.A.*		*N.A.*		
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	3.					
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		6.					

#	NOTES:	Component Calibrated and Ready for Start-up
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-20*
		Tag No.: *AIT-12-6*[pH]

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JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.20

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-20*	Valve Action	*JDS*	*Jun-03-20*
Positioner	*JDS*	*Jun-06-20*	Installation	*JDS*	*Jun-03-20*
Position Switches	*JDS*	*Jun-06-20*	Wire Connection	*JDS*	*Jun-04-20*
I/P Converter	*JDS*	*Jun-07-20*	Tube Connection	*JDS*	*Jun-04-20*
Actual Speed	*JDS*	*Jun-07-20*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-20	By: *J.D. Sewell*
	Date: *Jun-07-20*
	Tag No.: *FCV-10-2-1*

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JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.20

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*
Demonstration test(s): For each functional Requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.	
1. MEASURE EFFLUENT FLOW	
1.a With no flow, water level over weir should be zero and	
FIT indicator should read zero.	*Jun-20-20 BDG*
2. FLOW INDICATION AND TRANSMISSION TO LP & CCS	
With flow, water level and FIT indicator should be related by expression	
*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*	
Vary H and observe that following.	
2.a Reading of FIT indicator.	*Jun-6-20 BDG*
2.b Reading is transmitted to FI on LP-521-1	*Jun-6-20 BDG*
2.c Reading is transmitted and displayed to CCS.	*Jun-6-20 BDG*
H(measured) 0 5 10 15	
Q(computed) 0 47.96 135.7 251.7	
Q(FIT indicator) 0 48.1 137 253	
Q(LI on LP-521-1) 0 48.2 138 254	
Q(display by CCS) 0 48.1 136.2 252.4	

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-20*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-20*	Date: *Jun-6-20*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-20*	
Witnessed	*B. DeGlanville*	*Jun-6-20*	Loop No.: *30-12*

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SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Pressure Gauge: For other than process variable measurement.

1. Dial Size: Nominal 2-inch dial size.
2. Accuracy: 2 percent of span.
3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.

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4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
5. Manufacturer and Product: Ashcroft Utility; Gauge Series 1000.

B. Valve, Needle:

1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
2. Size: 0.020-inch orifice.
3. Manufacturers and Products:
   a. Whitey; Model 21RF2.
   b. Hoke; 3700 Series.

C. ON/OFF Valves:

1. Type: V306 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, NPT threaded ends, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 1,000 pounds per square inch gauge CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
      3) “Or-equal.”

D. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke; 3100 Series through 3300 Series.

E. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.

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2. Materials:
    a. Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
    b. Valve Seat: Buna-N.
3. Size: Normally closed or opened, as noted.
4. Coil: 115V ac, unless noted otherwise.
5. Solenoid Enclosure: NEMA 4.
6. Manufacturer and Product: ASCO; Red Hat Series 8260.

F. Pressure Regulator, Air:

1. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 pounds per square inch supply pressure.
2. Setscrew for outlet pressure adjustment.
3. Integral filter and relief valve.
4. Manufacturers and Products:
    a. Masoneilan; Series 77-4.
    b. Fisher; Series 67FR.

G. Pressure Regulator, Water:

1. Materials:
    a. Body: Bronze.
    b. Spring Case: Cast iron.
    c. Seat Rings: Brass.
    d. Valve Disk and Holder: Buna-N and bronze.
    e. Diaphragm: Buna-N diaphragm.
2. Sizing: For maximum of 7 pounds per square inch offset pressure.
3. Manufacturers and Products:
    a. Fisher; Controls Type 95H or 95L.
    b. Masoneilan; Series 17.

H. Test Tap:

1. Manufacturers and Products:
    a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
    b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
    c. Parker; CPI Series precision quick couplings.

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I. Plastic Tubing and Fittings:

1. Tubing:
   a. Polyethylene capable of withstanding 190 pounds per square inch gauge at 175 degrees F.
   b. Manufacturers and Products:
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

J. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on the Drawings.

K. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.
2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 pounds per square inch maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

L. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

M. Pneumatic Directional Control Valve Manifold Assembly
1. Manifold:
   a. Function: Modular pneumatic valve manifold for centralized mounting of electrically actuated directional control valves, providing controlled distribution of compressed air to multiple pneumatic devices.

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b. Type: Modular, field-expandable solenoid valve manifold with integrated electrical terminal assembly and speed controls.
c. Components:
    1) Manifold base compatible with valves.
    2) Electrical terminal assembly, 16-terminal configuration.
    3) Integrated speed controls.
    4) Pneumatic inlet, outlet, and exhaust ports.
    5) Mounting hardware and end plates.
d. Materials:
    1) Manifold Body: Anodized aluminum or equivalent corrosion-resistant alloy.
    2) Seals: NBR or equivalent elastomers suitable for compressed air service.
    3) Speed Control Components: Brass or stainless steel with polymer adjustment elements.
    4) Fasteners: Zinc-plated or stainless steel as appropriate for environment.
e. Electrical:
    1) Electrical interface via integrated terminal assembly.
    2) Terminal Strip Count: 16 terminals.
    3) Wiring capacity suitable for solenoid valve loads, per manufacturer.
    4) Electrical isolation between valve coils and manifold body per applicable standards.
f. Mechanical Connections:
    1) Push-in or threaded fittings compatible with industrial pneumatic tubing.
    2) Common supply and exhaust channels integrated into manifold base.

2. Directional Control Valve:
    a. Function: Electrically actuated directional control valve for controlling airflow to pneumatic actuators.
    b. Type: Solenoid-operated directional control valve, manifold-mount design.
        1) Single solenoid pilot, (spring return) w/flush non-locking override.
        2) Two position, four-way with speed control.
    c. Mechanical Connections: 1/4-inch push in fittings.
    d. Electrical:
        1) Voltage: 120V ac.
        2) Wiring: Plug-in AC with light.

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2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Standard DIN rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: Minimum of one at each end of rail.
   g. Wire Preparation: Stripping only permitted.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
      5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25-inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturer and Product: Entrelec; Type M4/6.T.

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3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25-inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P.
4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25-inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT.
5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 ma.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product: Phoenix Contact ST-IN.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25-inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512-inch, maximum.
   i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25-inch by 1.25 inches.
   g. Indication: Neon lamp, 110V ac.
   h. Leakage Current: 1.8 mA, maximum.
   i. Spacing: 0.512-inch, maximum.
   j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.

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8. Terminal Block, Fused, 120V ac, High Current:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 35 amps.
    c. Wire Size: 18 AWG to 8 AWG.
    d. Rated Wire Size: 8 AWG.
    e. Color: Gray.
    f. Fuse: 13/32-inch by 1.5 inches.
    g. Spacing: 0.95-inch, maximum.
    h. Manufacturer and Product: Entrelec; Type MB10/24.SF.
9. Terminal Block, Multi-Level Fused, 24V dc:
    a. Level 1: Fused.
    b. Level 2: Feed through.
    c. Grounding Foot: Yes.
    d. Rated Voltage: 12V dc to 30V dc.
    e. Wire Size: 26 AWG to 10 AWG.
    f. Rated Wire Size: 10 AWG.
    g. Color: Black.
    h. Fuse: 5x20 mm.
    i. Indication: LED.
    j. Manufacturer and Product: Phoenix Contact; UT 4 L/HESILED 24 (5×20).
10. Terminal Block, Multi-Level, 500V:
    a. Level 1: Feed through.
    b. Level 2: Feed through.
    c. Grounding Foot: Yes.
    d. Rated Voltage: 0V to 500V.
    e. Rated Current: 30A.
    f. Wire Size: 26 AWG to 10 AWG.
    g. Rated Wire Size: 10 AWG.
    h. Color: Grey.
    i. Manufacturer and Product: Phoenix Contact; UT 4 PE/L/L.

B. Relays:

1. General:
    a. Relay Mounting: Plug-in type socket.
    b. Relay Enclosure: Furnish dust cover.
    c. Socket Type: Screw terminal interface with wiring.
    d. Socket Mounting: Rail.
    e. Provide holddown clips.
2. Signal Switching Relay:
    a. Type: Dry circuit.
    b. Contact Arrangement: 2 Form C contacts.
    c. Contact Rating: 5 amps at 28V dc or 120V ac.
    d. Contact Material: Gold or silver.

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e. Coil Voltage: As noted or shown.
f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Seal Type: Hermetically sealed case.
k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.

3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
4. Control Circuit Switching Relay, Latching:
   a. Type: Relay and socket assembled interface modules for high-density interposing applications.
   b. Contact Arrangement: 1 Form C contacts.
   c. Contact Rating: 6A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.3 watts (dc), 0.4VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 10,000,000 operations.
   i. Manufacturer and Product: Allen-Bradley; Series 700-HLTN.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.

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k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage, high-energy metal oxide varistor and second-stage, silicon avalanche diodes separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 40 degrees C to plus 50 degrees C, derated at 70 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
   f. Monitoring: Local LED status indication and remote monitoring contact.
2. Suppressors on 120V ac Power Supply Connections:
   a. Occurrences: Tested and rated for IEEE C62.41 Categories A and B test waveform.
3. Manufacturer and Product:
   a. 120V ac Lines: Sola HD; STFE Elite Series.

D. Power Supplies:

1. Power instruments requiring external dc power, including PLC modules, two-wire transmitters and dc relays.
2. Furnish dual power supplies with redundancy module.
3. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
4. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.
5. Mount such that dissipated heat does not adversely affect other components.
6. Manufacturers and Products: Sola HD, SDN-C Series.
7. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.

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E. Uninterruptible Power Supply (UPS):

1. General:
   a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   b. Type: Continuous-duty, online, double conversion, power isolated.
      1) Major Parts: Rectifier, inverter, battery charger, sealed batteries, automatic bypass, control, and monitor electronics.
2. Performance:
   a. Capacity: 3,000 VA/2,700W minimum.
   b. Input Power:
      1) 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer's standard, unless otherwise noted.
   c. Output Power:
      1) 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer's standard, unless otherwise noted.
   d. Online Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 30 minutes minimum, unless otherwise noted.
      2) Half Load: 60 minutes minimum, unless otherwise noted.
   f. Include provisions for future expansion of battery capacity via manufacturer's standard battery packages.
      1) Furnish extra battery modules as required to meet backup runtime requirements.
   g. Continuous no-break power with no measurable transfer time.
   h. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 6 percent or less.
   i. Input Voltage Range: Plus 15 percent, minus 20 percent.
   j. Output Voltage Regulation: Plus or minus 3 percent nominal.
   k. Operating Temperature: 0 degree C to 40 degrees C (32 degrees F to 104 degrees F).
   l. Operating Relative Humidity: 5 percent to 95 percent without condensation.
   m. Batteries: Lithium-ion, hot-swappable.

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n. Features:
1) Provide relay connectivity card for communicating the to the plant control system:
a) Configure general alarm to trigger if any of the following conditions are true: Low Battery, Battery Fault, Current Limit, or Power Overload.
o. Enclosures:
1) Tower for control panels.
2) Rack mount for network panels.
3) Unless otherwise noted.
p. Manufacturer and Product:
1) Eaton: 9PX.
2) "Or approved equal."

F. Maintenance Bypass Switches:

1. General:
a. Function: Hot-swap maintenance bypass switch that will completely isolate power from the UPS without interruption of power to the loads being served.
2. Performance:
a. Input Power: 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
b. Output Power: 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
c. Operating Temperature: 0 degree C to 60 degrees C (32 degrees F to 140 degrees F).
3. Features:
a. Hand switch for mode toggle, UPS/Bypass
b. Power distribution unit, four or more outlets.
c. Mounting: 19-inch rack mount, or wall mount.

2.04 I&C COMPONENTS

A. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Section 40 90 00, Instrumentation and Control for Process Systems. Furnish equipment that is necessary to achieve required loop performance.

2.05 ANALYTICAL COMPONENTS

A. A20 Dissolved Oxygen Element, Luminescent (LDO):

1. General:
a. Function: Continuous measurement of dissolved oxygen (DO) concentration of process fluid.

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b. Type: Luminescent optical sensor.
c. Parts: Element (sensor), interconnecting cable, and noted accessories.
d. Transmitter: One multi-channel transmitter for each group of analytic probes as noted or shown.

2. Performance:
a. Measuring Range: 0 mg/L to 20 mg/L.
b. Sensor Accuracy: Plus or minus 0.1 mg/L.
c. Response Time: Less than 80 seconds to 90 percent of value upon step change.

3. Element:
a. Type: Luminescent optical digital sensor.
b. Process Temperature Range: 32 degrees F to 140 degrees F.
c. Submersion Depth: 300 feet.
d. Surge Protection: Integral overvoltage protection.
e. Sensor Cable: Integral cable with M12 plug, length as required.

4. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Multi-Channel.

5. Accessories:
a. Air Cleaning Head: For electrode cleaning air connection.
b. Mounting Hardware: Submersion mounting hardware with handrail swing and swivel mounting kit and associated hardware.
1) PVC immersion tube, length as required for application.
2) Pipe protection cap.
3) Cross clamp handrail assembly.
4) 45-degree probe connecting pipe.
5) Sensor connection adapter.
6) Immersion pipe maintenance tray, handrail mount.
c. Junction Box: Field termination box, mount near sensor location.
d. Cable: Lengths as required for wiring probe to junction box, and from junction box to transmitter, locations as shown on the Drawings.

6. Manufacturer and Product: Endress + Hauser; COS61D with CYA112 and CYH112 assemblies.

B. A150 Analytical Indicating Transmitter, Multi-Channel:

1. General:
a. Function: Interface with analytical probes provided by same vendor. Provide local indication, configuration, calibration, and output of probe measurements.

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2. Transmitter System:
    a. Ambient Conditions:
        1) Temperature minus 20 degrees C to 55 degrees C (minus 4 degrees F to 131 degrees F).
        2) Humidity: 0 percent to 95 percent, relative, noncondensing.
    b. Display: Graphic LCD, with LED backlighting.
        1) Display primary readout of probe data in engineering units.
        2) Auxiliary Readout:
            a) Temperature.
            b) Diagnostic warnings.
            c) Error messages.
            d) Probe configuration.
            e) Other information.
    c. Controller:
        1) Function: Communicate with probes. Maintain system configuration.
        2) Signal Interface:
            a) Number of Channels: Six.
            b) Analog Output: 4 mA dc to 20 mA dc.
            c) Discrete Output: Relay contact for the first four channels, for control of automatic air blast cleaning.
            d) Communication Protocol: PROFINET.
            e) Diagnostics Monitoring: Heartbeat Verification and Monitoring.
        3) Analytical Probe Measurement: As noted.
        4) Quantity: As shown. Each system supports up to four probes.
        5) Probe Detection: Automatic plug-and-play detection of connected probe.
        6) Probe Connection: Provide cable for each probe, length as required to suit installation.
    d. Enclosures: None. Mount in Analyzer Control Panel.
    e. Mounting: Back panel.
    f. Power Requirements: 110V ac plus or minus 10 percent, 50/60-Hz.
3. Configuration:
    a. CM448 PROFINET cyclic mapping by assigning internal device variables to AI-1..AI-16 and DI-1..DI-8.
        1) AI 1:
            a) DO Probe 1: DO concentration (mg/L).
        2) AI 2:
            a) DO Probe 1: Temperature (Celsius)
        3) AI 3:
            a) DO Probe 2: DO concentration (mg/L).

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4) AI 4:
   a) DO Probe 2: Temperature (Celsius).
5) AI 5:
   a) DO Probe 3: DO concentration (mg/L).
6) AI 6:
   a) DO Probe 3: Temperature (Celsius).
7) AI 7:
   a) DO Probe 4: DO concentration (mg/L).
8) AI 8:
   a) DO Probe 4: Temperature (Celsius).
9) AI 9:
   a) Probe 5 (future) Process Variable (reserved).
10) AI 10.AI 16: Leave spare for future expansion.
11) DI-1: Relay 1 Status (Air Blast Valve 1 Open Command Feedback).
12) DI-2: Relay 2 Status (Air Blast Valve 2 Open Command Feedback).
13) DI-3: Relay 3 Status (Air Blast Valve 3 Open Command Feedback).
14) DI-4: Relay 4 Status (Air Blast Valve 4 Open Command Feedback).
15) DI-5: Probe 1 Diagnostic Code.
16) DI-6: Probe 2 Diagnostic Code.
17) DI-7: Probe 3 Diagnostic Code.
18) DI-8: Probe 4 Diagnostic Code.

b. Provide SD-card backup of final transmitter configuration at turnover.

4. Accessories: Stainless steel equipment tags.
5. Manufacturer and Product: Endress + Hauser; CM448R.

2.06 FLOW COMPONENTS

A. F22 Control Unit, Flow (Transmitter):

1. General:
   a. Function: Control unit for level and open channel flow measurement. Accepts input from compatible ultrasonic, radar, hydrostatic, or universal 4 mA to 20 mA/HART sensors.
   b. Type: Multi sensor interface and display module.
   c. Parts: Control unit with display, power supply terminals, I/O module, and accessories as noted.
   d. Sensor Capacity: Supports up to two level sensors simultaneously.

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2. Service:
    a. Applications:
        1) Water and wastewater level measurement.
        2) Open channel flow measurement (weirs/flumes).
        3) Pump control.
        4) Rake/solids control.
    b. Vapor Space Pressure: Atmospheric.
    c. Operating Ambient Temperature Range: minus 40 degrees F to plus 140 degrees F typical (per FMA90 application range).
3. Performance:
    a. Inputs: One or two 4 mA to 20 mA or 4 mA to 20 mA/HART level signals.
    b. Functions:
        1) Level scaling and linearization.
        2) Open channel flow calculation using built in flume/weir curves.
        3) Pump control logic.
        4) Alarm and relay control.
    c. Accuracy: Measurement accuracy dependent on connected sensor.
4. Transmitter:
    a. Material: Aluminum.
    b. Rating: NEMA 4X / IP66/67.
    c. Mounting: Wall, pipe, DIN rail, or panel.
    d. Power Supply: 120V ac.
    e. Display: 3-1/2-inch color display with glove operable touch interface.
    f. Analog Outputs:
        1) One 4 mA to 20 mA output for single input.
        2) Two 4 mA to 20 mA outputs for dual inputs.
    g. Digital Outputs:
        1) Five mechanical relay outputs (2 × SPDT, 3 × SPST).
        2) Three open collector NPN outputs.
    h. Communication: ProfiNet or Modbus/TCP.
    i. Configuration: Configure transmitter for Parshall flume flow calculation.
5. Accessories: Mounting brackets or DIN rail kits as noted.
6. Manufacturer and Product: Endress + Hauser: FlexView FMA90.

B. F22 Flow/Level Sensor, Radar:

1. General:
    a. Function: Continuous, noncontacting level measurement.
    b. Type: Radar, 80 GHz.
    c. Parts: Element with integral transmitter, and accessories as noted.

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2. Service:
    a. Application: Water level measurement.
    b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
    c. Operating Temperature Range:
        1) Element: Minus 40 degrees F to plus 176 degrees F.
3. Performance:
    a. Range: As noted.
    b. Zero Reference: As noted.
    c. Accuracy: Plus or minus 0.25 percent of maximum range or 4 mm, whichever is greater.
    d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
    e. Blanking Distance: Sensor dependent, typically 1 foot.
4. Antenna:
    a. PTFE cladded, flush mount 40 mm (1-1/2-inch) antenna.
    b. Beam Angle: 8 degrees.
    c. Housing Seal: EDPM
5. Transmitter:
    a. Power Supply: Loop Powered.
    b. Analog Output:
        1) One Minimum: 4 mA dc to 20 mA dc for load impedance of 0 ohms to 750 ohms.
    c. Digital Communication: Bluetooth.
    d. Discrete Outputs: None.
6. Accessories:
    a. Remote Programming Software: If noted.
        1) Allows remote programming via computer and echo traces for troubleshooting.
        2) One per lot of units furnished.
    b. Others: As noted.
7. Manufacturer and Product: Endress + Hauser; Model FMR20B.

C. F51 Flow Element and Transmitter, Thermal Mass Flow:

1. General:
    a. Function: Directly measure, indicate, and transmit mass flow of gas in pipe.
    b. Type: Insertion type, thermal dispersion detection probe using platinum resistance temperature detectors (RTD).
    c. Parts: Flow conditioner, elements, transmitter, and interconnecting cable.
2. Performance:
    a. Process Gas: Low pressure process air.
    b. Range for Air at minus 40 degrees F to 266 degrees F.
    c. Calibrated Span: As noted.

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d. Accuracy:
   1) Flow: Plus or minus 1 percent of reading plus 0.5 percent full scale.
   2) Temperature: Plus or minus 2 degrees F.
e. Repeatability:
   1) Flow: Plus or minus 0.4 percent of reading.
   2) Temperature: Plus or minus 1 degree F.
f. Temperature, Operating:
   1) Flow Element: Minus 40 degrees F to plus 266 degrees F, unless otherwise noted.
   2) Transmitter Housing: Minus 40 degrees F to plus 140 degrees F.
g. Pressure, Operating, Flow Element: Up to 290 pounds per square inch gauge, unless otherwise noted.

3. Flow Element:
   a. Features:
      1) Insertion Length: As noted or manufacturer's recommendation for pipe diameter.
      2) Wetted Surfaces Materials: Type 316 stainless steel with nickel braze, unless otherwise noted.
   b. Process Connection:
      1) Line Size: As indicated.
      2) Connection Type: Insertion.
      3) Connection Material: Type 316 stainless steel.
   c. c. Sensor Enclosure:
      1) Type: Aluminum, NEMA 4X, unless otherwise noted.
4. Transmitter:
   a. Features: Four line by 20-character LCD, keypad programmable.
   b. Nonvolatile memory.
   c. Mounting Type: Integral.
   d. Signal Interface:
      1) Outputs:
         a) Analog: Two isolated 4 mA dc to 20 mA dc for maximum 600-ohm load, with HART.
         b) Discrete:
            (1) 10 amps at 115V ac or 24V dc.
            (2) Configurable as high or low flow or process temperature.
   e. Power: 100V ac to 240V ac.
   f. Electrical Connection: 1/2-inch NPT.
   g. Transmitter Enclosure: NEMA 4X, unless otherwise noted.
5. Accessories:
   a. Flow Conditioner:
      1) Mounting: In upstream pipe.
      2) Size: As noted.

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3) Function: Improve meter accuracy and repeatability for installation with reduced upstream straight approach.

b. Sun Shield.

c. Stainless steel equipment tags.

6. Cables:

a. Length: As required.

b. Cable Jacket: PVC rated for 220 degrees F, unless otherwise noted.

7. Manufacturer and Product: Endress + Hauser; Proline t-mass I300.

2.07 PRESSURE COMPONENTS

A. P04 Pressure Gauge:

1. General:

a. Function: Local pressure indication.

b. Type: Full size Bourdon tube element.

2. Performance:

a. Scale Range: As noted.

b. Accuracy: Plus or minus 0.50 percent of span.

3. Features:

a. Dial: 4 1/2-inch diameter.

b. Pointer Vibration Reduction: Required, unless otherwise noted. Method as follows:

1) Liquid filled gauge front. Glycerine fill, unless otherwise noted.

c. Case Material: Black phenolic.

d. Element Material: Type 316 stainless steel, unless otherwise noted.

e. Pointer: Adjustable by removing ring and window.

f. Window: Glass, unless otherwise noted.

g. Threaded reinforced polypropylene front ring.

h. Case Type: Solid front with blow-out back.

i. Movement: Teflon coated 400 series stainless steel rotary movement.

4. Process Connection:

a. Mounting: Lower stem, unless otherwise noted.

b. Size: 1/2-inch MNPT, unless otherwise noted.

c. Socket (Connection) Material:

d. Suitable for use with associated element.

e. Type 316 stainless steel, unless otherwise noted.

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5. Accessories:
    a. Provide diaphragm seals if specified in the Contract Documents and as indicated on the instrument data sheets.
        1) Ashcroft:
        2) Flushing connection: Type 201.
        3) Without Flushing Connection: Type 200.
    b. Throttling Device: Required, unless otherwise noted.
    c. Type: Throttle screw, unless otherwise noted.
    d. Material and Size: 0.020-inch, Type 316 stainless steel, unless otherwise noted.
6. Manufacturer and Product: Ashcroft; Duragauge Model 1279

2.08 CONTROL AND NETWORK COMPONENTS

A. Programmable Logic Controller System:

1. General:
    a. Type: Microprocessor based device programmable with chassis-mounted plug-in modules. Multiple chassis networked together to form distributed programmable controller systems.
    b. Parts:
        1) Furnish PLC components that are listed in the PLC Equipment List in Section 40 90 00, Instrumentation and Control For Process Systems, Supplement 5.
        2) Furnish components and accessories required to make a complete and totally operational system.
2. Manufacturer: Siemens.
    a. CPU: SIMATIC S7-1500 Series.
    b. RIO & I/O Modules: SIMATIC ET-200MP Series.
    c. No substitutions permitted.
3. Environmental:
    a. General: Noncontrolled environment (such as, variable heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering.
    b. Temperature: Operating range 32 degrees F to 140 degrees F (0 degrees C to 60 degrees C).
    c. Humidity: Operating range 5 percent to 95 percent noncondensing.
4. Identification: Nameplates installed above/below each PLC component (CPU, I/O rack, and power supply).

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B. Industrial Ethernet Switch (DIN Rail Mount):

1. General:
   a. Function: Connect remote IO modules and networked field equipment to its associated PLC.
2. SCADA Network Ethernet Switch:
   a. 10-Port Expandable Switch:
      1) Sixteen 10/100/BaseT(X) Ports. Two combination 10/100/1000BaseT(X) or 100/1000BaseT SFP+ Ports.
      2) Mounting: DIN-Rail.
      3) Power Input: Dual, 9.6V dc to 60V dc.
      4) Environmental Conditions:
         a) Operating Temperature: Minus 10 degrees C to 60 degrees C (minus 40 degrees F to plus 140 degrees F).
         b) Operating Relative Humidity: 5 percent to 95 percent without condensation.
      5) Accessories:
         a) Furnish two multimode OM3 SFP transceivers with LC connectors per network switch .
         b) 5-year hardware warranty.
      6) Manufacturer and Product:
         a) Moxa; EDS-2018-ML series.
         b) “Or approved equal.”

C. DIN Rail Mount Copper Patch Panels (CPP):

1. Function: Provides secure place to terminate Ethernet cables entering or exiting NIPs or LCPs.
2. Location: See Network Components List and Project Drawings.
3. Patch Panel:
   a. UL 1863 certified.
   b. Mounting: DIN rail.
   c. Ports: 8, minimum.
4. Connectors: CAT6 jack module, Compatible with CAT6 (Type 31) cable specified in Section 26 05 01, Electrical.
5. Manufacturers:
   a. Panduit; Mini-com series.
   b. RLH Industries Inc; Slimline series.

D. DIN Rail Mount Fiber Patch Panels (FPP):

1. Function: Provides secure place to terminate fiber optic cables in existing LCPs.
2. Location: See Network Components List and Project Drawings.

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3. Patch Panel:
   a. UL 1863 certified.
   b. Mounting: DIN rail.
   c. Connectors: LC style single mode connectors for entry and exit.
   d. Fiber Count: 12 strand, unless otherwise noted.
   e. Compatible with fiber optic cable specified in Section 40 95 80, Fiber Optic Communication System.
4. Manufacturers:
   a. Corning; Single-Panel Housing series.
   b. RLH Industries Inc; Slimline series.
5. Identification: Nameplates installed above/below each.

E. Ethernet Lightning and Surge Protector:

1. Application: Provide surge protection for copper Ethernet communication circuits serving outdoor devices.
2. Network Compatibility:
   a. Suitable for 10/100/1000 Base T Ethernet networks.
   b. Compatible with CAT5, CAT5e, CAT6, and CAT6a cabling.
   c. Connectors: Shielded RJ45 female connectors, input and output.
3. Protection: Provide gas tube protection for common-mode and differential-mode surge events.
4. Manufacturer:
   a. L-Com.
   b. “Or-equal.”

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. See the following Network Block Diagrams for more details: 008-N-0001 through 008-N-0003.

B. Contractor shall submit, provide, install, label, and test all fiber cabling. Refer to the Drawings. Network Block Diagrams illustrate the fiber cabling.

C. Furnish and install two 12-strand multi-mode fiber optic cables originating from control panel CP-3B located in the RAS building electrical room with one cable being routed to CP-3B, RIO-1 and the other cable being routed to CP-3B, RIO-2.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
    a. S-83-596, Optical Fiber Premises Distribution Cable.
    b. S-87-640, Optical Fiber Outside Plant Communications Cable.
    c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Telecommunications Industry Association (TIA):
    a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
    b. 568-D.1, Commercial Building Telecommunications Cabling Standards.
    c. 568-D.3, Optical Fiber Cabling Components Standard.
    d. 598, Optical Fiber Cable Color Coding.

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e. 606, Administration Standard for Commercial Telecommunications Infrastructure.

9. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
   a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
   b. 455-133, FOTP-133 IEC 60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
   c. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
   d. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
   e. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
   f. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and Type SC-APC.
   g. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
   h. 942, Telecommunications Infrastructure Standard for Data Centers.
   i. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
10. UL: 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. dB: Decibel.

D. DNI: Desktop Network Interface.

E. EMB: Effective Modal Bandwidth.

F. ETL: Electrical Test Laboratories.

G. FDDI: Fiber Distributed Data Interface.

H. FIM: Facilities Information Management.

I. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

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J. FOCS: Fiber Optic Communication System.

K. FOIRL: Fiber Optic Inter Repeater Link.

L. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

M. Hybrid Cable: Cable containing more than one type of fiber.

N. LAN: Local Area Network.

O. LIMS: Laboratory Information Management System.

P. m: Micrometer.

Q. Mbps: Megabits per Second.

R. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

S. Megahertz (MHz): One million cycles per second.

T. MHz: Megahertz.

U. micro: x 10^{-6}.

V. Micron: Micrometer or one millionth meter.

W. MIS: Management Information System.

X. n, nano: x 10^{-9}.

Y. N: Newton.

Z. nm: Nanometer—unit of measure equal to one billionth meter.

AA. OFL: Over-filled Launch.

BB. OFN: Nonconductive Optical Fiber Cable.

CC. OFNP: Nonconductive Optical Fiber Plenum Cable.

DD. OFNR: Nonconductive Optical Fiber Riser Cable.

EE. OLTS: Optical Loss Test Sets.

FF. OTDR: Optical Time Domain Reflectometer.

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GG. OVD: Outside Vapor Deposit.

HH. PIC: Process Instrumentation and Control.

II. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

JJ. RLM: Restricted Mode Launch.

KK. ROL: Reverse Oscillation Lay.

LL. SPC: Super Physical Contact.

MM. UPC: Ultra Physical Contact.

NN. UPS: Uninterruptible Power Supply.

OO. V ac: Volts Alternating Current.

PP. WAN: Wide Area Network.

1.04 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a FOCS based on referenced standards for use in the following local and wide area networks: Gigabit Ethernet.

C. Network(s) will be used by PIC to distribute data and coordinate Owner's operations.

D. Refer to Network Drawings and Site Electrical Drawings for routing, cabling, terminations, locations, labeling, and all other information required for fiber optic installation and testing.

1.05 SUBMITTALS

A. Action Submittals:

1. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable.
   c. Cable length.
2. Component Data:
   a. Manufacturer and model number.
   b. General data and description.

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c. Engineering specifications and data sheet.
d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
2. Subcontractor Qualifications:
   a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
   b. Qualification of Personnel:
      1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
      2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
         a) Fiber optic cable handling and placement techniques.
         b) Fiber optic splicing and installation of connections.
         c) Attenuation testing procedures.
3. Sample of Fiber Optic Test Report.
4. Signed Fiber Optic Test reports. Documentation covering fiber facility testing, not later than 5 days after testing, showing:
   a. Post-installation fiber optic cable test summary.
   b. Post-installation fiber optic cable attenuation results (measured with OLTS) and OTDR test results.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

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1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-D.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-D.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

PART 2 PRODUCTS

2.01 FIBER OPTIC CABLE

A. General Fiber Requirements:

1. Suitable for the installed environment.
2. Color-coded fibers according to TIA/EIA-598.

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3. Color-coded buffer tubes according to TIA/EIA-598.
4. Provide the high tensile strength Aramid yarns, Jevlar, and/or fiberglass helically stranded evenly around the cable core:
    a. No metallic elements whatsoever are allowed in non-armored cable.
5. The jacket or sheath shall be free of holes, splits, and blisters.

B. SINGLE-MODE FIBER OPTIC CABLE

1. Type OS2:
    a. Individual Fibers:
        1) 8.2/125 micron - Graded-index for use in ducts, backbone and horizontal distribution systems, and risers, meets or exceeds the requirements of TIA 568 C.3 including the following specifications:
            a) Chromatic Dispersion:
                (1) Zero-Dispersion Wavelength: Between 1,302 nm and 1,322 nm.
                (2) Maximum value of dispersion slope at zero dispersion wavelength shall be no greater than 0.093 ps per km-nm2.
            b) Maximum Mean Fiber Loss:
                (1) 0.4 dB per km at 1310 nm.
                (2) 0.4 dB per km at 1550 nm.
            c) Distance Capacity:
                (1) 1 GB Ethernet at 5000 m at 1310 nm.
    b. Assembly:
        1) Distribution Style with core of individually tight-buffered fibers surrounded by nonmetallic sheath.
        2) Cable: Comply with ICEA S-104-696.
        3) Water-swellable strength members
        4) Fiber Count: As shown on the Drawings.
    c. NEC/UL Listing: OFNR.
    d. Protective Covering: Flame retardant outer jacket with pull string.
2. Manufacturers and Products:
    a. Corning Cabling Systems; FREEDM cable.
    b. Mohawk; Distribution Riser cable.

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C. MULTIMODE FIBER OPTIC CABLE

1. Type 50/125/900 OM3, Indoor/Outdoor Cable:
   a. Individual Fibers:
      1) 50/125/900-micron, graded-index for use in ducts, backbone, and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568 C.3, including the following specifications:
         a) Maximum Mean Fiber Loss:
            (1) 3.5 dB per km at 850 nm.
            (2) 1.5 dB per km at 1,300 nm.
         b) Minimum OFL Bandwidth:
            (1) OM3-1500 MHz·km minimum at 850 nm; TIA 492AAAC.
            (2) 1,500 MHz·km minimum at 850 nm, and 500 MHz·km minimum at 1,300 nm.
         c) Distance Capacity per IEEE 802.3:
            (1) 100-Mbit Ethernet: OM3 1,000 m at 850 nm and 2,000 m at 1,310 nm.
         d) 1-Gbit Ethernet: OM3 1,000 m at 850 nm and 600 m at 1,310 nm.
         e) 10-Gbit Ethernet: OM3 300 m at 850 nm and 300 m at 1,310 nm.
   b. Assembly:
      1) Distribution Style with core of individually tight-buffered.
      2) fibers surrounded by nonmetallic sheath.
      3) Cable: Comply with ICEA S-104-696.
      4) Fiber Count: 12-strand, unless otherwise shown.
   c. NEC/UL Listing: OFNR.
   d. Protective Covering: Flame retardant outer jacket with pull string.
2. Manufacturers and Products:
   a. Corning Cabling Systems; FREEDM cable.
   b. Mohawk; Distribution Riser cable.

2.02 CONTROL PANELS (CP)

A. Supplied or modified by PICs System Integrator in accordance with Drawings and the Control Panel Schedule in Section 40 90 00, Instrumentation and Control for Process Systems.

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2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-D.3.
2. LC connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
    a. Ferrules: Free-floating low loss ceramic.
    b. Polarizing key on duplex connector systems.
5. Attenuation:
    a. In accordance with TIA 568-D.3.
    b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: AMP.

2.04 PATCHCORDS

A. General:

1. In accordance with TIA 568-D.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
    a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
    b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
    a. LC style.
    b. On-axial Pull Strength: 33 N.
    c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector:
    a. Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).

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2.05 CONDUIT

A. In accordance with Section 26 05 01, Electrical.

2.06 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
   a. Conduits and Innerducts: Size and number.
   b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts may be installed without exceeding manufacturer’s limitations.
   c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
3. Ensure conduit, and other confined routing is free and clear of debris before cable placement.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on the Drawings.
2. Installation by manufacturer’s certified installer.
3. Install cables in accordance with manufacturer’s requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer’s specification.
   c. Not bent to a radius below manufacturer’s minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.

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6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Splices: Install fiber optic cables in unspliced lengths between control panels.
8. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
9. Identification:
    a. Identify cable on both ends, in access holes, and pull points.
    b. In accordance with TIA 606.
10. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.

B. Control Panel, Fiber Patch Panels: Install securely in panels in accordance with manufacturer's installation instructions and as shown on the Drawings.

C. Cable Terminations:

1. In accordance with TIA 568-D.3.
2. Slack:
    a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
    b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
3. Connectors:
    a. Terminate 100 percent fibers in each cable to specified connector.
    b. Connect into fiber management system.
4. Exposed individual fibers is not permitted. All fibers must be installed within a patch panel.

3.03 LABELING CONVENTIONS

A. Individual cables: Label in accordance with the Network Block Diagrams.

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 48 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.

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5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results:
    a. Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
    a. Field test instrument shall be within calibration period recommended by manufacturer.
    b. Optical Loss Test Set (OLTS):
        1) Single-mode Optical Fiber Light Source:
            a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
            b) Output Power: Minus 10 dBm, minimum.
            c) Manufacturer: Fluke Networks.
        2) Multimode Optical Fiber Light Source:
            a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).
            b) Output Power: Minus 20 dBm minimum.
            c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-D.3, with Category 1 light source.
            d) Manufacturer: Fluke Networks.
        3) Power Meter:
            a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
            b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
            c) Store reference power measurement.
            d) Save at least 100 results in internal memory.
            e) PC interface (serial or USB).
            f) Manufacturer: Fluke Networks.
        4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

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3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Single-mode OTDR:
      1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      2) Event Dead Zone: 2 meters maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
      3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.
      4) Distance Range: Minimum 10,000 meters.
      5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,550 nm.
   g. Multimode OTDR:
      1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
      2) Event Dead Zone: 1-meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
      3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
      4) Distance Range: 2,000 meters minimum.
      5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.
   h. Manufacturer: Fluke Networks.
4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.
5. Integrated OLTS, OTDR, and Fiber Microscope:
   a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
   b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
   a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
   b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

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D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-D.1.
   g. TIA 568-D.3.
   h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-D.1.

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b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5

b. OTDR Testing:
   1) Reflective Events: Maximum 0.75 dB.
   2) Nonreflective Events: Maximum 0.3 dB.

c. Magnified Endface Inspection:
   1) Visually inspect fiber connections for end-face quality.
   2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

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H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
      1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
   c. Perform Testing:
      1) On each cabling segment (connector to connector).
      2) On each cabling channel (equipment to equipment).
      3) Using high-quality test cords of same fiber type as cabling under test.
         a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
         b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.
2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
      2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
      3) Perform tests in both directions.
3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Single-mode: 1,310 nm and 1,550 nm.
      2) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.
4. Length Measurement:
      1) Record length of each fiber.
      2) Measure optical length using OLTS or OTDR.

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5. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-D.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Circuit IDs reported by test instrument shall match specified label identification.
   d. Provide in electronic database for each tested optical fiber with the following information:
      1) Identification of Site.
      2) Name of test limit selected to execute stored test results.
      3) Name of personnel performing test.
      4) Date and time test results were saved in memory of tester.
      5) Manufacturer, model, and serial number of field test instrument.
      6) Version of test software and version of test limit database held within test instrument.
      7) Fiber identification number.
      8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
      9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
      10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
      11) Length for each optical fiber as calculated by the OTDR.
      12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

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I. Drawings:

1. As-built Drawings: Provide at end of Project.
   a. Include, but not limited to block diagrams, and cable labeling, cable termination points.
   b. Include field changes made up to construction completion:
      1) Network Block Diagrams.
      2) Field directed changes to cross connect and patching schedule.

END OF SECTION

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PART 2
DRAWINGS (BOUND SEPARATELY)