THE CITY OF GRESHAM

GRESHAM, OREGON

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

WWTP BFP REPLACEMENT

Project No. CIPWW00047

****

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JACOBS

Portland, Oregon

March 2026

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SEALS PAGE

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Kristina Milaj

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James H. Sackinger

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Brett W. Reistad

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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 new digested sludge dewatering centrifuges and maintenance platforms, thickening and dewatering polymer storage tanks, thickening and dewatering polymer blending units, modification to 4 existing stainless steel polymer storage tanks, revisions to primary sludge piping, and other miscellaneous associated improvements.

1.02 WORK NOT COVERED BY CONTRACT DOCUMENTS

A. Yard Filtrate Drain (FTR) piping modifications.

1.03 PROVISIONS FOR FUTURE WORK

A. None.

1.04 DEFINITIONS

A. General Conditions: The term “General Conditions” to be used interchangeably with “City Bid Booklet.”

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 DEFINITIONS

A. Owner: The City of Gresham.

B. Operator: Jacobs.

C. Engineer: Jacobs Engineering Group Inc.

1.02 SUBMITTALS

A. Informational:

1. Statement of Qualification (SOQ) for professional photographer and videographer.
2. Photographs:
   a. Digital Images: Submit one copy of DVD disc or other Owner approved media containing images within 5 days of being taken. Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
3. Video Recordings: Submit one copy, including updated copy of project video log, within 5 days of being taken.

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.

B. Upper Plant Nitrification Improvements:

1. Contact Person: Rob Chapler, City of Gresham.
2. Work to Be Performed by Contractor: None.

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C. Secondary Clarifier 5:

1. Contact Person: Rob Chapler, City of Gresham.
2. Work to Be Performed by Contractor: None.

D. Disinfection Improvements:

1. Contact Person: Rob Chapler, City of Gresham.
2. Work to Be Performed by Contractor: None.

E. Other Minor Projects:

1. Contact Person: Clark Flaharty, Jacobs.
2. Work to Be Performed by Contractor: None.

F. Plant Control System Work:

1. Contact Person: Jeff Kanyuch, Jacobs Engineering.
2. Work to Be Performed by Contractor: None.

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. Electricity Company:
   a. Contact Person: PGE, Utility Coordination.
   b. Telephone: (800) 332-2344.
2. Telephone Company:
   a. Contact Person: Verizon, Utility Coordination.
   b. Telephone: (800) 332-2344.
3. Water Department:
   a. Contact Person: Gresham Water Department.
   b. Telephone: (503) 618-2626.
4. Gas Department:
   a. Contact Person: NW Natural.
   b. Telephone: (800) 882-3377.

1.05 WORK SEQUENCING/CONSTRAINTS

A. Include the following work sequences in the Progress Schedule:

1. One belt filter press (BFP) with one dry polymer system, pair of polymer aging and feed tanks, and two BFP polymer feed pumps, or one dewatering centrifuge, dewatering polymer tank, and one

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dewatering polymer blending unit shall be in service at all times to maintain daily digested sludge dewatering operations.

2. A single dewatering centrifuge, dewatering polymer storage tank, and one dewatering polymer blending unit shall be started up and commissioned concurrently.
3. One pair of existing stainless steel dry polymer solution aging/feed tanks shall remain in service at all times until the thickening and dewatering polymer storage and associated polymer blending tanks have been commissioned and plant has completed startup for both thickening and dewater processes utilizing the new storage and feed system.
4. Primary sludge system modifications between the primary clarifier pump stations to the Sludge Blend tank shall be completed and placed in service before startup of any centrifuge system.
5. Two existing RDTs and corresponding polymer feed system and pumps shall be in service at all times.
6. The following is a potential work sequence of major critical activities required to accomplish the Work. The Contractor shall independently develop a work sequence for submittal and review and is not obligated to follow this sequence.
    a. Demolish Clarifier Polymer Pump 1 to Pump 4 (PFS 7551, PFS 7552, and PFS 7553) and the Orege system. Polymer service to clarifiers is being discontinued and piping can be removed in the building and capped at the building penetrations.
    b. Install Thickening Polymer Blend Units (PBUs) 1 to 3 (BLND 7601, BLND 7602, and BLND 7603) and install new polymer feed piping to each RDT unit. Commission PBUs one at a time with corresponding RDT unit. Use temporary emulsion polymer totes near the PBUs.
    c. Demolish Thickening Polymer Pump 7, Pump 8, and Pump 9 (PFS 7557, PFS 7558, and PFS 7559) and Dry Polymer Make Down Unit 1 (PDS 7511) along with associated piping, instruments, and controls. Modify Polymer Aging Tanks (PAT 7532 and PAT 7536) as shown on the Drawings to become new Dewatering Polymer Storage Tank 1 and Tank 2.
    d. Install Polymer Room Drain Sump in slab as shown on the Drawings.
    e. Install Dewatering PBU 1, PBU 2, and PBU 3 (BLND 7661, BLND 7662 and BLND 7663), polymer feed piping to BFP/Centrifuge 1 and Centrifuge 2 injection points, and electrical and control wiring.
    f. Install piping from Dewatering Polymer Storage Tank 1 and Tank 2 to Dewatering PBU 1, PBU 2 and PBU 3.
    g. Begin modifications to polymer room containment. Install Thickening Bulk Polymer Storage Pad and Tank (TNK 7631) and associated Recirculation Pump (PMP 7611) and piping. Install

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piping to Thickening PBUs (BLND 7601, BLND 7602, and BLND 7603).

h. Install truck unloading station and feed piping to the Thickening Polymer Storage Tank (TNK 7631) and Dewatering Polymer Storage Tank 1 and Tank 2 (PAT 7532 and PAT 7536).
i. Commission thickening polymer storage tank system and change over one thickening PBU at a time from temporary tote to bulk storage tank.
j. Commission Dewatering Polymer Storage Tank 1 and Tank 2 system and PBUs to feed existing BFPs.
k. Demolish BFP 2 and associated mechanical, electrical, I&C, and HVAC while continuing to keep BFP 1 and the associated polymer system in operation. Remove floor coating and containment curbing under BFP 2.
l. Install monorail supports on the ground floor and structural supports for new Centrifuge in the basement.
m. Install new air supply duct on the roof of the Solids Building.
n. Modify floor and containment as needed for the new Centrifuge. Install concrete support pedestals for Centrifuge 2.
o. Install Centrifuge 2 and associated discharge and transfer conveyors.
p. Modify existing MCC and run conduit to Centrifuge 2.
q. Install mechanical piping, and odor control duct connections to Centrifuge 2. Connect electrical and controls and install maintenance access platform.
r. Perform functional testing and commission Centrifuge 2 along with Dewatering PBU 2.
s. Once Centrifuge 2 has been commissioned and all dewatering operations have been transferred to Centrifuge 2, can repeat steps k-r for demolishing BFP 1 and installing Centrifuge 1 and then commissioning it along with dewatering PBU 1.
t. Demolish Dewatering Polymer Feed Pumps (PFS 7555 and PFS 7556).
u. Demolish Dry Polymer Make Down Unit 2 (PDS 7512) along with associated piping, instruments, and controls. Modify Polymer Aging Tanks (PAT 7542 and PAT 7546) as shown on the Drawings to become new Dewatering Polymer Storage Tank 3 and Tank 4. Install feed piping from truck unloading panel to dewatering polymer storage tanks.
v. Complete modifications to polymer room containment area curbs, grating, and stairs.
w. Install dewatering polymer storage pad and tank for Dewatering Polymer Storage Tank 5 (TNK 7681) and associated Recirculation Pump (PMP 7663). Install feed piping from truck unloading panel to Dewatering Polymer Storage Tank 5 and connect discharge

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piping from tank to Dewatering Polymer Storage Tank 1 to Tank 4 header. Commission Dewatering Polymer Storage Tank 5.

x. Concurrently with the work above, work can be done in each of the primary sludge pump stations to add new primary sludge piping as shown on the Drawing D-1010. One clarifier can be out of service at a time for between June 1 and September 30 to complete the Work.

y. The scum piping for all 3 primary clarifiers are interconnected. Maintain and coordinate with plant operations scum pumping capabilities to allow scum pumping to occur once per day.

z. Modifications to the piping for the Primary Sludge feed to the Sludge Blend Tank (TNK 7020 shall be completed as shown on the Drawing D-3004.

aa. For the yard piping modifications shown on the Drawing CY-1001, all three clarifiers must be kept in service at all times between October 1 and May 31. Between June 1 and September 30, only on clarifier can be offline at a time.

bb. Complete work to replace the pipe restraint for the 6-inch DS piping at the wall penetration in the Digester Control Building as shown on the Drawing D-4001.

cc. Protect and maintain existing tree(s) between Primary Clarifier Pump Station 1 and Primary Clarifier Pump Station 2.

7. Contractor's work must be coordinated with Engineer to accommodate Engineer's work, including the following:
   a. Preparation of network patching drawings to be used by the contractor for network cable labeling and termination detail.
   b. Configuration and deployment of the Operational Technology (OT) systems being installed as part of this Project.
   c. SCADA software programming and field testing for the new PLCs and SCADA HMI system. Contractor and Engineer will jointly participate in testing of the new infrastructure and systems.
8. Contractor cannot begin termination or patching of network cables until Engineer-provided patching drawings are complete.
   a. SCADA network and computer equipment cannot be installed or commissioned until all major construction is complete in the area. Network and computer electronic equipment is compromised by dust, dirt, and heat. Major work that must be complete in the area prior to installation of electronics includes flooring, drywall installation or mudding or taping or sanding, painting, and supply of UPS power.

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1.06 FACILITY OPERATIONS

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. 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.

D. Do not close lines, 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.

E. Process or Facility Shutdown:

1. The following shall require shutdown at some time during the Work:
   a. Sludge Blending Tank (TNK-7200) no longer than 8 continuous hours per day.
   b. Sludge thickening process no longer than 4 continuous hours per day.
   c. Only one primary clarifier can be down at a time for between June 1 and September 30. All primary clarifiers shall be in service between October 1 and May 31. Coordinate with plant operations staff to drain and cleanout clarifier that will be out of service for more than a day.
2. Provide 7 days advance written request for approval of need to shut down a process or facility to Owner and Engineer.
3. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.

F. Install and maintain temporary polymer storage totes and mixing units along with temporary polymer feed piping as required to keep Owner's thickening and dewatering operations on line while existing equipment is being demolished and new equipment installed. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

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G. 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.

H. 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.

1.07 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.

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. Upon receipt, Owner will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office.
3. 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.

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1.08 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 a minimum of 200 photographs of Site and property adjacent to perimeter of Site.
2. Particular emphasis shall be directed to structures both inside and outside the Site.
3. Format: Digital, minimum resolution of 1832 pixels by 3264 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 48 photographs using digital, minimum resolution of 1832 pixels by 3264 pixels and 24-bit, millions of color.
3. Monthly: Take 50 photographs using digital, minimum resolution of 1832 pixels by 3264 pixels and 24-bit, millions of color.

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

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1.09 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 the worksite 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 recording shall be by a professional commercial videographer, experienced in shooting exterior and interior construction videos, in both good and inclement weather.

F. 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.

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G. Documentation:

1. DVD or Other Media Format Label:
   a. DVD or other media format number (numbered sequentially, beginning with 001).
   b. Project name.
   c. Applicable location by direction of view.
   d. Date and time of coverage.
2. Project Video Log: Maintain an ongoing log that incorporates above noted label information for DVDs on Project.

1.10 REFERENCE POINTS AND SURVEYS

A. Owner's Responsibilities:

1. Establish benchmarks convenient to Work and at least every 500 feet on pipelines and roads.
2. Establish horizontal reference points or coordinate system with benchmarks and reference points for Contractor's use as necessary to lay out Work.

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

C. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
5. Maintain complete accurate log of survey work as it progresses as a Record Document.
6. On request of Engineer, submit documentation.
7. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
   a. Check layout, survey, and measurement work performed by others.
   b. Measure quantities for payment purposes.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Materials to be salvaged include: Salvaged items to be identified by Owner prior to construction. Coordinate salvage with Owner.

B. Salvage materials for Owner's use.

1. Remove material with extreme care so as not to damage for future use.
2. Store materials where instructed by Owner onsite.

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

D. 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.

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.

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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. Owner shall 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 PRECONSTRUCTION CONFERENCE

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

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor’s safety plan and representative.

B. Attendees will include:

1. Owner’s representatives.
2. Contractor’s office representative.
3. Contractor’s resident superintendent.
4. Contractor’s quality control representative.
5. Subcontractors’ representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer’s representatives.
7. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

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

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1.04 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.

1.05 QUALITY CONTROL MEETINGS

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

B. Attendees will include:

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

1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

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

B. Attendees will include:

1. Contractor.
2. Owner.
3. PICS Subcontractor/Installer.
4. Engineer's representatives.

1.07 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.

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C. Notify Engineer 5 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.

1.08 FACILITY STARTUP MEETINGS

A. Schedule and attend a minimum of four facility startup meetings. 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.

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.

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. Others as required by Contract Documents or as deemed necessary by Contractor.

1.09 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 at least 7 days prior to preconstruction conference.
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. Progress Schedule: One legible PDF copy.
   c. 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 90 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. Anticipated approval of major equipment Shop Drawings.
5. Replacement of each Belt Filter Press.
6. Demolition of each dry polymer makeup system, associated polymer solution aging and feed tanks, and polymer feed pumps.
7. Primary sludge piping installation from each primary clarifier.
8. Early procurement activities for long lead equipment and materials.
9. Initial Site work.
10. Earthwork.
11. Specified Work sequences and construction constraints.

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12. Contract Milestone and Completion Dates.
13. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
14. System startup summary.
15. Project close-out summary.
16. 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—Bar Chart.

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—Bar Chart Critical Path Network.

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

1.04 PROGRESS SCHEDULE—BAR CHART

A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, “Construction Project Planning and Scheduling Guidelines.” If a conflict occurs between the AGC publication and this Specification, this Specification shall govern.

B. Format:

1. Unless otherwise approved, white paper, 11-inch by 17-inch sheet size.
2. Title Block: Show name of Project and Owner, date submitted, revision or update number, and name of scheduler.

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3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
5. Legend: Describe standard and special symbols used.

C. Contents:

1. Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:
   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).
   e. Subcontract Work.
   f. Major equipment design, fabrication, factory testing, and delivery dates.
   g. Sitework.
   h. Concrete Work.
   i. Structural steel Work.
   j. Architectural features Work.
   k. Conveying systems Work.
   l. Equipment Work.
   m. Mechanical Work.
   n. Electrical Work.
   o. Instrumentation and control Work.
   p. Interfaces with Owner-furnished equipment.
   q. Other important Work for each major facility.
   r. Equipment and system startup and test activities.
   s. Project closeout and cleanup.
   t. Demobilization.

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.

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6. Revised projections of progress and completion.
7. Report of changed logic.
8. Minimum detailed 3-week look-ahead schedule.

B. Produce detailed sub-schedules 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).
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.

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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. Owner'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, Owner's acceptance of Contractor's schedule indicates that, in Owner's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Owner'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 Owner'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.

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.

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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 City of Gresham's Public Works Standards.

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. Schedule Contingency:

1. Contingency, when used in the context of the Progress Schedule, is time between Contractor's proposed Completion Time and Contract Completion Time.
2. Contingency included in Progress Schedule is a Project resource available to both Contractor and Owner to meet Contract Milestones and Contract Times. Use of Schedule contingency shall be shared to the proportionate benefit of both parties.
3. Use of schedule contingency suppression techniques such as preferential sequencing and extended activity times is prohibited.
4. Pursuant to Contingency sharing provisions of this Specification, no time extensions will be granted, nor will delay damages be paid until a delay occurs which (i) consumes all available contingency time, and (ii) extends Work beyond the Contract Completion date.

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.

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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 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 Owner at the following, unless specified otherwise.

1. City of Gresham.
   Attn: Rob Chapler.
2. Via Owner's construction documentation management tool Bentley Synchro.

B. Electronic Submittals: Submittals shall be made in electronic format and submitted via Bentley Synchro.

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. All submittals shall be made using a web-based construction management application developed by Bentley Synchro. The Contractor shall provide all equipment and internet access needed for its staff, subcontractors, and supplier to access Bentley Synchro throughout the duration of the Project.
3. Submit submittals in ample time for each to serve submittals' intended purpose.
4. 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.

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5. PDF files shall be set to open “Bookmarks and Page” view.
6. Add general information to each PDF file, including title, subject, author, and keywords.
7. PDF files shall be searchable by using the Find function. Scanned only PDF files will not be acceptable.
8. 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.
9. Submit new electronic files for each resubmittal.
10. Include a copy of the Transmittal of Contractor’s Submittal form, located at end of section, with each electronic file.
11. Engineer will reject submittal that is not electronically submitted.
12. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
13. 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 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.

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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.

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:

1. Schedule and submit in accordance Schedule of Submittals and requirements of individual specification sections. Action submittals for the following specification section shall be submitted within 90-days of notice to proceed (NTP):
   a. Section 40 90 00, Instrumentation and Controls for Process Systems.
   b. Section 44 44 63.01, Polymer Feed System, Liquid.
   c. Section 44 46 13.02, Screw Conveyor System.
   d. Section 46 76 33, Centrifuge Dewatering Equipment Package.

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.

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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.

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.

1.03 ACTION SUBMITTALS

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

B. Shop Drawings:

1. 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.
2. 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.
3. Product Data: Provide as specified in individual specifications.
4. Deferred Submittal: See 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.

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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.

5. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.

C. Samples:

1. Copies: Two, unless otherwise specified in individual specifications.
2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
   a. Manufacturer name.
   b. Model number.
   c. Material.
   d. 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.

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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.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Refer to individual specification sections for specific submittal requirements.
2. 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.

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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.

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 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.

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I. Payment:

1. Application for Payment: In accordance with City of Gresham Public Works Standards.
2. Schedule of Values: In accordance with City of Gresham Public Works Standards.
3. Schedule of Estimated Progress Payments: In accordance with City of Gresham Public Works Standards.

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

K. 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.

L. Special Guarantee: Supplier’s written guarantee as required in individual specification sections.

M. 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. Refer to General Conditions for the definition of Specialist.

N. 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.

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O. 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.
    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.

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

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

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1.05 SUPPLEMENT

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

1. Transmittal of Contractor’s Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____ _____ _____ _____ _____ **FROM**: _____ Contractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____

Contractor (Authorized Signature)

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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 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. Contractor is responsible for the cost to obtain a copy or access to the standards.

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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
34.	BHMA	Builders Hardware Manufacturers' Association

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

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

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114.	STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115.	SWI	Steel Window Institute
116.	TEMA	Tubular Exchanger Manufacturers' Association
117.	TCA	Tile Council of North America
118.	TIA	Telecommunications Industry Association
119.	UBC	Uniform Building Code
120.	UFC	Uniform Fire Code
121.	UL	formerly Underwriters Laboratories Inc.
122.	UMC	Uniform Mechanical Code
123.	USBR	U.S. Bureau of Reclamation
124.	WCLIB	West Coast Lumber Inspection Bureau
125.	WI	Wood Institute
126.	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. Training Session Recordings: Furnish Owner with two complete sets of recordings fully indexed and cataloged with printed label stating session and date recorded.

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 Owner. 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.

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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.

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. Pre-startup 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:

1. Furnish audio and color recording of pre-startup and post-startup instruction sessions, including manufacturers' representatives' hands-on equipment instruction and classroom sessions.
2. Video training materials shall be produced by a qualified, professional video production company.
3. Use recording format suitable for playback on standard equipment available commercially in the United States. Contractor shall obtain Owner's approval of the audio-video format and acceptable media type (such as, DVD, flash-drive, and hard-drive) prior to submission.
4. Approved media may contain multiple training sessions. If multiple training sessions are included on the media, files names for each session shall be specific and include vendor, date, and training session title.

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.
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 may perform other duties on the Project.
3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
4. 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.
5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
6. 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.

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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.
      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 Article Quality Control 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 on 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 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2024 IBC and is in addition to and supplements requirements included in Statement of Special Inspections shown on the Drawings.

1.02 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 and Associated Criteria for Buildings and Other Structures.
2. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency 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 Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
4. Special Inspector: Qualified person employed by Owner who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.

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B. Statement of Special Inspections: Detailed written procedure contained on the Drawings establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on the Drawings.
4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on the Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on the Drawings.

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E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections provided on the Drawings.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.
4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.04 SUBMITTALS

A. Informational Submittals:

1. Fabricator’s Certificate of Compliance: Form shall be completed by entity responsible for shop fabrication of structural load-bearing members and assemblies. Refer to Article Supplements located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated and subject to Special Inspection under Section 1705: None required.

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2. Wind-force-resisting systems designated under IBC Section 1705: None required.
3. Architectural, Plumbing, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.13.5 and IBC Section 1705.13.6 for Seismic Resistance: None required.

B. Statement of Special Inspections:

1. As included on the Drawings and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
   a. Designated seismic systems and main seismic force-resisting systems and components that are subject to Special Inspection and Structural Observation for lateral load resistance.
   b. Special Inspection and testing required by IBC Section 1705 and other applicable sections and referenced standards therein.
   c. Type and frequency of Special Inspection required.
   d. Type and frequency of testing required.
   e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Engineer, Contractor, building official, and Owner.
   f. Geotechnical Observation to be Performed: Not required for this Project.
   g. Structural Observations to be Performed: Required frequency and distribution of Structural Observation reports by registered design professional to Contractor, building official, and Owner.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction's (AHJ) approved, qualified inspection staff. Owner will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections on the Drawings and further provided in this section, is for benefit of Owner and does not:

1. Relieve Contractor of responsibility for providing adequate quality control measures.
2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.
3. Constitute or imply acceptance.
4. Affect continuing rights of Owner after acceptance of completed Work.

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E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the Owner. All other testing and inspections, unless noted otherwise, are provided by Contractor.

B. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

C. Notify Engineer in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

D. Provide access for Special Inspector to construction documents.

E. Retain special inspection records on-site to be readily available for review.

F. Cooperate with Special Inspector and provide safe access to the Work to be inspected.

G. Submit Fabricator’s Certificates of Compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.

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2. Providing storage space for the Special Inspector's exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
3. Providing the Special Inspector with access to all approved submittals.
4. Providing security and protection of samples and test equipment at the Project Site.
5. Provide samples of materials to be tested in required quantities.

I. When required by Registered Design Professional in Responsible Charge, provide access for plumbing, mechanical and electrical component inspections for those items requiring certification.

J. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

K. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination or both.
2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENT

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

1. Contractor's Statement of Responsibility.

END OF SECTION

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CONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

_____
(Name of Contracting Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing and Professional Observation and component certification requirements contained in Contract Documents for this Project for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections on the Drawings and Section 01 45 36, Equipment Seismic Certification, and that:

1. I, (We) are responsible for construction of the following components:

Facility	Component
Solids Building	Piping Distribution Systems for Hazardous Materials

2. Control of this Work will be exercised to obtain conformance with Contract Documents approved by building official.

3. Procedures within the Contractor's organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.

4. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.

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5. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

Name: _____

Qualifications: _____

_____

_____

(Print name and official title of person signing this form)

Signed by: _____

Date: _____

Project Name: _____

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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 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. Engineer’s field office plans.
   f. Staging area location plan.
   g. Traffic and Pedestrian Control and Routing Plans: As specified herein, and proposed revisions thereto.
   h. Plan for maintenance of existing plant operations.
3. Temporary Control Submittals:
   a. Noise control plan.
   b. Dust control plan.
   c. Plan for disposal of waste materials and intended haul routes.

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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.

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.

1.05 VEHICULAR TRAFFIC

A. Traffic Control Plan: 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.

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.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power: 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.

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.
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. Owner will provide a place of temporary connection for construction and drinking water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner’s current rate.
2. Provide means to prevent water used for testing from flowing back into source pipeline.

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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. 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. 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.

3.02 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. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities 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.
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.

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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 existing facilities. 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. Barricades and Lights:

1. Provide as required by the locally applicable Vehicle Code and in sufficient quantity to safeguard public and the Work.
2. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
3. Provide to protect existing facilities and adjacent properties from potential damage.
4. Locate to enable access by facility operators and property owners.
5. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
6. Locate barricades at the nearest intersecting public thoroughfare on each side of blocked section.
7. Illuminate barricades and obstructions with warning lights from sunset to sunrise.

D. Signs and Equipment:

1. Conform to requirements of manual published by the State of Oregon Department of Transportation.
2. Traffic Cones: Provide to delineate traffic lanes to guide and separate traffic movements.

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3. Provide at obstructions, such as material piles and equipment.
4. Use to alert general public of construction hazards, which would include surface irregularities, unramped walkways, grade changes, and trenches or excavations in roadways and in other public access areas.

E. 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.
   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.

F. 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.

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

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

I. 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.

3.03 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.
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: Local ordinance.
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.

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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. Comply with Section 01 57 13, Temporary Erosion and Sediment Control, for stormwater flow and surface runoff.
4. 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.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sediment Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.04 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.

3.05 ACCESS ROADS

A. Construct access roads as shown and within easements, rights-of-way, or Project limits. Use existing roads where shown.

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.

3.06 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.

3.07 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.

D. 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.

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

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3.08 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 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This section covers Work to implement structural and nonstructural Best Management Practices (BMP) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this specification and shown on the Drawings are part of the project Temporary Erosion and Sediment Control Plan (TESC Plan) and are the minimum for all project construction sites and conditions. This specification covers all project activities, including material sources, disposal sites, and offsite mitigation areas unless specific project activities are excluded elsewhere in this specification or in other Contract Documents controlling the Work.

B. National Pollutant Discharge Elimination System: Comply with Federal, state, and local laws, rules and regulations, and the National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permit or Permits applicable to the project. A copy of the Project's General Construction Permit, if applicable to the Project, is available from Owner. NPDES General Construction permits are required on projects that involve disturbance of 1-acre or more with potential to discharge stormwater to surface waters.

C. Other Regulations: A local government erosion and sediment control permit may apply and some local agency requirements may be more stringent than this specification. Adequate erosion and sediment control is essential for complying with the federal Endangered Species Act where construction runoff enters waters inhabited by protected species.

1.02 REFERENCES

A. Activities shall conform to the Oregon DEQ Construction Stormwater Erosion and Sediment Control Manual, Standard Specifications, City of Gresham Erosion and Sediment Control Manual and Drawings, 1200-C-NDPES General Permit and Drawings. In the event of a conflict, the more stringent requirement shall apply.

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

1. American Association of State Highway and Transportation Officials (AASHTO): M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.
2. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   c. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   d. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   f. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   g. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   h. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   i. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
   j. D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
   k. D6459, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
   l. D6460, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion.
   m. D6475, Standard Test Method for Measuring Mass Per Unit Area of Erosion Control Blankets.
   n. D7322, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions.
   o. D7367, Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting.
3. National Weather Service:
   a. Precipitation-Frequency of the United States by State/Territory, 2012.
   b. Precipitation Frequency Data Server, 2012.
4. North American Weed Management Association (NAWMA).

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5. U.S. Department of Agriculture, Natural Resources Conservation Service: *Urban Hydrology for Small Watersheds*; 1986. Technical Release 55.
6. U.S. Environmental Protection Agency:
   a. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites, 2007. EPA-833-R-06-004.
   b. National Menu of BMPs, 2012.

1.03 SYSTEM DESCRIPTION

A. Erosion and Sediment Control:

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases during construction period.
2. Design erosion and sediment controls to handle peak runoff resulting from 25-year, 24-hour storm event based on ODOT Hydraulics Manual, Chapter 7, Hydrology.
3. Size temporary stormwater conveyances based on procedures presented in ODOT Hydraulics Manual, Chapter 7, Hydrology.

B. Erosion and Sediment Control (ESC) Lead:

1. Identify the ESC Lead at the preconstruction conference and in the TESC Plan. The ESC Lead shall have certification in construction site erosion and sediment control from a course approved by Owner.
2. The ESC Lead shall implement the TESC Plan, including, but not limited to:
   a. Installing and maintaining all temporary erosion and sediment control Best Management Practices (BMPs) included in the TESC Plan to assure continued performance of their intended function. Damaged or inadequate TESC BMPs shall be corrected immediately.
   b. Updating TESC Plan to reflect current field conditions.
   c. Terminating TESC Plan.
3. When a TESC Plan is included in the Contract Plans, ESC Lead shall also inspect all areas disturbed by construction activities, all onsite erosion and sediment control BMPs, all stormwater discharge points, and all temporarily stabilized inactive sites per schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer. Complete erosion and sediment control inspection form provided by water resource agency or Owner for each inspection and submit a copy to Engineer no later than end of the next working day following inspection.

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C. Personnel Training:

1. Prior to commencement of construction, applicable personnel must have an understanding of the Construction Stormwater Discharge Permit's requirements and their specific responsibilities under the permit. At a minimum, personnel must be trained to understand the following as it relates to the scope of their job duties:
   a. The location of all stormwater controls and how to maintain them.
   b. Procedures for complying with the pollution prevention requirements.
   c. Procedures for conducting inspections, recording findings, and taking corrective action.

D. Temporary Erosion and Sediment Control Plan (Stormwater Pollution Prevention Plan):

1. A TESC Plan is furnished as part of the Drawings, which helps fulfill part of the plan requirement of the NPDES Permit. This initial TESC Plan, when adopted by Contractor, may be used as the basis of the construction TESC Plan. Additional or revised erosion and sediment control features, not shown on the initial TESC Plan, may be required depending on Contractor's methods of operation and schedule.
2. For each phase of the scheduled work, indicate on the TESC Plan all the BMPs proposed and installed for erosion and sediment control to minimize clearing, stabilize exposed soil, divert or temporarily store flows, limit runoff from exposed areas, and filter transported sediment. Include all temporary slopes, constructed for staging or other reasons, which may not have been identified in the original Contract plans. Refer to the current local jurisdiction's erosion and sediment control manual.
3. Some TESC Plan required elements typically required by NPDES permits:
   a. Narrative Site Description:
      1) Nature of construction activity planned for the Site.
      2) Estimates of total site area and the areas of the Site expected to be disturbed.
      3) Soil types found onsite and their erosion potential.
      4) The types of fill materials to be used.
      5) Timetable for sequence of major construction events.
   b. Site Map:
      1) All areas of development.
      2) Drainage patterns.
      3) Areas of soil disturbance, including pre-development and post-development elevation contours.
      4) Areas used for storage of soils or wastes.
      5) Areas where vegetative practices are to be implemented.

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6) Location of all erosion and sediment control BMP or structures.
7) Location of all impervious structures and surfaces after project is completed.
8) Springs, wetlands, and other surface waters located onsite.
9) Boundaries of the 100-year floodplain, if determined.
10) Ordinary High Water line, if determined.
11) Location of storm drainage outfalls to receiving waters, if applicable.
12) Details of sediment and erosion controls.
13) Details of detention ponds, storm drain piping, inflow and outflow details.

c. Required BMPs and Procedures for Erosion Prevention, Runoff Control, and Sediment Control:
1) Construction entrances and parking areas.
2) Unpaved site roads such as haul roads.
3) Hauling saturated soils from the Site.
4) Water washed from concrete trucks.
5) Correct installation of erosion and sediment control BMPs.
6) Prompt maintenance and repair of BMPs.
7) Clearing and grading practices to minimize area of exposed soil throughout life of the Project.
8) Schedule of phased clearing operations to limit soils to what can be stabilized.
9) Vegetative practices, including preservation of existing vegetation, seeding, mulching, and buffer strips.
10) Preventing erosion of exposed areas.
11) Diverting flows from exposed slopes.
12) Limiting runoff from exposed areas.
13) Limiting sediment transport within work sites and keeping it from moving off of project areas.
14) Perimeter controls for all clearing and grubbing, both planned and installed.
15) Additional controls for wet season work and temporary work suspensions.
16) Sensitive areas such as wetlands.
17) Offsite material source and waste areas.
18) Dust.
19) Emergency materials stockpiled onsite.
20) Storing flows and filtering sediment.
21) Soil stockpiles.

4. Contractor’s construction TESC Plan and implementation schedules must be prepared by a competent individual. Furnish a signed copy of the TESC Plan with individual’s name, title, state certifications, and employing firm if different than Contractor’s firm.

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5. Do not begin any Site activities that have potential to cause erosion or sediment movement until the TESC Plan and implementation schedules are approved by Engineer.
6. Keep a copy of the approved TESC Plan with updated changes onsite during all construction activities. During inactive periods longer than 7 calendar days, keep the TESC Plan onsite or provide a copy to Engineer to retain.
7. Continually update the TESC Plan and schedules as needed for unexpected storm or other events to ensure that sediment-laden water does not leave the construction site. Add approved changes to the TESC Plan no later than 24 hours after implementation.

E. Install high visibility fence along the Site as shown on the Drawings or as instructed by Engineer. Space posts and attach fence fabric to posts as shown on the Drawings. Do not fasten fence to trees. Throughout the life of the Project, preserve and protect delineated area, acting immediately to repair or restore any fencing damaged or removed.

F. Preventing erosion, and controlling runoff, sedimentation, and non-stormwater pollution, requires Contractor to perform temporary Work items including, but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water.
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows.
3. Controlling underground water found during construction.
4. Covering or otherwise protecting slopes until permanent erosion control measures are working.

G. To the degree possible, coordinate this temporary Work with permanent drainage and erosion control work the Contract requires.

H. Engineer may require additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the Work.

I. When natural elements rut or erode the slope, restore and repair damage with eroded material where possible, and remove and dispose of any remaining material found in ditches and culverts. When Engineer orders replacement with additional or other materials, unit Contract prices will cover quantities needed.

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

K. Water Management:

1. Manage site water in accordance with the conditions of the waste discharge permit from a local permitting authority. If site water management is not subject to permit, manage as follows:
    a. Groundwater. When groundwater is encountered in an excavation, treat and discharge as follows:
        1) When groundwater conforms to State of Oregon Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.
        2) When turbidity of groundwater is similar to turbidity of site runoff, groundwater may be treated using same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.
        3) When groundwater turbidity is greater than turbidity of site runoff, treat ground water separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.
    b. Process Water:
        1) Do not discharge high pH process water or wastewater (non-stormwater) that is generated onsite, including water generated during concrete grinding, rubblizing, washout, and hydrodemolition activities, to waters of the State of Oregon, including wetlands. Water may be infiltrated upon approval of Engineer. Offsite disposal of concrete process water is subject to approval of Engineer.

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

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

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

M. Detention/Retention Pond Construction: Whether permanent or temporary, construct before beginning other grading and excavation Work in the area that drains into that pond. Install temporary conveyances concurrently with grading in accordance with the TESC Plan so that newly graded areas drain to the pond as they are exposed.

N. Pollution Control:

1. Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:
   a. Written spill prevention and response procedures.
   b. Employee training on spill prevention and proper disposal procedures.
   c. Spill kits in all vehicles.
   d. Regular maintenance schedule for vehicles and machinery.
   e. Material delivery and storage controls.
   f. Training and signage.
   g. Covered storage areas for waste and supplies.

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O. If Engineer orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.

P. Nothing in this section shall relieve Contractor from complying with other Contract requirements.

1.04 SUBMITTALS

A. Action Submittal: Submit all BMPS to be used on the projects. Provide cut sheets for Engineer approval prior to installation.

B. Informational Submittals:

1. When a TESC Plan is included on the Drawings, either adopt or modify the TESC Plan. Provide a schedule for TESC Plan implementation and incorporate it into Contractor's progress schedule. Obtain Engineer's approval of the TESC Plan and schedule before any Work begins.
2. Modified TESC Plans shall meet all requirements of the applicable jurisdictions.
3. The TESC Plan shall cover all areas that may be affected inside and outside the limits of the Project (including all Owner-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water).
4. Allow at least 5 working days for Engineer to review any original or revised TESC Plan. Failure to approve all or part of any such Plan shall not make Owner liable to Contractor for any Work delays.
5. Certificate of Certified Erosion and Sediment Control Lead (CESCL).
6. Copy of the 1200C permit.

PART 2 PRODUCTS

2.01 COIR LOG

A. Logs made of 100 percent durable coconut (coir) fiber uniformly compacted within woven netting.

B. Netting: Made of bristle coir twine with minimum strength of 80 pounds tensile strength. Nominal 2-inch by 2-inch openings.

C. Log Segments: Maximum length of 20 feet, with a minimum diameter as shown on the Drawings.

D. Log Minimum Density: 7 lbs/cf.

E. Stakes: Untreated softwood species with a notch to secure rope ties.

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F. Rope Ties: 1/4-inch diameter commercially available hemp rope.

2.02 GEOTEXTILE

A. Geotextiles shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. Geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. Geotextile properties shall be as specified in Section 31 32 19.16, Geotextile, or as described in Table 1 through Table 3.

Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
AOS	D4751	See Table 2		See Table 2		U.S. No. 30 max.	
Water Permittivity	D4491	See Table 2		See Table 2		0.02 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	250 lb min.	160 1b min.	315 lb min.	200 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	15% -50%	≥50%	15% -50%	≥50%	<50%	≥50%
Seam Breaking Strength	D4632/ D4632M	220 lb min.	140 lb min.	270 lb min.	180 lb min.	220 lb min.	140 lb min.
Puncture Resistance	D6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.	495 lb min.	310 lb min.
Tear Strength, in machine and x-machine direction	D4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device					

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Table 2
Filtration Properties for Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements		
		Class A	Class B	Class C
AOS	D4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D4491	0.7 sec^{-1} min.	0.4 sec^{-1} min.	0.2 sec^{-1} min.

Table 3
Geotextile for Temporary Silt Fence

Geotextile Property	ASTM Test Method	Geotextile Property Requirements	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	D4751	U.S. No. 30 max. for silt wovens, U.S. No. 50 for all other geotextile types, U.S. No. 100 min.	
Water Permittivity	D4491	0.2 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	180 lb min. in machine direction, 100 lb min. in x-machine direction	100 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	30% max. at 180 lb or more	
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device	

2.03 HIGH VISIBILITY FENCING

A. High Visibility Fence: UV stabilized, orange, high-density polyethylene or polypropylene mesh.

B. Height: 4 feet minimum.

C. Support Posts: Wood or steel with sufficient strength and durability to support the fence through the life of the Project.

2.04 INLET PROTECTION

A. As specified under Article Geotextile.

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2.05 PLASTIC COVERING

A. Clear plastic meeting requirements of ASTM D4397 for polyethylene sheeting having a minimum thickness of 6 mils.

2.06 SILT (SEDIMENT) FENCE

A. Geotextile: As specified in Article Geotextile.

B. Reinforcing: Welded wire fabric, 14-guage minimum with 2-inch by 4-inch mesh.

C. Support Posts: As recommended by manufacturer of geotextile.

D. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

2.07 STABILIZED CONSTRUCTION ENTRANCE

A. Construct a pad from stone 3 inches to 6 inches in size, placed at least 8 inches deep and not less than 50 feet long.

B. Provide aggregate free of extraneous materials that may cause or contribute to track out.

C. Place separation geotextile under the rock to prevent fine sediment from pumping up into the rock pad. See Article Geotextile for required geotextile properties.

D. Use of constructed or constructed/manufactured steel plates with ribs (such as, shaker/rumble plates or corrugated steel plates) for entrance/exit access is allowable.

2.08 STREET CLEANING

A. Use self-propelled pickup street sweeper(s). Mechanical broom sweepers are not allowed where environmental concerns exist about storm water pollution or air quality.

2.09 TEMPORARY CURB

A. Temporary curbs may consist of asphalt, concrete, sand bags, compost socks, wattles, or geotextile/plastic encased berms of sand or gravel, or as approved by Engineer.

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2.10 WATTLES

A. Cylinders of biodegradable plant material such as weed-free straw, coir, compost, wood chips, excelsior, or wood fiber or shavings encased within biodegradable netting.

B. Diameter: 5 inches minimum.

C. Netting Material: Clean, evenly woven, and free of encrusted concrete or other contaminating materials such as preservatives. Also free from cuts, tears, or weak places with a minimum lifespan of 6 months.

D. Compost Filler: Coarse compost, wood chips, or wood shavings.

E. Wood Stakes: Untreated softwood species, 2-inch by 2-inch nominal dimension and 36 inches in length.

PART 3 EXECUTION

3.01 PREPARATION

A. Engineer’s acceptance of the TESC Plan is required prior to starting earth disturbing activities.

B. Include proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities in Work phasing plans.

C. Areas designated for Contractor’s use during Project may be temporarily developed as specified to provide working, staging, and administrative areas. Include control of sediment from these areas in the TESC Plan.

D. Coir Log: Install coir logs in accordance with the Drawings.

E. High Visibility Fencing: Install high visibility fencing in accordance with the Drawings.

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F. Inlet Protection: Install inlet protection below or above, or as a prefabricated cover at each inlet grate, as shown on the Drawings. Install inlet protection devices prior to beginning clearing, grubbing or earthwork activities. Geotextile fabric used in prefabricated inlet protection devices must meet or exceed the requirements for Moderate Survivability and minimum filtration properties. When depth of accumulated sediment and debris reaches approximately one-half the height of an internal device or one-third the height of external device (or less when so specified by the manufacturers) or as designated by Engineer, remove deposits and stabilize onsite.

1. Below Inlet Grate:
    a. Prefabricated units specifically designed for inlet protection.
    b. Must remain securely attached to drainage structure when fully loaded with sediment and debris or at the maximum level of sediment and debris specified by manufacturer.
2. Above Inlet Grate:
    a. Devices may be silt fence, sandbags, or prefabricated units specifically designed for inlet protection.
    b. Must remain securely in place around drainage structure under all conditions.
3. Inlet Grate Cover:
    a. Prefabricated units specifically designed for inlet protection and:
        1) Be a sewn geotextile fabric unit fitted to individual grate and completely enclosing grate.
        2) Have built-in lifting devices to allow manual access of stormwater system.
        3) Use an orange monofilament geotextile fabric.
    b. Check dams or functionally equivalent devices may be used as inlet protection devices with approval of Engineer.

G. Plastic Covering: Use clear plastic covering to promote seed germination when seeding is performed outside of specified dates. Use black plastic covering for stockpiles or other areas where vegetative growth is unwanted. Place plastic with at least a 12-inch overlap of all seams. Install and maintain plastic cover tolon prevent water from cutting under the plastic and to prevent cover from blowing open in the wind.

H. Sediment Control Barriers: Install sediment control barriers in accordance with TESC Plan or manufacturer’s recommendations in the areas of clearing, grubbing, earthwork, or drainage prior to starting those activities. Maintain sediment control barriers until soils are stabilized.

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I. Silt (Sediment) Fence:

1. Silt fence shall be installed in accordance with the Drawings. When backup support is used, use steel wire with a maximum mesh spacing of 2 inches by 4 inches, or plastic mesh as resistant to ultraviolet radiation as the geotextile it supports. Provide wire or plastic mesh with strength equivalent to or greater than as required for unsupported geotextile (for example, 180 pounds grab tensile strength in the machine direction).
2. Attach geotextile to posts and support system using staples, wire, or in accordance with manufacturer's recommendations. Geotextile shall be sewn together at the point of manufacture, or at a location approved by Engineer, to form geotextile lengths as required.
3. Provide wood or steel support posts at sewn seams and overlaps and as shown on the Drawings and necessary to support fence.
4. Wood Posts: Minimum dimensions of 1-1/4-inch by 1-1/4-inch by the minimum length shown on the Drawings.
5. Steel Posts: Minimum weight of 0.90 lb/feet.
6. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.

J. Stabilized Construction Entrance: Construct temporary stabilized construction entrance in accordance with the Drawings, prior to beginning any clearing, grubbing, earthwork, or excavation. When stabilized entrance no longer prevents track out of sediment or debris, either rehabilitate existing entrance to original condition or construct a new entrance.

K. Street Cleaning: Use self-propelled pickup street sweepers whenever required by Engineer to prevent transport of sediment and other debris off Project Site. Provide street sweepers designed and operated to meet air quality standards. Street washing with water will require approval by Engineer. Intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

L. Temporary Curb: Provide temporary curbs to divert or redirect water around erodible soils. Temporary curbs shall be installed along pavement edges to prevent runoff from flowing onto erodible slopes. Water shall be directed to areas where erosion can be controlled. Temporary curbs shall be a minimum of 4 inches in height. Ponding shall not be in roadways.

M. Wattles: Install wattles as soon as construction will allow or when designated by Engineer. Begin trench construction and wattle installation at base of slope and work uphill. Spread excavated material evenly along the uphill slope and compact using hand tamping or other method approved by Engineer. On gradually sloped or clay-type soils, provide trenches 2 inches to 3 inches deep.

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On loose soils, in high rainfall areas, or on steep slopes, provide trenches 3 inches to 5 inches deep, or half the thickness of the wattle. Exercise care when installing wattles to minimize disturbance of waterways and prevent sediment or pollutant discharge into waterbodies.

3.02 ADDITIONAL REQUIREMENTS

A. Natural Buffer or Equivalent:

1. Unless natural buffer between the Project Site and receiving waters has previously been eliminated by pre-existing development disturbances, comply with one of the following alternatives if stormwater from construction will discharge to surface water:
   a. Provide a 50-foot, undisturbed natural buffer between construction disturbances and surface water.
   b. Provide an undisturbed natural buffer that is less than 50 feet supplemented by additional erosion and sediment controls, which in combination, achieve a sediment load reduction that is equivalent to a 50-foot buffer.
   c. If it is infeasible to provide an undisturbed natural buffer of any size, implement erosion and sediment controls that achieve a sediment load reduction that is equivalent to a 50-foot buffer.

3.03 MAINTENANCE

A. The ESCP measures described in this specification are minimum requirements for anticipated Site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.

B. Maintain erosion and sediment control BMPs so they properly perform their function until Engineer determines they are no longer needed.

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

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

E. Inspect BMPs in accordance with the schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer.

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

G. Unless otherwise specified, remove deposits before the depth of accumulated sediment and debris reaches approximately height of BMP. Dispose of debris or contaminated sediment at approved locations. Clean sediments may be stabilized onsite using BMPs as approved by Engineer.

H. Sediment Fence: Remove trapped sediment before it reaches one-third of the above ground fence height and before fence removal.

I. Other Sediment Barriers (such as biobags): Remove sediment before it reaches 2 inches depth above ground height and before BMP removal.

J. Catch Basins: Clean before retention capacity has been reduced by 50 percent.

K. Sediment Basins and Sediment Traps: Remove trapped sediments before design capacity has been reduced by 50 percent and at completion of Project.

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

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

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

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

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

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Q. Within 14 days of initiating stabilization or as specified in permit, either seed or plant stabilized area (see Section 32 92 00, Turf and Grasses); or apply non-vegetative measures and cover all areas of exposed soil. Seed dry areas as soon as Site conditions allow. Ensure that vegetation covers at least 70 percent of stabilized area. In areas where Contractor's activities have compromised erosion control functions of existing grasses, overseed existing grass. Non-vegetative measures may include blown straw and a tackifier, loose straw, or an adequate covering of compost mulch. Complete initial stabilization within 7 days if storm water discharges to surface waters impaired for sediment or nutrients, or high quality waters.

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

3.04 EMERGENCY MATERIALS

A. Provide, stockpile, and protect the following emergency erosion and sediment control materials on the Project Site for unknown weather or erosion conditions. Emergency materials are in addition to other erosion control materials required to implement and maintain the TESC Plan. Replenish emergency materials as they are used. Remove all unused emergency materials from the Project Site at completion of the Project.

Item	Quantity
Silt (sediment) fence	100 ft
Plastic sheeting	260 sq. ft.
Rope	1,000 ft
Sand bags (empty, to be filled as needed)	50
Biofilter bags (with stakes)	10

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3.05 REMOVAL

A. When Engineer determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits. When materials are biodegradable, Engineer may approve leaving temporary BMP in place.

B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and seed graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

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 codes adopted by the Owner.

1. See General Structural Notes sheets on the Drawings for design criteria requirement s for loading such as wind, seismic, soil and groundwater pressures and related design parameters. Refer to Section 01 88 15, Anchorage and Bracing, for code and Project-specific requirements.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 65 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 107 degrees F.

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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.

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.

    20015 N.E. Sandy Blvd., Gresham, OR, 97230

5. Notify Owner upon arrival for transfer of materials.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

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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 equipment 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.

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.

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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.

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. 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.

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

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

F. 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.

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

H. 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.

I. 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 UL shall conform to those standards and shall have an applied UL listing mark.

J. 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 finish as approved by Engineer.

K. 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.

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L. 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.

M. 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.

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.

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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.

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.

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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.

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 Section 01 29 00, Payment Procedures.
   h. Extra Materials: As required by individual Specification sections.

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 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 Drawings.
        2) Red when showing information added to 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 (such as RFIs) 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.
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. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.

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 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. 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 data in the form of an instructional manual on electronic media. Prepare final data on electronic media.

B. Instructional Manual Format:

1. Size: 8-1/2 inches by 11 inches, minimum.
2. Coverpage: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
    a. Project title.
    b. Designate applicable system, equipment, material, or finish.
    c. Identity of separate structure as applicable.
    d. Identify volume number if more than one volume.
    e. Identity of general subject matter covered in manual. Identity of equipment number and Specification section.
3. 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.
4. Table of Contents:
    a. Neatly 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.
5. Text: Manufacturer’s printed data, or neatly typewritten.
6. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. 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.

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1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit one electronic copy of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit one electornic copy for Engineer's and Owner's review.
3. Final Data: Submit one copy in electronic media format.

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: Supplement product data with Drawings as necessary to clearly illustrate:
   a. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.

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4) 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.

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.

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2. Circuit Directories of Panelboards:
    a. Electrical service.
    b. Control requirements and interfaces.
    c. Communication requirements and interfaces.
    d. List of electrical relay settings, and control and alarm contact settings.
    e. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
    f. As-installed control diagrams by control manufacturer.
3. Operating Procedures:
    a. Routine and normal operating instructions.
    b. Startup and shutdown sequences, normal and emergency.
    c. Safety precautions.
    d. Special operating instructions.
4. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
5. Manufacturer’s printed operating and maintenance instructions.
6. 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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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 SUPPLEMENT

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

1. Maintenance Summary Form.

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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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 REFERENCES

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

1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Code Council (ICC): International Building Code (IBC).
4. The locally adopted code, Oregon Structural Specialty Code 2025, as amended by all other applicable local agencies.

1.03 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 Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

C. Component Important Factor:

1. Ip is equal to 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.

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b. Component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if 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.

1.04 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.
2. Design anchorage into concrete including embedment in accordance with ACI 318-19; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
   a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within 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. Design anchorage and bracing for modified existing architectural, mechanical, or electrical systems where code requirements would dictate design for similar new components.
6. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
7. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
8. Distribution Systems: Includes, but are not limited to, piping, conduit, cable trays, and ductwork.
9. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
10. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.

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11. Design anchorage and bracing for all 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:
        1) All Seismic Design Categories:
            a) Furniture, excluding storage cabinets.
            b) Temporary components that remain in place for 180 days or less.
            c) Mobile units and equipment including components that are moved from one point in the structure to another during ordinary use.
        2) SDC A: All components.
        3) SDC B:
            a) Architectural Components, other than parapets, provided that the component Importance Factor, Ip, is equal to 1.0.
            b) Mechanical and electrical Components.
        4) SDC C:
            a) Mechanical and Electrical Components, provided that either:
                (1) The component Importance Factor, Ip, is equal to 1.0 and the component is positively attached to the structure.
                (2) The component weighs 20 pounds or less.
        5) 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, the component weighs 400 pounds or less, the center of mass is located 4 feet or less above the adjacent floor level, flexible connections are provided between the component and associated ductwork, piping, and conduit, and the component Importance Factor, Ip, is equal to 1.0.
                (2) For discrete mechanical and electrical components, the component weighs 20 pounds or less.
                (3) For distribution systems, the component Importance Factor, Ip, is equal to 1.0 and the operating weight of the system is 5 pounds/feet or less.

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12. Design anchorage and bracing for equipment and components for loads other than seismic, except those exempted below:
    a. For discrete floor mounted components not exposed to wind, in which the component weighs 400 pounds or less, and the center of mass is located 4 feet or less above the adjacent floor.
    b. For discrete equipment exposed to wind, in which the equipment weighs 400 pounds or less, the center of mass is located 4 feet or less above the adjacent floor or roof, and the effective wind area is 2 feet or less.
    c. For discrete components mounted above the adjacent floor or roof, and the component weighs 75 pounds or less.
    d. For distribution systems not exposed to wind that weigh 5 pounds/feet or less.
13. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
    a. Refer to Section 01 45 36, Equipment Seismic Certification, for list of designated components which Ip is equal to 1.5.
14. 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.
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. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
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.
    d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications, or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer’s ICC-ES report.

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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. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip is equal to 1.5.
3. Provide support drawings and calculations for architectural components in accordance with Section 13.5 of ASCE 7.
4. Provide support drawings and calculations for mechanical and electrical systems in accordance with Section 13.6 of ASCE 7.
5. Existing components, systems, and equipment in their final condition that are modified by Project requirements and are not exempted by above paragraph require the same anchorage and bracing drawing and calculation submittals as new equipment. Field verify existing conditions.
6. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new and modified or noted architectural, mechanical and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
    b. Manufacturers’ engineered seismic and non-seismic hardware product data.

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c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors showing concrete edge distance, or anchor bolts for nonexempt components, equipment, and systems. Provide drawings sealed by a civil or structural engineer registered in the State of Oregon.
d. List of existing architectural, mechanical, and electrical equipment or components to be modified in Project requiring Contractor-designed anchorage and bracing in final retrofitted condition.
e. Drawings for seismic attachment assemblies include connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or components' final condition would require anchorage or bracing under this specification for new equipment.
f. 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 when Designated Seismic Systems 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.

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1.06 SOURCE QUALITY CONTROL

A. Contractor and supplier responsibilities to accommodate Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections on the Drawings, and Section 01 45 33, Special Inspection, Observation, and Testing.

B. Provide all 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.

C. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

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.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. 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.

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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 a 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 snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Calculations shall limit anchor bolt concrete edge distance to a maximum of 4 inches or as required to provide sufficient anchor bolt capacity to resist the applied loads.

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

F. 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 Engineer.

G. Do not attach architectural, 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 Engineer and AHJ.

B. Notify Engineer upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

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3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications, and Section 05 05 19, Post-Installed Anchors.

B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. 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 DEFINITIONS

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

B. 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.

C. Pre-performance Test: Test or tests in the presence of Engineer and Owner performed to demonstrate continuous reliable operation prior to Performance Test.

D. 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.

E. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as Blended Sludge Thickening with new polymer feed system and RDT blended sludge thickeners and Digested Sludge Dewatering with new centrifuges and dewatering feed system, Primary Sludge Pumping from each primary clarifier pump station, dewatered sludge loadout, and polymer storage tank fill operations.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.

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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.
   e. For startup of Thickening Polymer PBUs with the associated RDT, provide a form for the temporary operations using totes and a form for operations using the new bulk storage tanks.
   f. For startup of Dewatering Polymer PBUs, with the associated centrifuge, provide a form for temporary operations using the converted existing pairs of dewatering polymer storage tanks and a form for operations using the new bulk storage tanks.
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.
   f. One Facility Performance Demonstration/Certification form is required for the blended sludge thickening process including bulk polymer storage tank loading, and thickening polymer PBU operation with their respective RDT.
   g. One Facility Performance Demonstration/Certification form is required for the sludge dewatering process including bulk polymer storage tank loading, and thickening polymer PBU operation with their respective RDT.

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.

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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 and their subcontractors and equipment manufacturers.
3. Provide labor and materials as required for laboratory analyses.

3.02 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: Provide written test report for each item of equipment to be tested, to include the minimum information:
    a. Owner/Project Name.
    b. Equipment or item tested.
    c. Date and time of test.
    d. Type of test performed (Functional or Performance).
    e. Test method.
    f. Test conditions.
    g. Test results.
    h. Signature spaces for Contractor and Engineer as witness.
    i. See individual Specification sections for other equipment specific requirements.

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5. Cleaning and Checking: Prior to beginning functional testing.
    a. Calibrate testing equipment in accordance with manufacturer's instructions.
    b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    c. Lubricate equipment in accordance with manufacturer's instructions.
    d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
    e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
    f. Check power supply to electric-powered equipment for correct voltage.
    g. Adjust clearances and torque.
    h. Test piping for leaks.
    i. See individual Specification sections for other equipment specific requirements.
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.

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C. Pre-Performance and Performance Testing:

1. Conduct as specified in individual Specification sections and as listed below:
   a. Thickening polymer loading, storage and feed systems.
   b. Dewatering polymer loading, storage and feed systems.
   c. Dewatering centrifuge and dewatered cake systems.
2. Coordinate with Owner and Engineer on proceeding from pre-performance testing to the Performance Test.
3. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
4. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
5. Type of fluid, gas, or solid for testing shall be as specified.
6. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
7. Prepare Equipment Test Report summarizing test method and results.
8. 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.

3.03 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 as chosen by Contractor to meet schedule requirements.

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.

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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.

3.04 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.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility, 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 operation.

3.05 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/closed, 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. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. 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.

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. Copies of reports and other documentation required for abandoning wells.
4. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped.
5. Submit a shipping receipt or bill of lading for all containers of ACM shipped.
6. 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 City Bid Booklet, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition and 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.

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. Facilities:

1. Portions of buildings and other areas scheduled for selective demolition, partial demolition, and renovation Work are as shown. In general the following major pieces of equipment and ancillary features will be demolished:
   a. Two belt filter presses, associated control panels, concrete containment curbs and ventilation hoods.
   b. Thickening and dewatering dry polymer systems, stainless steel aging and feed tanks, polymer solution feed pumps and associated control panels.

B. Structures: Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

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C. Utilities and Related Equipment:

1. Notify Owner or appropriate utilities to turn off affected services at least 48 hours before starting demolition or renovation activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
3. When utility lines are encountered that are not indicated on the Drawings, notify Engineer prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Owner.
5. Provide a permanent leak-proof closure for water and gas lines.

D. Reroofing:

1. Sequence Work to minimize building exposure between the time of existing roof removal and new roof material installation. Install temporary roofing and flashing as necessary to maintain a watertight condition throughout the course of the Work.
2. Remove temporary roofing and flashing prior to installation of permanent roof system materials unless otherwise approved by Engineer.
3. Refer to Section 07 53 23, Ethylene-Propylene-Diene-Monomer Roofing for details regarding new roofing materials and installation.

E. Masonry: Sawcut and remove masonry to prevent damage to surfaces to remain.

F. 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.

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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.

G. 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 masonry or concrete walls with an approved patching material, applied in accordance with the manufacturer’s printed instructions.

H. 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.
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.
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.

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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.

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

3.02 PROTECTION

A. Building Occupancy: Refer to Section 01 31 13, Project Coordination, for specific requirements related to concurrent occupancy of facilities to be partially demolished.

B. 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.

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

D. 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.

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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.

E. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

F. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer. See the Drawings for additional protection requirements.

G. 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.

H. 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.

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2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
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 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 TITLE TO MATERIALS

A. All salvaged equipment and materials will remain the property of Owner.

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

1. Salvaged items to be identified by Owner prior to construction. Coordinate salvage with Owner.

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

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3.07 DISPOSITION OF MATERIAL

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

B. Salvage equipment and material to the maximum extent possible.

C. Remove materials and equipment that are indicated and specified to be removed by Contractor and deliver to a storage site as directed on the Site.

D. Repair or replace, at the discretion of Engineer, items damaged during removal or storage.

E. Remove salvaged items designated as the property of Owner in a manner to prevent damage.

F. Deliver salvaged items that are designated as the property of Owner to a storage site as directed on the Site.

G. Owner will not be responsible for the condition or loss of, or damage to, property scheduled to become Contractor's property after Engineer's authorization to begin demolition or renovation. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

H. Owner will not be responsible for the condition or loss of, or damage to, such property after Engineer's authorization to begin work.

I. Store salvaged items as approved by Engineer and remove them from Owner's property before completion of the Contract. Materials and equipment shall not be either viewed by prospective purchasers or sold on the Site.

3.08 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, and reinstall as the Work progresses.

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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D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.

3.09 SPECIALIZED SALVAGE

A. Ozone Depleting Substances (ODS):

1. Class I and Class II ODS are defined in Section 602(a) and Section 602(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.

3.10 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of at the Contractor selected recycling and disposal facility.

B. Combustible material shall be disposed of off the Site.

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

3.11 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 33
REPAIR OF HORIZONTAL CONCRETE SURFACES

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 and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or [50-mm] Cube Specimens).
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
   k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

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p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
s. D638, Standard Test Method for Tensile Properties of Plastics.
t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
v. D4259, Standard Practice for Abrading Concrete.
w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 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.

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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. New Concrete: Concrete less than 60 days old forming structures constructed as part of the Work.

1.03 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 system for each repair location in existing concrete.
3. Drawings indicating results of sounding for hollow areas including location, size, 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. Manufacturer’s Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems meet requirements of ASTM C928/C928M.
    b. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to water, or receive traffic.
    c. Mortar Manufacturer’s Certificate of Proper Installation.
    d. Confirmation epoxy resin bonding agents conform to ASTM C882/C882M.
4. Statements of Qualification: Repair mortar system applicator.
5. Field and laboratory test results.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.

B. 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 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 the 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.

1.05 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.

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PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 2—HIGH EARLY STRENGTH REPAIR MORTAR

A. One or two-component, fast-setting, high early strength repair mortar.

B. Compressive Strength, ASTM C109/C109M:

1. 2 Hours: 1,500 pounds per square inch minimum.
2. 1-Day: 4,500 pounds per square inch minimum.
3. 7 Days: 8,000 pounds per square inch minimum.
4. 28 Days: 9,000 pounds per square inch minimum.

C. Flexural Strength, ASTM C348:

1. 1-Day: 850 pounds per square inch minimum.
2. 7 Days: 1,000 pounds per square inch minimum.
3. 28 Days: 1,100 pounds per square inch minimum.

D. Modulus of Elasticity, ASTM C469:

1. 1-Day: 3.8 by 10^6 pounds per square inch minimum.
2. 28 Days: 4.5 by 10^6 pounds per square inch minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M (Modified):

1. 1-Day: 2,500 pounds per square inch minimum.
2. 7 Days: 2,900 pounds per square inch minimum.
3. 28 Days: 3,100 pounds per square inch minimum.

F. Splitting Tensile Strength, ASTM C496/C496M:

1. 1-Day: 850 pounds per square inch minimum.
2. 7 Days: 1,200 pounds per square inch minimum.
3. 28 Days: 1,300 pounds per square inch minimum.

G. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 98 percent RDM.

H. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 or AASHTO T277, 28 Days: 960 coulombs maximum.

I. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco T 415.
2. Euclid Chemical Co., Cleveland, OH; VersaSpeed.

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2.02 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

A. One or two-component, fast-setting, polymer modified cementitious based repair mortar system.

B. Compressive Strength, ASTM C109/C109M:

1. 1-Day: 2,500 pounds per square inch minimum.
2. 7 Days: 5,000 pounds per square inch minimum.
3. 28 Days: 7,000 pounds per square inch minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 1,500 pounds per square inch minimum.

D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 pounds per square inch minimum.

E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 pounds per square inch minimum.

F. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033-inch maximum.

G. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.

H. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 28 Days: Under 850 coulombs maximum.

I. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco T 310CI.
2. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.
3. Sika Corp., Lyndhurst, NJ; SikaTop 111 PLUS.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

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2.04 REINFORCEMENT

A. Deformed Steel reinforcement:

1. ASTM A615/A615M, Grade 60, where welding is not required.
2. ASTM A706/A706M, Grade 60, for steel reinforcement to be welded.

2.05 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. Color: Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 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:
      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 mortar system used.

B. Manufacturers and Products:

1. Sika Corp., Lyndhurst, NJ; SikaEmaco P 124.
2. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH; Dural Prep AC.

2.06 EPOXY BONDING AGENT

A. Two-component, moisture insensitive, 100 percent solids epoxy resin.

B. Tensile Strength, ASTM D638, at 14 Days: 4,400 pounds per square inch minimum.

C. Elongation at Break, ASTM D638: 1.49 percent minimum.

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D. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 pounds per square inch minimum.

E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 pounds per square inch minimum.

F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.

G. Manufacturers and Products: Sika Corp., Lyndhurst, NJ;
SikaEmaco ADH 326 when ambient temperature is 73 degrees F or higher.

2.07 EVAPORATION RETARDANT

A. As specified in Section 03 30 10, Structural Concrete.

2.08 CURING COMPOUND

A. As specified in Section 03 30 10, Structural Concrete.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.

B. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

A. General:

1. Repair Mortar System No. 2: Patches, joints, or overlays 1/2-inch to 3 inches thick. Return to service in 3 hours to 7 days.
2. Repair Mortar System No. 5:
    a. Patches and Overlays: 1/4-inch to 3 inches thick.
    b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
    c. Working Time: 30 minutes at 70 degrees F.
    d. Application Temperature Range: 45 degrees F to 90 degrees F.

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3.03 PREPARATION

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

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

1. Use 8,000 pounds per square inch minimum high-pressure water or abrasive blasting machine, as appropriate to suit Site conditions.
2. Remove concrete to abrade substrate concrete surface 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. For existing structures, extent of concrete removal as shown on the Drawings.
4. 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.

C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers 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.

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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 entire 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. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System Nos. 2, and 5: 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. Spalled Joints:

1. Saw cut edge 1-inch deep and 6 inches back from old joint.
2. Remove unsound concrete and concrete between saw cut and joint.
3. Place wood or fiber spacer to thickness of joint at joint line.

L. Overlays:

1. Square cut edges to a minimum of 1/4-inch deep.
2. Do not feather edge area.
3. Perform special preparation recommended by mortar manufacturer.

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

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3.04 REINFORCEMENT INSTALLATION

A. Provide steel reinforcement when existing steel reinforcement is not exposed and when mortar application is more than 4 inches deep, unless otherwise shown on the Drawings.

B. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement.

C. Fasten steel reinforcement to chairs with tie wire to prevent from moving during placement of repair mortar.

D. Lap reinforcement mesh a minimum of one mesh spacing and securely fasten mesh to mesh anchors, or to steel reinforcement fastened to mesh anchors, with tie wire at intervals no more than 12 inches to prevent movement during application of repair mortar.

E. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at the same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.05 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.06 PLACEMENT

A. Repair Mortar System No. 2, and No. 5:

1. Remove standing and free water from prepared area.
2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer's instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.

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6. Finish to same texture as existing concrete around patch.
7. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.

B. Joint Repair:

1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2-inch.
2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer's instructions.

3.07 FINISHING

A. Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.08 CURING

A. Repair Mortar System No. 2, or No. 5: Apply curing compound in accordance with Section 03 30 10, Structural Concrete.

3.09 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or 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 materials from mixer during construction for compliance with specifications.
3. Provide 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 Contractor 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.

3.10 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.

3.11 MANUFACTURERS' SERVICES

A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.12 CLEANING

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

END OF SECTION

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SECTION 03 30 10
STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Work shall conform to requirements of ACI 301, Specifications for Structural Concrete, unless otherwise specified.

1.02 REFERENCES

A. In accordance with ACI 301 and the following:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 305.1, Specification for Hot Weather Concreting.
   c. 306.1, Specification for Cold Weather Concreting.
   d. 308.1, Specification for Curing Concrete.
   e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.
   f. SP 66, Detailing Manual.
2. ASTM International (ASTM):
   a. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
   b. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.
   b. Placing Reinforcing Bars.
   c. ANSI/CRSI – RB 4.1, CRSI Standard for Supports for Reinforcement Used in Concrete.
4. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
5. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

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

C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

D. Hot Weather: As defined in ACI 305.1.

E. Hydraulic Structure: Liquid containment structure.

F. New Concrete: Concrete less than 60 days old.

G. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Formwork and Formwork Accessories: Unless otherwise specified, conform to requirements of ACI 301.
    b. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
        1) Bending lists.
        2) Placing drawings.
    c. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
    d. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type.
2. Mix Design:
    a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
    b. Documentation of average strength for each proposed mix design in accordance with ACI 301.

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c. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   1) Portland cement.
   2) Fly ash.
   3) Slag cement.
   4) Aggregates, including specified class designation for coarse aggregate.
   5) Admixtures.
   6) Concrete producer has verified compatibility of constituent materials in design mix.

d. Test Reports:
   1) Cement: Chemical analysis report.
   2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
   3) Aggregates:
      a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
      b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
   4) Water-Soluble Chloride-Ion Content in Hardened Concrete: One of the following:
      a) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
      b) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
      c) All of the following:
         (1) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
         (2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
         (3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
   5) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.

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6) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

e. Product Data:

1) Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.

3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.
4. Letter stating compatibility between liquids being contained and materials used for waterstops and joint fillers.
5. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
   a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
   b. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.
   c. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   d. Methods for temperature protection during placement.
   e. Types of covering, insulation, housing, or heating to be provided.
   f. Curing methods to be used during and following protection period.
   g. Use of strength accelerating admixtures.
   h. Methods for verification of in-place strength.
   i. Procedures for measuring and recording concrete temperatures.
   j. Procedures for preventing drying during dry, windy conditions.
6. Detailed plan for hot-weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
7. Concrete repair techniques.

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B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
3. Manufacturer’s Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
   c. Repair materials.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Manufacturer’s written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Waterstop.
   b. Joint filler and primer.
   c. Preformed control joint.
6. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. In accordance with ASTM C94/C94M, including Requirement 14.2.1 through Requirement 14.2.10.
   c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor’s Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.

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4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
    b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician–Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician–Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Contractor, including pumping, placing and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Testing and sampling personnel.
    e. Steel Reinforcement Installer.
    f. Owner and/or Owner’s designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Owner of location and time.
3. Agenda shall include:
    a. Admixture types, dosage, performance, and redosing at Site.
    b. Mix designs, test of mixes, and Submittals.
    c. Placement methods, techniques, equipment, consolidation, and form pressures.
    d. Slump or slump flow and placement time to maintain slump and slump flow.
    e. Finish, curing, and water retention.
    f. Steel reinforcement details.
    g. Protection procedures for weather conditions.
    h. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301.

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2.02 FORMWORK

A. Form Materials:

1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
2. For unexposed areas, use new shiplap or plywood.
3. Earth cuts may be used for forming footings.

B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Ties:

1. Material: Steel.
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Design to maintain positive contact with forming material.
   c. Furnish units that will leave no metal closer than 1-1/2 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Form Ties with Water Stop: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
   a. Integral steel waterstop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.
   b. Neoprene waterstop 3/16-inch thick and 15/16-inch diameter whose center hole is one half diameter of tie or molded plastic water stop of comparable size.
   c. Orient waterstop perpendicular to tie and symmetrical about center of tie.
   d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

2.03 CONCRETE

A. Materials:

1. Cementitious Materials:
   a. Cement:
      1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.

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2) Blended Hydraulic Cement:
   a) Unless otherwise specified, excluding Type IS (greater than 70), conforming to ASTM C595/C595M.
   b) Portland cement used in blended hydraulic cement; conform to requirements of ASTM C150/C150M.
3) Performance-Based Cement: Conform to requirements of ASTM C1157/C1157M.
   a) For sections of structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture conforms to Table 4.2.1.1(b) of ACI 301.
4) Furnish from one source.

b. Supplementary Cementitious Materials (SCM):
1) Fly Ash (Pozzolan):
   a) Class F and Class C fly ash in accordance with ASTM C618, except as modified herein:
      (1) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
2) Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.
3) Silica Fume: In accordance with ASTM C1240.

2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
a. Aggregates:
1) In accordance with ASTM C33/C33M, except as modified herein.
   a) In accordance with ACI 301, except as modified herein.
   b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c) Aggregates that are susceptible to alkali-carbonate reactions shall not be used.
   d) Alkali Silica Reactivity: See Article Concrete Mix Design.
2) Fine Aggregates:
   a) In accordance with ASTM C33/C33M, except as modified herein.
   b) In the event manufactured sand is included in the mix design, the material shall be from the same source as the coarse aggregate.

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c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
(1) Limit material finer than 75-µm (No. 200) sieve to 3 percent mass of total sample.
(2) Limit coal and lignite to 0.5 percent.

3) Coarse Aggregate:
a) Crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles as determined by ASTM D4791.
b) Class designation in accordance with ASTM C33/C33M, Table 3: 4S unless otherwise specified.
c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

3. Admixtures:
a. Characteristics:
1) Compatible with other constituents in mix.
2) Contain at most, only trace amount chlorides in solution.
3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
b. Air-Entraining Admixture: ASTM C260/C260M.
c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
d. Retarding Admixture: ASTM C494/C494M, Type B.
e. Accelerating Admixture: ASTM C494/C494M, Type C.
f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
g. Shrinkage Reducing Admixture:
1) Manufacturers and Products:
a) Master Builders Solutions, Shakopee, MN; MasterLife SRA 20.
b) Euclid Chemical Co., Cleveland, OH; Eucon SRA Series.
c) W. R. Grace & Co., Cambridge, MA; Eclipse Series.
h. Admixtures with no standard, ASTM or other, designation may be used where permitted.

4. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.
a. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
1) Chloride Content: 1,000 ppm.
2) Sulfate Content as SO_4: 3,000 ppm.

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3) Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
4) Total Solids by Mass: Less than 50,000 ppm.

B. Concrete Mix Design:

1. General:
   a. Unless otherwise specified, refer to Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
      1) Alternate product for small concrete placements:
         a) Concrete product intended for use on small concrete placements, such as equipment pads, in full depth form and pour applications. Use shall be approved by the Owner. Not to be used in water holding applications.
         b) One component cementitious concrete mix containing factory blended coarse aggregate.
         c) Self-consolidating with maximum pour depth compatible with the required placement depth.
         d) Contains integral corrosion inhibitor.
         e) Compressive Strength, ASTM C39:
            (1) 7 days, 4,500 pounds per square inch minimum.
            (2) 28 days, 5,000 pounds per square inch minimum.
         f) Drying Shrinkage, ASTM C157/C157M at 28 Days:
            (1) 0.07 percent maximum.
            (2) Chloride Ion Permeability Based on Charge Passed, ASTM C1202.
            (3) 1,800 Coulombs maximum.
         g) Manufacturers and Products:
            (1) Sika Corp., Lyndhurst, NJ; Sika Emaco S 440CI.
            (2) Euclid Chemical Co. Cleveland, OH; EucoRepair SCC.
            (3) Sika Corp., Lyndhurst, NJ; Sikacrete 211 SCC Plus.
   b. Unless otherwise specified, prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301.
   c. Unless otherwise specified, selection of constituent materials and products in mix design are optional.

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d. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, or water-reducing admixture for the following:
   1) Pumped concrete.
   2) Concrete with a water-cementitious materials ratio below 0.50.
   3) Concrete mixtures used in walls.
   4) When needed to achieve fresh properties that facilitate handling, placing, and consolidating of concrete mixtures, and to achieve specified hardened properties.
   5) When anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.

e. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.

f. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing, and self-consolidating concrete.

2. Potential Alkali-Aggregate Reactivity of Concrete:
   a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
   b. Unless otherwise specified, or unless members are assigned to Exposure Class C0, use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction. Option 3) shall not be used with natural pozzolans, or fly ash that has a CaO content more than 18 percent, or for aggregates with expansions greater than or equal to 0.24 percent when tested in accordance with ASTM C1293. Fly ash with an alkali content greater than 4 percent shall not be used in option 2) or option 3).
      1) For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 shall not exceed 0.04 percent at 1-year.
      2) For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 shall not exceed 0.10 percent at an age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.

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3) Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, shall not exceed 4 pounds/yd3 for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 pounds/yd3 for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity shall be determined by testing in accordance with ASTM C1293. Alkali content shall be calculated as follows:
   a) LBA is equal to (cement content, lb/yd3) × (equivalent alkali content of portland cement in percent/100 percent)

3. Proportions:
   a. Design mix to meet aesthetic, durability, and strength requirements.
   b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.
   c. Where silica fume is included in mix, minimum silica fume content shall be 5 percent of weight of total cementitious materials.
4. Slump:
   a. Unless otherwise specified, and prior to submitting mix design, select a target slump at the point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches. Concrete shall not show visible signs of segregation. The target slump indicated on the submittal shall be used as the basis for acceptance during the project. Determine the slump by ASTM C143/C143M.
   b. Slump tolerance shall meet requirements of ACI 117.
5. Self-Consolidating Concrete:
   a. Unless otherwise specified, select a target slump flow at the point of delivery for self-consolidating concrete mixtures. Selected target slump flow shall not exceed 30 inches. Concrete shall not show visible signs of segregation. The target slump flow value indicated on the submittal shall be used as the basis for acceptance during the project. Determine slump flow in accordance with ASTM C1611/C1611M.
   b. Slump flow tolerances shall be in accordance with ASTM C94/C94M.
   c. If specified, evaluate during the mixture qualification stage, proposed concrete mixtures for passing ability in accordance with ASTM C1621/C1621M and for static segregation in accordance with ASTM C1610/C1610M to meet criteria indicated in Contract Documents.

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6. Size of Coarse Aggregate:
    a. Unless otherwise specified, nominal maximum size of coarse aggregate shall not exceed:
        1) Three-fourths of minimum clear spacing between reinforcement.
        2) One-fifth of narrowest dimension between sides of forms.
        3) One-third of thickness of slabs or toppings.
7. Temperature Limits:
    a. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set, plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
    b. For mass concrete sections, provide documentation that maximum concrete temperature in structure will not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.
    c. Accelerating admixture may not be used in mass concrete sections unless the thermal control plan specifically addresses the concrete mixtures with the same accelerating admixture, at a dosage equal to or greater than being proposed for the mass concrete.

2.04 REINFORCING STEEL

A. Unless otherwise specified, use Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60.

B. Where specified, steel reinforcement subjected to welding shall conform to ASTM A706/A706M, Grade 60.

C. Fabrication: Follow CRSI Manual of Standard Practice.

2.05 ANCILLARY MATERIALS

A. Bonding Agent:

1. Unless otherwise specified, in accordance with the following:
    a. ASTM C881/C881M, Type V.
    b. Two-component, moisture-insensitive, 100 percent solids epoxy.
    c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
    d. Manufacturers and Products:
        1) Euclid Chemical Co., Cleveland, OH; Euco No 352 Epoxy System LV.

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2) Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
3) Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
   a. Dayton Superior Corporation, Miamisburg, OH; Sure Lift J6WB.
   b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Reinforcing Steel Accessories:

1. Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports.
2. Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 2 Reinforcement Supports, except legs shall be made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports.
   a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
   b. Precast concrete bar supports shall be four square inches minimum, in plan.
   c. Precast concrete bar supports shall have tie wires.

D. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-coated, epoxy-coated, or plastic-coated wire.

E. Plastic Waterstop:

1. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
2. Specific Gravity: Approximately 1.37.
3. Shore Durometer Type A Hardness: Approximately 80.
4. Performance Requirements: COE Specification CRD-C-572.
5. Type Required in Contraction and Control Joints: 6 inches wide and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on the Drawings.
6. Type Required in Construction Joints: Flat ribbed with same dimensional properties as described above.
7. Corrugated or tapered type waterstops are not acceptable.

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8. Thickness: Constant from center bulb (or center of waterstop), to outside stop edge.
9. Waterstop Weight: 1.60 pounds for 3/8-inch by 6 inches, minimum per foot.
10. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.
11. Manufacturers and Products:
    a. Center Bulb Type:
        1) Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN: No. RB6-38H (6 inches by 3/8-inch).
        2) Greenstreak Plastic Products, St. Louis, MO; Catalog No. 03150/GRD: Style 732 (6 inches by 3/8-inch).
        3) Four Seasons Industries Durajoint, Garrettsville, OH; Catalog No. CSP-162: Type 9 (6 inches by 3/8-inch).
        4) BoMetals, Carrollton, GA; Catalog No. RCB-638LB (6 inches by 3/8-inch).
        5) Dacon Plastics LLC, Portland, OR, (903) 245-0048; Catalog No. RCB17 (6 inches by 3/8-inch).
    b. Flat Ribbed Profile: Use same manufacturers as bulb type. Caution.

F. Hydrophilic Waterstop:

1. For use at construction joints only, where new concrete is placed against existing concrete and as shown on the Drawings.
2. Material shall be a nonbentonite hydrophilic rubber compound.
3. Manufacturers and Products:
    a. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
    b. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

G. Premolded Joint Filler:

1. Bituminous Type: ASTM D994/D994M or ASTM D1751.
2. Sponge Rubber:
    a. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 pounds per square inch to 24 pounds per square inch) minimum.
    b. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK515IHD.

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H. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   c. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
   d. Dayton Superior; Safe Cure and Seal 1315 EF.

I. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. Sika Chemical Corp., Lyndhurst, NJ; Sikagard-30 ER.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.

J. Nonshrink Grout:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. Pass fluid grout through flow cone with continuous flow 1-hour after mixing.
6. Minimum Strength of Fluid Grout:
   a. 3,500 pounds per square inch at 1-day.
   b. 4,500 pounds per square inch at 3 days.
   c. 7,500 pounds per square inch at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Sika Chemical Corp., Lyndhurst, NJ; SikaGrout-928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
   d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.

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K. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products: Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series, SikaEmaco S Series.

L. Crack Repair:

1. Obtain Letter of Certification from manufacturer's technical representative, that products selected are appropriate for the specific applications.
2. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
3. Use part epoxy injection resin for structural crack repairs.
    a. Manufacturers:
        1) Euclid Chemical Co., Cleveland, OH.; Euco Series (No. 452).
        2) Sika Chemical Corp., Lyndhurst, NJ.; Sikadur Series.
4. Use hydrophilic polyurethane injection resin for non-structural crack repairs.
    a. Manufacturers:
        1) Euclid Chemical Co., Cleveland, OH.; Dural Aqua-Fil.
        2) Sika Chemical Corp., Lyndhurst, NJ.; SikaFix HH Hydrophilic.
        3) Prime Resins, Inc., Conyers, GA.; Prime Flex 900 XLV.

2.06 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Owner shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and subcontractors, providing products included in this section.

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PART 3 EXECUTION

3.01 FORMWORK

A. Form Construction:

1. Construct forms and provide smooth-form finish.
2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
4. Brace as required to prevent distortion during concrete placement.
5. On exposed surfaces, locate form ties in uniform pattern or as shown.
6. Construct so ties remain embedded in the member with no metal within 1-inch of concrete surface when forms, inserts, and tie ends are removed.

B. Form Removal:

1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
   a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
   b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.
3. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

3.02 PLACING REINFORCING STEEL

A. Unless otherwise specified, in accordance with ACI 301.

B. Accessories:

1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
   a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Bar Supports in Contact with Forms: Unless otherwise noted, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete block bar supports.
   a. Use stainless steel protected wire bar supports or precast concrete block bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.

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3. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.

C. Splices and Laps:

1. Lap Splice Reinforcing: Refer to Structural General Notes on the Drawings for additional information.
2. Tie splices with 18-gauge annealed wire as specified in CRSI Standard.

3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop, as specified, shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
4. Secure waterstop in correct position. Tie waterstop to reinforcing steel using grommets, hog rings, or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
    a. Ensure space beneath plastic waterstop is completely filled with concrete.
    b. Make visual inspection of waterstop area during concrete placement.
    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.
8. Plastic Waterstop:
    a. Install in accordance with manufacturer’s written instructions.
    b. Splice in accordance with waterstop manufacturer’s written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
        1) Allow at least 10 minutes before new splice is pulled or strained in any way.
        2) Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.

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3) Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
4) Field splice permitted only for straight butt welds.

c. Wire looped plastic waterstop may be substituted for plastic waterstop.

9. Hydrophilic Waterstop:
   a. Prepare concrete surfaces and install in accordance with waterstop manufacturer's written instructions and the following:
      1) Surface Preparation:
         a) Concrete surface must be smooth, clean, and dry. Grind concrete as required.
         b) Clean debris, dirt, dust, and foreign material from concrete surface.
      2) Installation:
         a) Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
         b) Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
         c) Lap ends of waterstop strip together at splices and corners and join with sealant.
         d) Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
         e) Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

3.04 MASS CONCRETE

A. Strength measurement must be representative of in-place concrete within 2 inches of concrete surface.

B. Concrete strength must be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.

C. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at time of protection removal, is less than specified temperature difference limit.

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D. Unless otherwise specified, place one temperature sensor at center of mass of placement and one temperature sensor at a depth 2 inches from center of nearest exterior surface. Place additional sensor at each location to serve as a backup in event that other temperature sensor fails. In addition, provide temperature sensor in shaded location for monitoring ambient onsite temperature.

1. Unless otherwise specified, monitor temperatures hourly using electronic sensors capable of measuring temperature from 32 degrees F to 212 degrees F to an accuracy of 2 degrees F.
2. Ensure temperature sensors are operational before placing concrete.
3. Unless otherwise specified, provide data from sensors to Owner daily, until requirements are met.
4. Compare temperatures and temperature differences with maximum limits specified in Article Temperature Limits every 12 hours, unless otherwise permitted. If either exceeds specified limits, take immediate action as described in accepted thermal control plan to remedy situation. Do not place additional mass concrete until cause of excessive temperature or temperature difference has been identified and corrections are accepted.

3.05 CONCRETE PLACEMENT INTO FORMWORK

A. Inspection: Notify Owner and Special Inspector at least 1-work day in advance before starting to place concrete.

B. Placement into Formwork:

1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use means and methods that prevent segregation.
5. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
6. Joints in Footings and Slabs:
   a. Ensure space beneath plastic waterstop completely fills with concrete.
   b. During concrete placement, make visual inspection of entire waterstop area.

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c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, and place remaining concrete to full height of slab.
d. Apply procedure to full length of waterstop.

7. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Wipe clean with device that does not allow mortar to adhere to belt.
4. Cover conveyor belts and chutes.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

F. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction, joints where shown.
3. Construction Joints:
   a. Unless otherwise shown or permitted, locate construction joints as follows:
      1) Locate construction joints as shown on the Drawings or where approved in the joint location submittal.
      2) Locate expansion, control, and contraction joints where shown on the Drawings.
      3) Provide vertical construction joints at maximum spacing of 40 feet unless shown or approved otherwise.
      4) When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.

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5) Uniformly space vertical construction joints within straight sections of walls, avoiding penetrations.

4. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
5. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

G. Minimum Time between Adjacent Placements:

1. Typical Unless Noted Otherwise: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
2. Expansion or Contraction Joints: 1-day.
3. If continuous placement of beams, girders, or slabs with columns or walls is indicated in Contract Documents, do not place horizontal elements until the underlying concrete is consolidated and bleed water is not on the surface of the supporting member, unless otherwise specified.

3.06 CONSOLIDATION AND VISUAL OBSERVATION

A. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

3.07 COLD WEATHER PLACEMENT

A. Unless otherwise permitted, shall be in accordance with requirements of ACI 301, ACI 306.1, and as follows:

1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Owner.
3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 pounds per square inch or design compressive strength if less than 3,500 pounds per square inch.

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B. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.

C. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

D. Cure as specified.

3.08 HOT WEATHER PLACEMENT

A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:

1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
2. Internal concrete temperature in structure shall not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
4. Cure as specified.

3.09 CONCRETE BONDING

A. Construction Joints at Existing Concrete:

1. Thoroughly clean and roughen existing concrete surfaces to roughness profile range between CSP 7 to CSP 9 when verified by comparison to PC1-10.
2. Saturate surface with water for 24 hours prior to placing new concrete.

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3.10 PREMOLDED JOINT FILLER INSTALLATION

A. Sufficient in width to completely fill joint space where shown.

B. Drive nails approximately 1-foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.

C. Secure premolded joint filler in forms before concrete is placed.

3.11 FINISHING FORMED SURFACES

A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.

A. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
   a. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

B. Repair defective areas of concrete.

1. Cut edges perpendicular to surface at least 1/2-inch deep. Do not feather edges. Soak area with water for 24 hours.
2. Patch with specified repair material.
3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Owner prior to use.
4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Owner.
5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Owner.

C. Inject cracks that meet the definition of defective area.

1. When crack repair is deemed by Owner as requiring a structural repair, use part epoxy injection resin.
2. When crack repair is deemed by Owner as requiring a nonstructural repair, use hydrophilic polyurethane injection resin.

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3.12 FINISHING UNFORMED SURFACES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Do not dust surfaces with dry materials nor add water to surfaces.
4. Cure concrete as specified.

B. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Steel gauge block 5/16-inch thick.
4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
5. Thickness: Maximum 1/4-inch minus or 1/2-inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

C. Interior Slab Finish: Provide trowel finish unless specified otherwise.

D. Exterior Slab Finish:

1. Provide broom finish unless specified otherwise.
2. Finish exposed edges with steel edging tool.
3. Mark sidewalks transversely at 5-foot intervals with jointing tool.

3.13 EXPOSED METAL OBJECTS

A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.

B. Repair area of chipped-out concrete as specified for defective areas.

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3.14 BLOCKOUTS AT PIPES OR OTHER PENETRATIONS

A. Where shown, install in accordance with requirements of the Drawings.

3.15 PROTECTION AND CURING

A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:

1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
2. Continuously wet cure concrete surfaces of hydraulic structures for a 7-day period. Intermittent wetting is not acceptable.
3. Use curing compound only where approved by Owner.
4. Cure formed surfaces with curing compound applied in accordance with manufacturer's written instructions as soon as wet curing and finishing are completed.
5. Remove and replace concrete damaged by freezing.
6. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.16 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's written instructions.

B. Grouting Machinery Foundations:

1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.
2. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.
3. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.
4. Form with watertight forms at least 2 inches higher than bottom of plate.
5. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's written instructions.

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3.17 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.18 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. General:

1. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.
3. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours and for additional time as may be required before transporting to test lab.
4. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
5. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
    a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
6. Evaluation will be in accordance with ACI 301 and Specifications.
7. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
8. Frequency of testing may be changed at discretion of Owner.
9. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.

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10. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Owner.
4. Segregation Test Objective: Concrete shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump or slump flow test.
    a. Test Procedure: Make slump or slump flow test and check for excessive slump or slump flow. Observe to see if mortar or moisture flows from slumped concrete.
    b. Reject concrete if mortar or moisture separates and flows out of mix.

C. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
    a. Six extra test cylinders from last 100 cubic yards of concrete.
    b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.

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5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal.

D. Slab Finish Tolerances and Slope Tolerances:

1. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.19 MANUFACTURER'S SERVICES

A. Provide representative at Site for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

B. Concrete Producer Representative:

1. Observe how concrete mixes are performing.
2. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
3. Establish control limits on concrete mix designs.
4. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump or slump flow, and air content when specified.

C. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

D. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.20 SUPPLEMENTS

A. Requirements of concrete mix designs following "End of Section," are a part of this specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design—CMD-1.
2. Concrete Mix Design—CMD-5.

END OF SECTION

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Concrete Mix Design
CMD-1

A. Mix Locations: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F3S1W2C2 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) must be 5,000 pounds per square inch at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive a hard-troweled finish.
   b. Slabs to receive a dry shake floor hardener.
   c. Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0

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Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3§	4.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.
* Tolerance of air content is ±1-1/2 percent.
§ Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

5. Limit supplementary cementitious materials as follows:

Limits on Cementitious Materials for Concrete Assigned to Exposure Class F3‡*	
Supplementary Cementitious Materials	**Maximum Percent of Total Cementitious Materials by Mass**
Fly ash or natural pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or natural pozzolans and silica fume	35
Total of fly ash or natural pozzolans, slag cement, and silica fume	50

‡Supplementary cementitious materials, including fly ash and natural pozzolans, slag cement, and silica fume, used in the manufacture of ASTM C595/C595M and ASTM C1157/C1157M blended cements shall be included in assessing compliance with these limits.

*Individual limits shall apply regardless of the number of cementitious materials in a concrete mixture.

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6. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
7. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.15.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

D. Refer to Part 1 through Part 3 of this section for additional requirements.

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Concrete Mix Design
CMD-5

A. Mix Locations: Concrete curbs and sidewalks.

B. Exposure Categories and Classifications: F3S1W1C2 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) must be 4,500 pounds per square inch at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0

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Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is ±1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

5. Limit supplementary cementitious materials as follows:

Limits on Cementitious Materials for Concrete Assigned to Exposure Class F3 ‡*	
Supplementary Cementitious Materials	**Maximum Percent of Total Cementitious Materials by Mass**
Fly ash or natural pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or natural pozzolans and silica fume	35
Total of fly ash or natural pozzolans, slag cement, and silica fume	50

‡ Supplementary cementitious materials, including fly ash and natural pozzolans, silica fume, and slag cement, used in the manufacture of ASTM C595/C595M blended cements shall be included in assessing compliance with these limits.

*Individual limits shall apply regardless of the number of cementitious materials in concrete mixtures.

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6. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
7. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.30.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

D. Refer to Part 1 through Part 3 of this section for additional requirements.

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SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. 2024 International Building Code (IBC).
   b. Evaluation Services Reports.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection (Plan) on the Drawings.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
2. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.
4. Field Test Reports: Reports documenting ratio checks made for metering and mixing devices where a batch process is used for mixing adhesive.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within last 3 years.
2. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2024 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind and seismic loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
   a. Capable of dispensing both components in proper mixing ratio.
   b. Fit into manually or pneumatically operated caulking gun.
6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.
7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
8. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500 V3 (ESR-3814) or HIT-HY 200 (ESR 3187) Adhesive Anchors.

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b. Powers Fasteners, Brewster, NY; Power PURE220 Epoxy Adhesive Anchor System (ESR-5144).
c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors (ESR-4057).

B. Mixing Nozzles:

1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
2. Nonremovable internal static mixer required to ensure proper blending of components.

C. Reinforcing Dowels: As specified in Section 03 30 10, Structural Concrete.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on the Drawings and in accordance with adhesive manufacturer’s instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical and intersection with steel reinforcement or other obstruction is likely, slant drill to address edge distance or to clear obstruction. If drill must be slanted more than indicated in the manufacturer’s installation instructions to clear obstruction, notify Engineer for direction on how to proceed.
4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.

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E. Adhesive:

1. Install in accordance with written manufacturer's instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.
3. Dispensing, Metering, and Mixing Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Testing of Automatic Metering and Mixing Devices:

1. Test for Proper Ratio:
   a. Retain small amount of dispensed adhesive for inspection after each time pump is refilled.
   b. Check samples for color change.
   c. Should change in color occur, follow manufacturer's service instructions to obtain proper operation.
2. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.
3. Ratio Check Procedure:
   a. Disconnect dispensing head behind ON/OFF valve.
   b. Place volume containers of required proportions under "B" and "A" component hose ends.
   c. Actuate pump.
   d. Both cups should fill in an equal time to proper volume, thereby verifying proportion ratio by volume.
   e. Document timing and results of each ratio check procedure.

B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection (Plan) on the Drawings. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Continuous inspection required where noted on the Drawings and where concrete dowels are installed in overhead applications.

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3. Periodic inspection required where continuous inspection is not specified.
4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
   a. Product Description: Product name, rod diameter, and length.
   b. Drill bit compliance.
   c. Hole diameter, diameter, and depth and cleanliness.
   d. Adhesive expiration date.
5. Verification of dowel installation in accordance with manufacturer's published instructions.

C. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

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SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   c. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   d. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
   e. F436/F436M, Standard Specification for Hardened Steel Washers.
   f. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   g. F594, Standard Specification for Stainless Steel Nuts.
   h. F1554, Standard Specification for Anchor Bolts, Steel, 36-ksi, 55-ksi, and 105-ksi Yield Strength.
5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   c. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.

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7. Specialty Steel Industry of North America (SSINA):
    a. Specifications for Stainless Steel.
    b. Design Guidelines for the Selection and Use of Stainless Steel.
    c. Stainless Steel Fabrication.
    d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete and Masonry Anchors:
    a. Manufacturer’s product description and installation instructions.
    b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
    c. Adhesive Anchor Installer Certification.
2. Passivation method for stainless steel members.

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1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage because of metal banding and rough handling.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36
Flat and Beveled Washers (Hardened)	F436/F436M
Nuts*	A194/A194M, Grade 2H

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Item	ASTM Reference
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ICC-ES ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ICC-ES ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; KWIK Bolt-TZ2 Expansion Anchor Safe Set System with hollow drill bit and vacuum and SI-AT-A22 tool with adaptive torque for applicable sizes (ESR-4266).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

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C. Self-Tapping Concrete Screw Anchors:

1. Do not use for equipment anchorage unless specifically shown on the Drawings.
2. Manufacturers and Products:
    a. DeWalt/Powers Fasteners, Brewster, NY; Screw-Bolt+ (ESR-3889).
    b. DeWalt/Powers Fasteners, Brewster, NY; Hangermate+ Rod Hanger Screw Anchor (ESR-3889).
    c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
    d. Hilti, Inc., Tulsa, OK; Kwik HUS, KH-EZ, KH-EZ CRC, KH-EZ SS316, KH-EZ C, KH-EZ E, KH-EZ I, and KH-EZ P Screw Anchor Safe Set System with hollow drill bit and vacuum (ESR-3027).
    e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713 and IAPMO UES-493).

D. Adhesive Anchors:

1. Threaded Rod:
    a. Diameter as shown on the Drawings.
    b. Length as required to provide minimum depth of embedment indicated and thread projection required.
    c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
    a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
    b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
    a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
    b. Store adhesive on pallets or shelving in a covered storage area.
    c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
    d. Dispose of When:
        1) Shelf life has expired.
        2) Stored other than in accordance with manufacturer’s instructions.

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4. Manufacturers and Products:
    a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System:
        1) HIT-HY 200 V3 Safe Set System with HIT-Z ROD or HAS threaded rod (ESR 4868) unless anchor rod indicated on the Drawings.
        2) HIT-RE 500 V3 Safe Set System with HAS threaded rod (ESR 3814), unless anchor rod indicated on the Drawings.
        3) HIT-RE 500 V3 Safe Set System with Hilti Roughening Tool (HIT-RT) with HAS threaded rod (ESR-3814) for diamond cored holes, unless anchor rod indicated on the Drawings.
    b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
    c. DeWalt/Powers Fasteners, Brewster NY; Pure 220+ Epoxy adhesive anchor system with Dust X+ System (ESR-5144).

E. Adhesive Threaded Inserts:

1. Type 316 stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500 V3 or HIT-HY 200 adhesive.

2.03 POST-INSTALLED MASONRY ANCHORS

A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of section.

B. Current ICC Evaluation Report indicating acceptance for anchors at structural applications in masonry.

C. Manufacturers and Products:

1. Hilti, Inc., Tulsa, OK; HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4143) for solid grouted masonry, HIT-HY 200 V3 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4878) for solid grouted masonry, HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4144) for unreinforced three-wythe brick.
2. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 (IAPMO ER 240) for grout filled CMU, Titen-HD (ESR-1056) for grout filled or hollow CMU, AT-XP (IAPMO ER-281) for grout filled CMU.
3. DeWalt/Powers Fasteners, Brewster NY; Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Screw-Bolt+ (ESR-4042) for grout-filled masonry, AC100+ Gold with Dust X+ System for unreinforced three-wythe brick (ESR-2966 2582).

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PART 3 EXECUTION

3.01 CONCRETE AND MASONRY ANCHORS

A. Begin installation only after concrete or masonry to receive anchors is a minimum of 21 days old or has attained design strength whichever requires a longer duration.

B. Locate existing reinforcing with ground penetrating radar or other method approved by the Engineer prior to drilling. Coordinate with the Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on the Drawings.

E. Use only drill type, bit type, and diameter recommended by anchor manufacturer. Use rotary hammer drill unless otherwise approved by the Engineer. Core drilling may only be used if specifically allowed by the Engineer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify the Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by the Engineer and adhesive manufacturer:
    a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
    b. Do not install prior to concrete attaining an age of 21 days.
    c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
    d. Do not disturb anchor during recommended curing time.
    e. Do not exceed maximum torque as specified in manufacturer's instructions.
2. For hollow-unit masonry, install screen tube in accordance with manufacturer's instructions.
3. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without the Engineer's prior approval unless specifically shown on the Drawings.

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3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan as shown on the Drawings. The Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify the Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	**Product**	**Remarks**
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application

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Service Use and Location	Product	Remarks
2. Anchors in Grout-Filled Concrete Masonry Units		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, galvanized anchors to anchor galvanized equipment).	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel anchors	
3. Anchors in Hollow Concrete Masonry Units		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, galvanized anchors to anchor galvanized equipment).	Adhesive anchors shall be installed with screen tubes.
Exterior, Interior Wet, and Corrosive Areas	Stainless steel anchors	Adhesive anchors shall be installed with screen tubes.
4. All Others		
All service uses and locations	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

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SECTION 05 05 23
WELDING

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):
   a. BPVC SEC V, Nondestructive Examination.
   b. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society of Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0, Standard Welding Terms and Definitions.
   c. D1.1/D1.1M, Structural Welding Code—Steel.
   d. D1.8/D1.8M, Structural Welding Code—Seismic Supplement.
   e. D1.2/D1.2M, Structural Welding Code—Aluminum.
   f. D1.3/D1.3M, Structural Welding Code—Sheet Steel.
   g. D1.4/D1.4M, Structural Welding Code—Reinforcing Steel.
   h. D1.6/D1.6M, Structural Welding Code—Stainless Steel.
   i. QC1, Standard for AWS Certification of Welding Inspectors.

1.02 DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

1. Contractor’s Welding Inspector: Contractor’s CWI acts for, and on behalf of, the Contractor for all inspection and quality matters within the scope of the Contract Documents. Contractor is required to provide a welding inspector to oversee welding operations and be responsible for visual inspection and necessary correction of all deficiencies in materials and workmanship required to meet referenced welding codes. This type of Quality Control Inspection is not classified as Special Inspection.
2. Verification Inspector: This independent inspection is the prerogative of the Owner, who may employ their own, independent CWI, or waive this supplementary, independent CWI inspection.

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C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. Special Inspection: Nondestructive weld examination including MT, PT, UT, and RT.

1. Special Inspection personnel report to, and are retained by the Owner, except as noted below:
   a. Contractor and fabricator are required to complete nondestructive weld examinations for welded steel tanks, welded steel pipe, and process piping.
2. See additional requirements in Section 01 45 33, Special Inspection, Observation, and Testing.

J. RT: Radiographic Testing.

K. UT: Ultrasonic Testing.

L. VT: Visual Inspection/Testing.

M. WPQ: Welder/Welding Operator Performance Qualification Record.

N. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Shop and field WPSs and PQRs.
   b. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
   c. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.
      1) Show on the Shop Drawings, or on a weld map, complete information regarding base metal ASTM specifications, and location, type, size, and length of welds.

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2) Identify WPS to be used, and NDE requirements in tail of welding symbol.
3) Clearly distinguish between shop and field welds.
4) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.
5) Welding and NDE Symbols shall be in accordance with AWS A2.4. Welding terms and definitions shall comply with AWS A3.0.

B. Informational Submittals:

1. WPQs.
2. CWI credentials.
3. Testing agency NDE inspector credentials.
4. CWI visual inspection (VT) reports.
5. Welding Documentation: Submit on forms provided in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex J Forms) for shop or field welding; or ASME BPVC SEC IX (Form QW-482 and Form QW-483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex J Forms); or ASME BPVC SEC IX (Form QW-484).

C. CWI: Certified in accordance with AWS QC1 and having prior experience with specified welding codes. Alternate welding inspector qualifications require prior approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

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PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Fabricator's CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job materials and proper storage.
2. Monitor conformance with approved WPSs.
3. Monitor welder performance and conformance with approved WPQs.
4. Inspect weld joint fit-up and perform in-process inspections.
5. Provide 100 percent visual inspection of completed welds.
6. Coordinate with nondestructive testing personnel and review NDE results.
7. Maintain records and prepare reports documenting results of CWI VT and required NDE complies with the Work and referenced welding codes.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Quality Control Inspection:

1. All Welds: 100 percent VT by Contractor's CWI.
2. Acceptance Criteria:
   a. Structural Pipe and Tubing: AWS D1.1/D1.1M, Paragraph 10.24.
   b. All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 8.9, Visual Inspection, Statically Loaded Nontubular Connections.
   c. Stud Connections: AWS D1.1/D1.1M, Paragraph 9.8.1.

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B. Nondestructive Testing Requirements:

1. NDT frequency shall be as specified below, as required by referenced fabrication or welding codes, or as specified in the attached table. In case there is a conflict, the higher frequency level of NDT shall apply.
   a. Nontubular Connections:
      1) CJP Butt Joint Groove Welds: 10 percent random RT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.
      2) All Other CJP Groove Welds: 10 percent random UT.
      3) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
   b. Tubular Connections:
      1) CJP butt joint groove welds made from one side without backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 10.25.2 requirements.
      2) CJP Butt Joint Groove Welds made with back-gouging: 10 percent random RT.
      3) CJP Butt Joint Groove Welds made with backing and other butt joint groove welds that cannot be readily radiographed: 10 percent random UT.
      4) All Other CJP Groove Welds: 10 percent random UT.
      5) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
2. NDT Procedures and Acceptance Criteria:
   a. Nontubular Connections:
      1) RT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part E. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.12.1.
      2) UT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part F. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.13.1.
      3) PT and MT:
         a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
         b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.9, Visual Inspection, Statically Loaded Nontubular Connections.
   b. Tubular Connections:
      1) RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.27, and Paragraph 10.28.

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2) UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.26, and Paragraph 10.29.
3) PT and MT:
   a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
   b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 10.24.

3.03 FIELD QUALITY CONTROL

A. The Contractor's CWI shall be present whenever field welding is being done and shall perform inspection, at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job materials and proper storage.
2. Monitor conformance with approved WPS.
3. Monitor welder performance and conformance with approved WPQs.
4. Inspect weld joint fit-up and perform in-process inspection.
5. Provide 100 percent visual inspection of all welds in accordance with Paragraph Quality Control Inspection.
6. Coordinate with nondestructive testing personnel and review test results.
7. Maintain records and prepare reports confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal have been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENT

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

1. Welding and Nondestructive Testing Table.

END OF SECTION

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Welding and Nondestructive Testing						
Specification Section	**Governing Welding Codes or Standards**	**Submit WPS**	**Submit WPQ**	**Onsite CWI Required?**	**Submit Written NDT Procedure Specifications**	**NDT Requirements**
05 50 00 Metal Fabrications	AWS D1.1/D1.1M, Structural Welding Code–Steel or AWS D1.2/D1.2M, Structural Welding Code—Aluminum or AWS D1.6/D1.6M, Structural Welding Code—Stainless Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 05 50 00
05 52 16 Aluminum Railings	AWS D1.1/D1.1M, Structural Welding Code—Steel or AWS D1.2/D1.2M, Structural Welding Code—Aluminum	No	No	No	No	100% VT; also see Section 05 52 16, Aluminum Railings
05 53 00 Metal Gratings	AWS D1.1/D1.1M, Structural Welding Code—Steel or AWS D1.2/D1.2M, Structural Welding Code—Aluminum	No	No	No	No	100% VT; also see Section 05 53 00
40 27 00 Process Piping—General	ASME BPV Code, Section IX; and ASME B31.3 Normal Fluid Service Category	Yes	Yes	Yes	Yes	100% VT and 5% RT; also see Section 40 27 00

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

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j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 pounds per square inch Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A489, Standard Specification for Carbon Steel Lifting Eyes.
s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
aa. A992/A992M, Standard Specification for Structural Steel Shapes.
bb. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ee. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

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ff. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
gg. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
hh. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
ii. F436, Standard Specification for Hardened Steel Washers.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ll. F594, Standard Specification for Stainless Steel Nuts.
mm. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
nn. F1554, Standard Specification for Anchor Bolts, Steel, 36-ksi, 55-ksi, and 105-ksi Yield Strength.

9. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910.27, Fixed Ladders.
    b. 29 CFR 1926.105, Safety Nets.
    c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
11. Specialty Steel Industry of North America (SSINA):
    a. Specifications for Stainless Steel.
    b. Design Guidelines for the Selection and Use of Stainless Steel.
    c. Stainless Steel Fabrication.
    d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

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E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.
2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

1. Pre-engineered Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
2. Passivation method for stainless steel members.
3. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

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PART 2 PRODUCTS

2.01 GENERAL

A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C
Aluminum:	
Aluminum Plates	B209, Alloy y6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW

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Item	ASTM Reference
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on the Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

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B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

2.04 STUD SHEAR CONNECTORS

A. Headed anchor studs (HAS), or threaded anchor studs (TAS), or stud shear connectors, as indicated on the Drawings.

1. Carbon Steel: ASTM A108, Standard Quality Grade 1010 through Grade 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.
2. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

B. Manufacturers:

1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
2. Stud Welding Associates, Inc., Elyria, OH.

2.05 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

2.06 STEEL LINTELS AND SHELF ANGLES

A. ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.07 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

B. Welded anchors for stainless steel support frames shall also be stainless steel.

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2.08 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on the Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
2. Epoxy abrasive shall extend over and form curved front edge of nosing.
3. Base of Nosing: Extruded aluminum alloy 6063-T5, heat-treated.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3 inches wide by 1/4-inch to 3/8-inch thick by length as shown.

E. Color: Selected by Engineer from manufacturer’s standard color range.

F. Manufacturers and Products:

1. Wooster Products, Inc., Wooster, OH; Spectra Type WP3J and Spectra Type WP3C.
2. American Safety Tread Co., Inc., Helena, AL; Type BF-311D and Type FA-311D.

2.09 LADDERS

A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, CFR-Part 1910.27, and ALI A14.3.

1. Design ladder for concentrated load of 200 pounds imposed by user concentrated at points that will cause maximum stress in structural member being considered.
2. Include weight of ladder and attached appurtenances together with live load in design of rails and fastenings.
3. Self-closing gates at landings.

B. Flat Bar Ladder:

1. Punch rails, pass rungs through rails, and weld on outside.
2. Weld brackets to ladder for fastening ladder to wall.
3. Hot-dip galvanize steel after fabrication in accordance with ASTM A123/A123M and ASTM A385/A385M.

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C. Aluminum Pre-engineered Pipe Ladder:

1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Cage Assembly Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

D. Ladder Safety Post:

1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post: Stainless steel, AISI Type 304.
3. Hardware: Stainless steel, AISI Type 316.
4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; “Ladder Up” to fit ladder rungs.

2.10 ALTERNATING STAIR TREADS

A. Material:

1. Landings, Treads, and Foot Castings: Cast aluminum Alloy F356F.
2. Handrails: Aluminum Alloy 6063-T4, 1-1/2-inch by 1/8-inch tube.
3. Central Stringer: Aluminum Alloy 6063-T52, 1-3/4-inch by 4-inch by 1/8-inch tube with rubber bumper strip.

B. Treads: Skid-resistant with upturned integrally cast skid barriers.

C. Risers: Equally spaced to within 3/16-inch for adjacent risers and to within 3/8 inch for nonadjacent risers.

D. Handrails: Contoured for body guidance and underarm support, with supports positioned to allow free sliding of hands along rails.

E. Foot Divider: Cast aluminum integral part of landing, which provides support for rubber bumper strip attached to central stringer.

F. Stair Angle: 68 degrees from horizontal.

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G. Vertical Drop: As shown on the Drawings.

H. Finish: Natural aluminum finish.

I. Manufacturer and Product: Lapeyre Stair, Inc., Harahan, LA; 68-Degree Alternating Tread Aluminum Stair.

2.11 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
   a. Bostik, Middleton, MA; Neverseez.
   b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on the Drawings.
2. Thickness: Minimum 1/4-inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

2.12 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.

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3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.

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6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in contact with sewage. Cover full bearing surfaces.

H. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

I. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.13 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer’s recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

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B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on the Drawings.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

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3.04 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer’s written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.05 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

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C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.06 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on the Drawings.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
2. Manufacturer's Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing.

3.07 FASTENER SCHEDULE

A. Unless indicated otherwise on the Area Classification and Materials Selection Table, Drawing G-0085, provide fasteners as follows:

Service Use and Location	**Product**	**Remarks**
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating

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Service Use and Location	Product	Remarks
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Anchors Cast in Grout-Filled Concrete Masonry Units		
Dry Areas	Hot-dip galvanized steel headed anchor bolts	
Exterior and Interior Wet Areas	Stainless steel sleeve anchors	
5. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
6. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
7. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

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B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

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SECTION 05 52 16
ALUMINUM RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
2. American Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
    a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
    b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
    c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
    d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
    e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
5. International Code Council (ICC): International Building Code (IBC).
6. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Special Inspection: As defined by the ICC IBC.

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D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Railing System:
   a. Capable of withstanding the following load cases applied:
      1) Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC and OSHA.
      2) Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
      3) Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. Toeboard: Capable of withstanding, without failure, force of at least 50 pounds applied in downward or outward direction at any point along toeboard.
3. Calculated lateral deflection at top of posts shall not exceed 1-inch.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and Detail Drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.
   c. Design Data: Calculations or test data using specified design performance loads and including the following:
      1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
      2) Design of post base connection.
      3) Documentation that concrete anchors have been designed in accordance with one of the following:
         a) ACI 318, Chapter 17.
         b) ICC Evaluation Services Report for selected anchor.

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B. Informational Submittals:

1. Manufacturer’s assembly and installation instructions.
2. Special Inspection: Manufacturer’s instructions for Special Inspection of post-installed anchors.
3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
   a. Test data for railing and components showing load and deflection as a result of load, in enough detail to prove railing is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Railing expansion joint connections.
      4) Railing system gate assembly, including latch, gate stop, and hinges. Both gate latch and stop to support required loads applied independent of each other.
   b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with ICC IBC.
   c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.
   d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.
4. Manufacturer’s written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.05 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to extent possible until railing is completely installed.

B. Delivery:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.

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3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.

1. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

A. General:

1. Furnish pre-engineered and prefabricated railing systems as shown on the Drawings.
2. Railing systems using pop rivets or glued railing construction are not permitted.
3. Sand cast accessories and components are not permitted.
4. Fasteners shall be AISI Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:

1. Extruded Alloy 6105-T5, Alloy 6061-T6, or equivalent.
2. Tensile Strength: 38,000 pounds per square inch, minimum.
3. Yield Strength: 35,000 pounds per square inch, minimum.
4. Nominal Wall Thickness: 0.145-inch, minimum.
5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

1. Fittings and Accessories:
   a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
   b. Gauge metal components are not acceptable for load-resisting components.
   c. Fittings shall match color of pipe in railings.

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2. Miscellaneous Extruded Aluminum Parts: Alloy 6063-T6, Alloy 6061-T6, or Alloy 6105-T5 aluminum, or equivalent, and of adequate strength for all loads.
3. Castings for Railings:
   a. Cast Al-mag with sufficient strength to meet load and test requirements.
   b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
   a. Refer to standard details for types of post anchorages and minimum requirements.
   b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Wall Brackets: Adjustable wall fitting, with provision for minimum three 3/8-inch diameter AISI Type 316 stainless steel bolts or concrete anchors.
6. Rail Terminals (including Wall Returns): Aluminum wall fitting with provision for three 3/8-inch Type 304 fasteners.
7. Railing System Gate:
   a. Extruded aluminum rail components.
   b. Hardware Manufacturers and Products:
      1) Julius Blum & Co., Inc., Carlstadt, NJ; No. 782/3 gate hinges with springs, and No. 784 gate latch and stop.
      2) CraneVeyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
      3) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.
8. Toeboards:
   a. Molded or extruded Alloy 6063-T6 or Alloy 6061-T6 aluminum.
   b. Provide slotted holes for expansion and contraction where required.

D. Finishes:

1. Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings and Toeboards: In accordance with AA DAF45, designation AA-M10-C22-A41.

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2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 316 stainless steel.

C. Concrete Anchors:

1. Stainless steel, AISI Type 316.
2. Post-installed anchors in accordance with Section 05 05 19, Post-installed Anchors, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
   a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
   b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

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PART 3 EXECUTION

3.01 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer’s written recommendations for installation.

B. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

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C. Posts and Rails:

1. Surface Mounted Posts:
   a. Bolt post baseplate connectors firmly in place.
   b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.
2. Set posts plumb and aligned to within 1/8-inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8-inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

D. Wall Brackets: Support wall rails on brackets spaced maximum 5 feet on centers as measured on the horizontal projection.

E. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.
2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.
3. Dimension between bottom of toeboard and walking surface not to exceed 1/4-inch.
4. Install plumb and aligned to within 1/8-inch in 12 feet.
5. Attach toeboards to posts via clamp that complies with design requirements while facilitating expansion and contraction. Do not screw directly to post or base.

F. Railing System Gate: Install in accordance with manufacturer’s installation instructions.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

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3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Post-installed anchors supporting railing systems require special inspection.

B. Owner-Furnished Quality Assurance, in accordance with ICC IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.05 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with railing manufacturer’s recommendations or replace stained railings.

END OF SECTION

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SECTION 05 53 00
METAL GRATINGS

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 and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   d. B210/B210M, Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
   e. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531, Metal Bar Grating Manual.
   b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
   c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
   d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.

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1.03 DELIVERY, STORAGE, AND HANDLING

A. As far is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
2. IKG, Houston, TX.
3. Ohio Gratings, Inc., Canton, OH.

2.02 GRATING MATERIALS

A. Aluminum: Provide alloy and temper as designated below.

1. Bearing Bars and Banding: ASTM B221 Alloy 6061-T6 or Alloy 6063-T6.
2. Swaged Crossbar Rods: ASTM B221 Alloy 6061 or Alloy 6063, or ASTM B210/B210M Alloy 3003.
3. Finish: Mill.

2.03 LIGHT-DUTY AND MEDIUM-DUTY METAL BAR GRATING (TYPE A AND TYPE B)

A. General Requirements:

1. Maximum Service Load:
   a. Light Duty (Type A): 100 psf uniformly distributed load.
   b. Medium Duty (Type B): 500 psf uniformly distributed load.
2. Maximum Deflection: Span/240 or 1/4-inch, whichever is less.
3. Bearing Bar Spacing:
   a. Light Duty: 1-3/16-inch maximum, center-to-center.
   b. Medium Duty: 15/16-inch maximum, center-to-center.
4. Cross Bar Spacing: 4 inches maximum, center-to-center. For aluminum I-bar grating with depths greater than 2 inches, provide cross bars at 2 inches maximum, center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on the Drawings.

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B. Grating Materials: Aluminum, pressure-locked I-bar grating fabricated by swaging crossbars between extruded I-shaped bearing bars.

C. Surface: Plain.

D. Stair Treads:

1. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
2. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
3. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

2.04 HEAVY-DUTY METAL BAR GRATING (TYPE C)

A. General Requirements:

1. Maximum Service Load: AASHTO H-20.
2. Maximum Deflection: Span/240.
3. Bearing Bar Spacing: 1-7/8-inch maximum center-to-center.
4. Cross Bar Spacing: 4 inches maximum center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 532 or as shown on the Drawings.

B. Grating Type: Galvanized steel, heavy-duty, rectangular bar grating fabricated by welding crossbars between rectangular bearing bars.

C. Surface: Plain.

2.05 ACCESSORIES

A. Embedded Frames: As indicated on the Drawings and as specified in Section 05 50 00, Metal Fabrications.

B. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

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C. Anchor Stud and Saddle Clip:

1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
   a. Welded Stud Anchor:
      1) Nelson Stud Welding, Inc., Elyria, OH.
      2) Stud Welding Associates, Inc. Elyria, OH.
   b. Saddle Clip:
      1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
      2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
      3) Struct-Fast, Inc., Baltimore, MD; Grate-Fast.

2.06 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.
7. Field measure areas to receive grating. Verify dimensions of new fabricated supports and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
9. Minimum Bearing: 1-inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

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B. Light-Duty and Medium-Duty Metal Bar Grating: Single grating section shall be not less than 1.5 feet or greater than 3 feet in width or weigh more than 150 pounds.

C. Heavy-Duty Metal Bar Grating: Minimum width of grating sections shall be 2 feet regardless of length and weight.

D. Supports:

1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
2. Coordinate dimensions and fabrication with grating to be supported.

PART 3 EXECUTION

3.01 PREPARATION

A. Electrolytic Protection:

1. Protect aluminum surfaces in contact with dissimilar metals, or embedded or in contact with masonry, grout, or concrete as specified in Section 09 90 00, Painting and Coating.
2. Allow paint to dry before installation of material.

3.02 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer’s recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.

G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

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H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09 90 00, Painting and Coating.

END OF SECTION

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SECTION 06 82 00
GLASS-FIBER-REINFORCED PLASTIC

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. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
   d. D638, Standard Test Method for Tensile Properties of Plastics.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C.
   g. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   h. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) by Plastics Displacement.
   i. D2344, Standard Test Method for Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method.
   j. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Building Officials and Code Administrators International (BOCA): National Building Code (NBC).
3. International Conference of Building Officials (ICBO): Uniform Building Code (UBC).
4. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.
5. Southern Building Code Congress International (SBCCI): Standard Building Code (SBC).
6. UL: 94, UL Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances.

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1.02 DESIGN REQUIREMENTS

A. This section contains components and connectors that require Contractor design.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Catalog information and catalog cuts showing materials, design tasks, and showing load, span, and deflection; include manufacturer's specifications.
   b. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   c. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
   d. Stairs, Platforms, Stringers, Handrails, Ladders, and Support Structures:
      1) Show dimensions, weight, size, and location of connections to adjacent supports and other Work.
      2) Structural calculations for platforms, ladders and cages, handrails, and other fabrications shown.
2. Samples: Each type of grating, handrail, and handrail connection.

B. Informational Submittals:

1. Handling and storage requirements.
2. Manufacturer's installation instructions.
3. Factory test reports for physical properties of product.
   a. Test data for handrails and supports may supplement load calculations providing data covers the complete system, including anchorage.
   b. Test data for all components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 19.10, using design loads specified.
   c. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Post and base connections.
      4) Railing expansion joint connections.
4. Manufacturer's Certification of Compliance for specified products.
5. Fabricator's qualification experience.

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6. Manufacturer’s qualification experience.
7. Independent laboratory test report, dated within 2 years of submittal date, of fire retardant testing conducted on exact type of grating proposed (not a resin test report).

1.04 QUALIFICATIONS

A. Designer: Calculations and drawings required for Contractor design shall be stamped by a registered engineer, licensed in state where Project will be constructed.

B. Fabricator: Minimum of 5 years’ experience.

C. Manufacturer: Minimum of 5 years’ experience in manufacturing of products meeting these specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:

1. Insofar as is practical, factory assemble items provided hereunder.
2. Ladders shall be shipped fully shop-fabricated and assembled.
3. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.

B. Storage and Handling: In accordance with manufacturer’s recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS

2.01 GENERAL

A. Like Items of Materials: Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

B. Unless otherwise specified, all products shall be manufactured by a pultruded process using vinyl ester resin.

C. Products shall be manufactured with ultra-violet (UV) inhibitor additives.

D. Exterior surfaces shall have a synthetic surface veil covering.

E. Furnish molded products as an option where permitted by specifications.

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F. Fire Retardance:

1. Flame spread shall be less than 25 as measured by ASTM E84.
2. Include combinations of aluminum trihydrate, halogen, and antimony trioxide, where required to meet fire retardance, in the resin system.
3. Meet self-extinguishing requirements of ASTM D635.

G. Color pigment shall be dispersed in resin system.

H. Fabricate FRP products exposed to outdoor conditions with an additional 1-mil thick UV coating to shield product from UV light.

I. All cut ends, holes, and abrasions of FRP shapes shall be sealed with resin to prevent intrusion of moisture.

2.02 GRATING AND STAIR TREADS

A. General:

1. 100 psf minimum, unless otherwise shown.
2. Maximum Deflection: 1/4-inch, unless otherwise shown.
3. Stair Tread: 100 psf uniform load or concentrated load of 300 pounds on area of 4 square inches located in center of tread, whichever produces greater stress.

B. Molded Type:

1. Nonskid grit affixed to top of bar surface or a concave, meniscus top to all bars, providing skid resistance.
2. Load bars in both directions with equal stiffness.
3. Square mesh with 1-1/2-inch maximum spacing.

C. Pultruded Type:

1. Main bars joined by cross bars secured in holes drilled in main bars.
2. Cross bars with 6-inch maximum spacing shall mechanically lock main bars in position such that they prevent movement.
3. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
4. Main Bar Ends: Minimum bearing support width of 1-1/2 inches.
5. Skid-Resistant Surface: Grit adhesively bonded, manufacturer’s standard.
6. Provide extra stiffness around openings.

D. Hold-Down Clamps: Same material as grating.

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E. Bolts and Connectors:

1. Corrosion-resistant FRP or Type 316 stainless steel.
2. Size and strength to meet UBC requirements.

F. Fabrications:

1. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
2. Section Length: Sufficient to prevent it falling through clear opening when oriented in span direction when one end is touching either concrete or vertical leg of grating support.

G. Manufacturers:

1. Fibergrate Composite Structures, Inc., Addison, TX.
2. IKG/Borden, Clark, NJ.
3. Strongwell Corp., Bristol Division, Bristol, VA or Chatfield Division, Chatfield, MN.
4. International Grating, Inc., Houston, TX.

2.03 STRUCTURAL PLATFORMS

A. Deflection and Safety Factors:

1. Deflection Criteria: Not to exceed L/360.
2. Safety Factors: Minimum ratios of ultimate stress to allowable static service stress:
   a. Flexural Members: 2.5.
   b. Compression Members: 3.0.
   c. Shear: 3.0.
   d. Connections: 4.0.
3. Minimum design safety factors for dynamic or impact loads shall be twice the values for static service loads.

B. Loads: 100 psf uniform live load over platform.

C. Glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent resin-to-glass ratio.

D. Continuous glass strand rovings shall be used internally for longitudinal strength.

E. Continuous strand glass mats shall be used internally for transverse strength.

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F. Material Properties:

Minimum Ultimate Coupon Properties (UN)		
Material Properties	**Test Method**	**Units**
Pultruded Fiberglass Structural Shapes		
Ultimate tensile stress in longitudinal direction, psi (MPa)	ASTM D638	30,000 (207)
Ultimate compressive stress in longitudinal direction, psi (MPa)	ASTM D695	30,000 (207)
Ultimate flexural stress in longitudinal direction, psi (MPa)	ASTM D790	30,000 (207)
Ultimate short beam shear in longitudinal direction, psi (MPa)	ASTM D2344	4,500 (31)
Ultimate tensile stress in transverse direction, psi (MPa)	ASTM D638	7,000 (48)
Ultimate compressive stress in transverse direction, psi (MPa)	ASTM D695	15,000 (103)
Ultimate flexural stress in transverse direction, psi (MPa)	ASTM D790	10,000 (69)
Density (lb/in.^{3}) (kg/mm^3)	ASTM D792	0.060-0.070 (0.00166-00194)
Water absorption (25-hr immersion)	ASTM D570	0.60 max, % by weight
Barcol hardness	ASTM D2583	45
Coefficient of thermal expansion 10^{-6} in./in./º C	ASTM D696	
Expansion, LW10^{-6} in./in./º F		4.4
Thermal conductivity, Btu-in./ft^2/hr/º F	ASTM C177	

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Minimum Ultimate Coupon Properties (UN)		
Material Properties	**Test Method**	**Units**
Flame-Retardant Properties		
Flammability test	ASTM D635	Self-extinguishing
Surface burning characteristics	ASTM E84	25 maximum
Flammability class	UL 94	VO
Temperature index	UL 94	130 C

G. Manufacturers and Designers:

1. Strongwell Corp., Bristol, VA.
2. Fibergrate Composite Structures, Inc., Addison, TX.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's written instructions.

B. Install plumb or level, rigid and neat, as applicable.

C. Furnish fasteners and anchorages for complete installation.

D. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin.

3.02 GRATING

A. Anchor grating securely to supports to prevent displacement.

B. Install each grating section such that it is easily removable.

C. Clearance (Grating to Vertical Surfaces): 1/4-inch (plus or minus 1/8-inch tolerance).

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3.03 STRUCTURAL SHAPES

A. Connect parts with approved connectors meeting manufacturer’s design requirements and with corrosion resistance equal to structural shapes.

B. Provide supports and bracings required to comply with applicable codes and design requirements.

END OF SECTION

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SECTION 07 53 23
ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Wood Preservers' Association (AWPA): U1, Use Category System: User Specification for Treated Wood.
2. ASTM International (ASTM):
   a. C728, Standard Specification for Perlite Thermal Insulation Board.
   b. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   c. D41, Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   d. D226, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   e. D312, Standard Specification for Asphalt Used in Roofing.
   f. D1863, Standard Specification for Mineral Aggregate Used on Built-up Roofs.
   g. D4637, Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
3. FM (Factory Mutual) Global (FM), Loss Prevention Data Sheet:
   a. 1-28, Wind Loads.
   b. 1-49, Perimeter Flashing.
4. National Roofing Contractors Association (NRCA): Waterproofing Manual.
5. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Layout of tapered insulation.
2. Project specific details of roof penetrations and perimeter conditions.
3. Layout and details of mechanical fastening system.
4. List of materials proposed for use including roofing materials, accessories, insulation, and fasteners.
5. Manufacturer's specifications selected for use, including a description of the complete system from the deck up.
6. Documentation that anchoring system meets uplift requirements.

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B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Manufacturer's installation instructions.
3. A letter or other documentation from roofing materials manufacturer stating that installer has been trained and approved to apply the roof.
4. Sample copy of guarantee to be provided.
5. Record of Preroofing Conference.
6. Inspection reports for inspections conducted by membrane manufacturer's representative, including written instructions or recommendations as conditions to special guarantee.
7. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Include sketches where applicable; recommendations for periodic inspections, care, and maintenance; identify common causes of damage with instructions for temporary patching until permanent repair can be made.
8. Manufacturer's Certificate of Proper Installation per Section 01 43 33, Manufacturers' Field Services, (or alternately, test results or calculations) that assure item's and its anchorage's design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.

1.03 QUALITY ASSURANCE

A. Installer:

1. Trained and approved by roof membrane manufacturer.
2. Experience: 3 years, minimum, in the installation of the specific roofing and flashing system specified.

B. Materials, including insulation used in roofing system, shall be furnished by or approved by manufacturer whose roofing system is selected for use.

C. Preroofing Conference:

1. Attendees: Conduct Preroofing Conference with Engineer, roofing installer, roofing manufacturer, installers of related Work, and other entities concerned with roofing performance including (where applicable) Owner's insurer, test agencies, governing authorities, and Owner.

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2. Agenda: Follow outline in NRCA's Waterproofing Manual; including acceptability of deck, roofing system materials, manufacturer's specifications selected, flashing details, roof guarantee, and protection of furnished roofing system.
3. Record discussions and agreements; furnish copy to each participant and entity invited.

D. Membrane manufacturer's inspection as required to meet conditions of guarantee.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in their original, unopened containers, clearly labeled with manufacturer's name, brand name, and such identifying numbers as are appropriate.

B. Storage:

1. Store materials at temperatures between 60 degrees F and 80 degrees F. Should they be exposed to lower temperatures, restore to 60 degrees F prior to use.
2. Store rigid roof insulation materials on clean, raised platform.
3. Do not store uncured flashing membrane on roof or at temperatures exceeding 75 degrees F.

C. Protect materials against wetting, moisture absorption, and construction traffic.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Weather: Do not install roofing during precipitation or when it is probable.

B. Temperature:

1. Install roofing when ambient temperature is 50 degrees F or above.
2. When temperature is below 50 degrees F, install only with approval of, and under supervision of, membrane manufacturer.

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1.06 SPECIAL GUARANTEE

A. Product: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing as special guarantee. Special guarantee shall provide for correction or removal and replacement of roofing membrane, flashing, insulation, and accessories found defective during a period of 20 years after date of Substantial Completion, with no dollar limit. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

B. Coverage and Conditions:

1. Costs for repairs required to maintain roofing system, flashing, expansion joint covers, and roof vents in watertight condition.
2. Natural deterioration of roofing system as a result of ordinary wear and tear by elements.
3. Defects as a result of faulty materials or workmanship during application.

1.07 MAINTENANCE SERVICE

A. Provide maintenance service for roof after it is substantially complete and placed in use for a period of 5 years.

B. Maintenance Work: Performed by trained employees of installer.

C. Roof Inspections:

1. At least twice a year and after severe storms.
2. Perform in Spring and Fall.
3. Clear and remove debris from roof.
4. Check and unclog drains, scuppers, and downspouts.
5. Check full field of roof for blisters, alligatoring, and cracking.
6. Check roof edges and flashings.
7. Check roof penetrations and expansion joints.

D. After inspections and in emergency situations, make repairs needed to keep roof in leak-free condition and to ensure guaranteed service life.

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PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carlisle SynTec, Inc.; Sure-Seal Systems.

B. Firestone Building Products; RubberGard EPDM.

C. Johns Manville; EPDM Single Ply.

2.02 ROOFING SYSTEM

A. Complete system including:

1. Roof Insulation.
2. Vapor Retarder.
3. Membrane.
4. Flashings.
5. Fasteners and Accessory Materials.

B. Meeting these specifications and approval of membrane manufacturer to provide a fully adhered or mechanically fastened to match existing EPDM system to match existing and meeting the following:

1. UL Class A fire resistance rating.
2. FM Loss Prevention Data 1-28 requirements for I-60 wind uplift rating.

2.03 MEMBRANE MATERIALS

A. Membrane: ASTM D4637, reinforced minimum 0.060-inch-thick Ethylene Propylene Diene Monomer (EPDM) compounded elastomer.

B. Membrane Sheet Size: Maximum of 10-foot width, or largest sheet possible, determined by Project conditions.

C. Color: White.

2.04 ACCESSORY MATERIALS

A. Furnish bonding adhesive, splicing primer and cement, mechanical fasteners, or self-vulcanizing tape, pourable sealant, lap sealant, water cutoff mastic, night seal, and prefabricated pipe seals approved by membrane manufacturer.

B. Flashings: EPDM, 0.060-inch thick.

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C. Anchoring System: Membrane manufacturer's standard metal bars or battens with screw anchors, screw-anchored plates to which membrane is bonded, or nonpenetrating anchors.

D. Asphalt: ASTM D312, Type III.

E. Asphalt Primer: ASTM D41.

F. Roofing Felt: No. 15, asphalt saturated, perforated, organic felt, ASTM D226, Type 1.

G. Roof Vents: Roofing manufacturer's standard.

H. Reflective Coating:

1. Color: White.
2. Roofing manufacturer's standard reflective coating.

2.05 RIGID ROOF INSULATION

A. Average Aged R-Value for Total Thickness of Rigid Roof Insulation: Match Existing.

B. Insulation Board:

1. Any one of the following materials may be used on this Project, provided roofing materials manufacturer will guarantee roofing system:
   a. Polyisocyanurate Foam Board:
      1) ASTM C1289, Type II, with Factory Mutual Class I approval, minimum size: 2 feet by 4 feet, as manufactured by:
         a) Carlise; Polyisocyanurate HP-H.
         b) Firestone Building Products; ISO 95+.
         c) Johns Manville; E'NRG'Y 2.
   b. Composite Board:
      1) Of polyisocyanurate foam core bonded to 1/2-inch-thick perlite or wood fiber board, ASTM C1289 minimum size 3 feet by 4 feet, as manufactured by:
         a) Firestone Building Products; Firestone ISO 95+ Composite.
         b) Johns Manville; E'NRG'Y Composite.
   c. Expanded Perlite Board:
      1) ASTM C728, minimum size 2 feet by 4 feet, as manufactured by:
         a) Firestone Building Products.
         b) Johns Manville; Fesco Board.

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d. Tapered Board System:
   1) Factory precut or field-tapered insulation board, minimum 1-inch thick with top surface cut to a uniform, continuous slope of 1/4-inch per foot.
   2) Fabricate miters and edges to match abutting blocks.
   3) Maximum aged thermal conductance value “C” at the average thickness of the insulation shall match existing, or be as shown.
   4) Manufacturers and Products:
      a) Carlise; Polyisocyanurate HP-H.
      b) Firestone; ISO 95+ Tapered.
      c) Johns Manville; Tapered E’NRG’Y 2 Plus System.

2.06 ROOF WALKWAYS

A. Nonskid white molded rubber walk pads, 30 inches by 30 inches by 3/8-inch nominal.

B. Manufacturers and Products:

1. Carlisle SynTec; EPDM Walkway Pads.
2. Firestone; RubberGard Quickseam Walkway Pads.
3. Johns Manville; UltraGard EPDM Walkway Pads.

2.07 FASTENERS

A. Into Wood: Zinc-coated, 12-gauge roofing nails with 1-inch diameter metal caps or heads and deformed shanks.

B. Into Insulation and Fiberboard:

1. Nails as manufactured by:
   a. Simplex Nail and Manufacturing Co.; Tube-Loc nail with 1-inch diameter cap.
   b. E. G. Building Fasteners Corp.; Insuldeck Loc-Nail.

C. Into Insulating Concrete: Nails as manufactured by:

1. W.R. Grace; Zono-Tite.
2. Simplex Nail and Manufacturing Co.; Tube-Loc nail with 1-inch diameter cap.

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PART 3 EXECUTION

3.01 PREPARATION

A. Verify deck is firm, dry, clean, free of sharp edges, burrs, loose and foreign materials, oil, and grease, and reasonably smooth.

B. Report immediately to Engineer cracks, breaks, holes, or other unusual irregularities in the surface.

C. Fill surface joints and cracks wider than 1/4-inch with pourable sealer.

D. Existing Roofing:

1. Check for dryness by core sampling, probing, or moisture scanning.
2. Remove wet insulation, dry deck, and replace insulation to original thickness.
3. Remove loose gravel, debris, and cutout blisters from existing built-up roofing.

E. Reroofing:

1. Completely remove existing gravel, roof membrane, and insulation from roof deck.
2. Inspect deck for damage and notify Engineer of areas that require repair.

F. Correct irregularities to deck/substrate that may cause ponding longer than 48 hours.

G. Nailers:

1. Install wooden nailer at perimeter of each roof level, curb flashing, skylights, expansion joints, and similar penetrations.
2. Firmly anchor nailers to resist a force of 75 pounds per linear foot in all directions.
3. Thickness: Such that top of nailer is flush with surface to which membrane is to be applied.
4. Vertical nailer that secures membrane at horizontal plane may be used.

3.02 INSTALLATION

A. Install a complete UL listed Class A system of compatible materials that will create a monolithic watertight single-ply roof membrane.

B. In accordance with membrane manufacturer’s instructions for installation of complete, warrantable roof system.

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C. In accordance with membrane manufacturer's standard details for flashing and termination conditions.

D. Roof Walkways: Adhere to membrane with bonding adhesive or place paver blocks in walkway pattern.

E. Existing roof is EPDM**.**

F. Meet FM Loss Prevention Data 1-28 requirements for I-60 wind uplift rating.

3.03 INSULATION INSTALLATION

A. Install thickness necessary to match adjacent existing roof area in two or more layers.

B. Provide sumps around roof drains.

C. Fasten insulation so that it will meet uplift requirements of FM Global.

D. Position boards of first layer so end joints are staggered and edges parallel to deck span are supported by roof deck.

E. Install additional layers with joints staggered or offset from those below.

F. On Metal Roof Deck:

1. Mechanically fasten 100 percent with a FM Global approved fastener in pattern and quantity recommended by insulation or mechanical fastener manufacturer to meet FM Global requirements.
2. Provide a minimum of one fastener per 2 square feet of insulation board, unless otherwise specified by manufacturer.

G. On Wood Roof Deck: 100 percent mechanically fastened with nails designed for wood penetration with a 1-inch diameter cap, applied at rate of one every 2 square feet of insulation board.

H. On Gypsum Roof Deck: 100 percent mechanically fastened with insulation fasteners with a minimum 1-inch penetration into the deck surface, applied at minimum rate of one every 2 square feet of insulation board.

I. On Concrete or Nonnailable Deck: Set insulation boards in hot asphalt applied at equiviscosity temperature plus or minus 25 degrees F, and at rate of 23 pounds per 100 square feet.

J. Loose lay insulation over substrate with insulation joints 1/4-inch or less in width.

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K. Do not install more insulation each day than can be covered with membrane before end of day or start of inclement weather.

3.04 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, and training of Owner's personnel for maintaining specified system.

B. Provide Engineer with copies of inspection reports.

3.05 CLEANUP

A. Remove spots and smears of adhesive, sealant, asphalt, or other material resulting from the Work in this section from flashing, gravel stops, and other surfaces not intended to be coated with such material.

B. During removal of spots and smears, ensure no damage will be done to the surfaces.

C. Use solvents, if necessary, to satisfactorily clean the materials.

3.06 PROTECTION OF INSTALLED WORK

A. Limit traffic of personnel and equipment on completed roof to that deemed essential for completion of Project.

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. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   b. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   c. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
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.
   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.

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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. MDFT: Minimum Dry Film Thickness, mils.
4. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
5. Mil: Thousandth of an inch.
6. PPDS: Paint Product Data Sheet.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SP: Surface Preparation.

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.

B. Informational Submittals:

1. Applicator’s Qualification: List of references substantiating experience.
2. Coating manufacturer’s Certificate of Proper Installation , in accordance with Section 01 43 43, 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.

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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. Perform surface preparation and painting in accordance with recommendations of the following:

1. Paint manufacturer's instructions.
2. SSPC PA 10.
3. Federal, state, and local agencies having jurisdiction.

D. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

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.

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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.

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.

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

1. Azko 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.

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B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
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
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required.

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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.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.

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c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

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.

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.

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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 Salts or 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 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.

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d. 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.

e. 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.

f. 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.

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.
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.

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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.

D. 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.

E. 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.

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F. 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, 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.

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.

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3.06 APPLICATION

A. General:

1. The intention of these specifications is for new, and existing metal, surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. 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.
4. 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.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
7. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
8. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
9. Keep paint materials sealed when not in use.
10. 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, masonry, nonferrous metal, plastic, and wood surfaces 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 the Work in question.

A. System No. 2 Submerged Metal—Nonpotable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	Per manufacturer's recommendations
	High Build Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Iron and steel metal surfaces below a plane 1-foot above the maximum liquid surface.

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b. Metal surfaces above the maximum liquid surface that are part of the immersed equipment or in an enclosed hydraulic structure.
c. Metallic items, such as pipes, wall pipes, pipe sleeves, access manholes, and structural steel.
d. Other items where shown or specified.

B. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near- Metal White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	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 inside and outside of structures and subject to weather, except where otherwise shown or specified.
   b. Exposed metal surfaces inside of structures and exposed to unconditioned air, except where otherwise shown or specified.
   c. Exposed metal joists and structural beams inside buildings.
   d. New exposed metal surfaces, located inside or outside of structures or exposed to weather, including metal doors and frames, vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim and the following specific surfaces:
   e. Inside duct stack heads behind diffusers, registers, and grilles with flat black.
   f. Instrumentation and control systems exposed enclosures for process.
   g. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

C. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial 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 thimble.

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D. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
Iron and Steel Pipe Fittings and Joints, unless otherwise coated as specified: SP 1, Solvent Cleaning	Petrolatum Wax Tape Coat System	AWWA C217, with non-shielding outer wrap
Other Iron and Steel: SP 10, Near-White Blast Cleaning	High Build Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Buried, belowgrade items as specified or shown.
2. If coating outer wraps are recommended by coating manufacturer, wraps shall be electrically non-shielding in nature.
3. For buried ductile iron piping, see Section 40 27 00, Process Piping--General.

E. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting and the following specific surfaces:
      1) Exposed galvanized structural beams inside buildings.
   b. After application of System No. 10, apply finish coats as required for exposure.

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F. 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. On saw-cut concrete surfaces that intersect and exposes ends of reinforcing steel and metal embeds where the concrete surface will not be coated by another specified coating system. Coat entire area of saw cut. and as indicated on the Drawings.

G. 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 exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

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H. System No. 27 Aluminum and Dissimilar Metal Insulation:

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. Use on aluminum surfaces embedded or in contact with concrete.

I. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Metal Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.
2. Use on the following items:
   a. Anchor bolts per Section 05 50 00, Metal Fabrications.
   b. As specified or shown on the Drawings.

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.
   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.

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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: In accordance with Piping Schedule on the Drawing G-0086.
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. 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 an electronic 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.
   b. 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.
   c. 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.

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d. 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.
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.

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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: (from Spec)		
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.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

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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. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
4. National Fire Protection Association (NFPA):
   a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
   b. HAZ-01, Fire Protection Guide to Hazardous Materials.
5. Occupational Safety and Health Act (OSHA).

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, and label specified.

B. Informational Submittals: Manufacturer’s installation instructions.

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PART 2 PRODUCTS

2.01 SIGN TYPES

A. Metal Sign (Type B):

1. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.
2. Manufacturers:
   a. Seton Identification Products.
   b. Nutheme Illustrated Safety Co.

2.02 IDENTIFICATION LABELS

A. Pipe Labels:

1. Labels: Self-adhesive tape, with separate directional flow arrow banding tape.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background unless otherwise scheduled.
4. Color Field as indicated on the Piping Schedule on the Drawings.
5. Letter Height: ASME A13.1.
6. Message: Piping system Service name as indicated on the Piping Schedule on the Drawings.
7. 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 Arrows-On-A-Roll Tape.

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: Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
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.

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7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
   a. Brady Signmark.
   b. Seton Identification Products.

2.03 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 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.

B. Information, Exit, and Safety Signs: Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

3.03 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:

1. Locate and install on equipment or concrete equipment base.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.04 SUPPLEMENT

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

1. Sign Schedule.

END OF SECTION

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Sign Schedule

Sign									Lettering					
			Size			Mounting								
Number[1]	Sign Type[2]	Detail Reference[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
S-1	C	1014-002	20"	14"	Yellow	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	CAUTION Ear Protection Required	1	
S-3	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	Polymer Fill Station*	1	*TO DEWATERING POLYMER STORAGE TANK 5 (TNK-7685)
S-4	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	Polymer Fill Station*	1	*TO THICKENING POLYMER STORAGE TANK (TNK-7631)
S-5	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	Polymer Fill Station*	1	*TO DEWATERING POLYMER STORAGE TANK 1 AND 2 (PAT 7532/PAT 7536)
S-6	A	N/A	As required		White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	Polymer Fill Station*	1	*TO DEWATERING POLYMER STORAGE 3 AND 4 (PAT 7542/PAT 7546)

[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to Sign Types specified in this section.
[3]Numbers refer to Design Details that show sign layout.
[4]Verify requirements for this sign with Regulations in state where Project is located.

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.
3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.

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4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:

1. Furnish cast iron or flanged steel sheaves.
2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.
B. Adjust and balance the following systems:
1. Supply, and exhaust air systems.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

1. Prior to beginning the Work, perform the following activities:
a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
c. Verify proper startup procedures have been completed on the system.
d. Verify controls installation is complete and system is in stable operation under automatic control.
e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

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B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.

C. Equipment Data:

1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, hp, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully OPEN. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.
   d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
   e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to Owner if drive or belt changes were made.

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4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully OPEN.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

3.03 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

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C. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
   a. Air and water balancing procedures, vibration tests, and verification of test results.
   b. Perform spot tests on a maximum of 20 percent of total diffusers and grilles, on two air handling fan devices per building, and on 10 percent of total water balance fittings, with measuring equipment used in original tests, at random points selected by Engineer.
   c. Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

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SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
5. ASTM International (ASTM):
    a. A36/A36M, Standard Specification for Carbon Structural Steel.
    b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
    e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
    h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
    j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

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k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   e. 259, Standard Test Method for Potential Heat of Building Materials.
   f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.
   b. Guidelines for Seismic Restraints of Mechanical Systems.
   c. Fibrous Glass Duct Construction Standards.

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d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
e. HVAC Air Duct Leakage Test Manual.

9. UL:
   a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
   b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
   c. 555, Standard for Safety Fire Dampers.
   d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. CFM: cubic feet per minute.
2. FPM: feet per minute.
3. PCF: pounds per cubic foot.
4. WC: water column.

B. Sealing Requirements:

1. For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:
   a. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
   b. Joints, duct surface connections including:
      1) Girth joints.
      2) Branch and subbranch intersections.
      3) Duct collar tap-ins.
      4) Fitting subsections.
      5) Louver and air terminal connections to ducts.
      6) Access door, and access panel frames and jambs.
      7) Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular, Rigid Round, and Oval Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.

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4) Seam and joint construction details.
5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

b. Ductwork Accessories:
1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
a) Fittings and volume control damper installation (both manual and automatic) details.
b) Duct liner.
c) Sealing materials.
d) Dampers; include leakage, pressure drop, and maximum back pressure data.
e) Duct-mounted access panels and doors.
f) Flexible ducts.
g) Sheet metal fasteners.

2. Duct Fabrication Drawings:
a. Drawn after actual job measurements are obtained.
b. Drawn to a scale not smaller than 1/4-inch equals 1-foot, on drawing sheets same size as Contract Drawings.
c. Include the following features:
1) Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.
2) Duct layout, indicating pressure classifications, and sizes in plan view.
3) Duct material and thickness.
4) Fittings and volume control damper installation (both manual and automatic) details.
5) Reinforcing details and spacing.
6) Seam and joint construction details.
7) Penetrations through fire-rated and other partitions.
8) Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.
9) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
10) Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.
11) Coordination with ceiling suspension members.
12) Spatial coordination with other systems installed in same space with duct systems.

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13) Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.
14) Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.
15) Coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment.

3. 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. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Sound Attenuators Certified Test Data:
   a. Dynamic insertion loss.
   b. Self-noise power levels.
   c. Static pressure loss.
   d. Dimensions and weights.
4. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

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C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing by Engineer.
2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

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B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.

2.02 SHEET METAL MATERIALS

A. Construct metal duct systems from aluminum.

B. Aluminum Ductwork:

1. Comply with ASTM B209.
2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or equivalent.

C. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

D. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.03 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
   a. Foster; Series 32.
   b. Childers; CP-145A, 146.
   c. Rectorseal; Airlok 181.

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2.04 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Aluminum Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel, complete with bonded metal and fiber washer for dielectric separation.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.

2.05 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts: 3-inch WC.
2. Exhaust Ducts: See Section 23 31 16.16, Thermoset Fiberglass Reinforced Plastic Ducts and Accessories.

2.06 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.07 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

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B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
5. Manufacturers and Products:
   a. Elgen; All-Tight.
   b. Duro-Dyne; Type TR.

2.08 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections or with factory fabricated, field installed taps, with spin-in or mechanical fastened tap to main duct connections.

2.09 RECTANGULAR DUCTWORK INSULATION LINER

A. Location: Provide ductwork with internal insulation liner on all outdoor ductwork and elsewhere as indicated.

B. Material:

1. Fiberglass, nominal 1.5 pcf density liner, K factor 0.25 maximum at 75 degrees F mean.
2. Black composite coating on surface exposed to airstream to prevent erosion of glass fibers, for temperatures to 250 degrees F.
3. Liquid water repellency rating not less than 4.0 when tested in accordance with INDA IST 80.6.
4. Potential heat value not exceeding 3,500 Btu per hour per pound when tested in accordance with NFPA 259 and meeting classification of “Limited Combustible” as defined by NFPA 90A.
5. Maximum rated velocity not less than 6,000 fpm when tested in accordance with ASTM C1071.
6. Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139.
7. Manufacturers and Products:
   a. CertainTeed; Toughgard.
   b. JohnsManville; Linacoustic RC.
   c. Knauf; Duct Liner M.

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C. Thickness: Minimum 2 inches.

D. Liner Adhesive: In accordance with NFPA 90A and ASTM C916.

E. Mechanical Fasteners:

1. Same material as ductwork, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
2. Provide fasteners that do not damage liner when applied as recommended by manufacturer, that do not cause leakage in duct, and will indefinitely sustain 50-pound tensile dead load test perpendicular to duct wall.
3. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8-inch into airstream.
4. Adhesive for Attachment of Mechanical Fasteners: In accordance with Fire Hazard Classification of duct liner system.

F. Liner Application:

1. Ductwork liner shall be applied at time of ductwork manufacture in an approved sheet metal workshop.
2. Adhere single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
3. Apply coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
4. Butt transverse joints without gaps and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
6. Longitudinal Joints:
   a. Shall not occur except at corners of ducts, unless size of duct and standard liner product dimensions make longitudinal joints necessary.
   b. Apply adhesive coating on longitudinal seams in ducts exceeding 2,500 fpm air velocity.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter, at 3 inches from transverse joints, and at intervals not exceeding 18 inches longitudinally.

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8. Secure transversely oriented liner edges facing airstream with metal nosing that are either channel or “Z” profile or are integrally formed from duct wall at the following locations:
    a. Fan discharge.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts.
9. Seal insulation edges.
10. Repair abrasions or tears with mastic.

2.10 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
3. Wire hangers are not acceptable.
4. Hanger Spacing:
    a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
    b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials:

1. Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:
    a. Aluminum Ductwork Indoors and Outdoors:
        1) Carbon steel, hot-dipped galvanized after fabrication.
        2) Non-metallic pad between lower attachment and ductwork, to achieve dielectric separation.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
    a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
    b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
    c. Concrete attachments shall be made of steel.

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D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.11 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:

1. Size: 18-inch and 24-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturer and Product: Flexmaster; Inspector Series.

C. Casing and Plenum Access Doors:

1. Size: 57 inches high by 24 inches wide minimum where possible.
2. Complete with hardware, hinges, seals, and latch handles.
3. Doors and frames shall be designed to close as indicated on the Drawings.
4. Latch Handles: Ventlock, Series No. 260.
5. Hinges: Ventlock, Series No. 200 and No. 300.

D. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

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2.12 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.
5. Operator Manufacturers:
   a. Accessible Ductwork: Ventlok; Type 620 or Type 635.
   b. Accessible Insulated Ductwork: Ventlok; Type 639.
   c. Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

B. Manual Opposed-Blade Balancing Dampers:

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers and Products:
   a. Ruskin; CD102.
   b. American Warming and Ventilating; Model VC-31.

2.13 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge sheets of same material as louver/grille.
2. Line with sound attenuation/insulating material.
3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

B. Accessories Hardware:

1. Instrument Test Holes:
   a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
   b. Size to allow insertion of pitot tube and other testing instruments.
   c. Provide in length to suit duct insulation thickness.

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2. Flexible Duct Clamps:
   a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
   b. Provide in sizes from 3 inches to 18 inches to suit duct size.
3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

2.14 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.
2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

2.15 PAINTING OF DUCTWORK

A. Refer to Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer’s recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.

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3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
   a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.
   c. Same gauge and material as duct.
   d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
   e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Concealment:

1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
2. Do not encase horizontal runs in solid partitions, except as specifically shown.
3. Limit clearance to 1-inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

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E. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on the Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.02 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

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3. Mechanical Joint Option:
   a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
   b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
   c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
   d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
   e. Conform to SMACNA Class A sealing requirements.

3.03 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

H. Install seismic restraints on ductwork systems and sway bracing as described in SMACNA Guidelines for Seismic Restraints of Mechanical Systems.

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3.04 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

3.05 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on the Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers as indicated on the Drawings in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

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3.06 ACCESS DOORS

A. Ductwork:

1. Install access doors in ductwork, in accordance with manufacturer's instructions, at each:
   a. Turning vane.
   b. Volume damper.

3.07 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

B. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

3.08 DUCT SEALING

A. Seal duct seams and joints as follows:

1. In accordance with SMACNA requirements.
2. In accordance with the following:
   a. Pressure Classifications Greater than 3-Inch WC: Transverse joints, longitudinal seams, and duct penetrations.
3. In addition to other requirements, provide the following duct sealing:
   a. For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape.
   b. For exterior ductwork, tape joints with Hardcast outdoor tape and rosin.

B. Seal all audible leaks.

3.09 PAINTING OF DUCTWORK

A. Refer to Section 09 90 00, Painting and Coating.

3.10 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

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3.11 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.12 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION

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SECTION 23 31 16.16
THERMOSET FIBERGLASS-REINFORCED PLASTIC DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500-D, Laboratory Methods of Testing Dampers for Rating.
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Class 25, Class 125, and Class 250).
   b. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24.
   c. B18.22.1, Plain Washers.
4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
   d. D3982, Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods.
   e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
5. Sheet Metal and Air Conditioning Contractors’ National Association, Inc., (SMACNA): Thermoset FRP Duct Construction Manual.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. cfm: Cubic feet per minute.
2. fpm: Feet per minute.
3. FRP: Fiberglass reinforced plastic.
4. H2S: Hydrogen sulfide.
5. MDFT: Mean dry film thickness.

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6. pcf: Pounds per cubic foot.
7. ppmv: Parts per million (volume).
8. wc: Water column.

1.03 SUBMITTALS

A. Action Submittals:

1. Duct:
   a. Statement of resins and reinforcing proposed for use.
   b. Pressure, vacuum, and temperature rating of duct.
   c. Dimensions of subassemblies to be shipped.
   d. Manufacturer’s data and descriptive literature for duct accessories, including hardware and gaskets.
   e. Drawings showing overall layout, slopes, supports, and joint details.
   f. Shop spool drawings including location of field joints, flexible connectors, dampers, and any other duct accessories.
   g. Stamped and signed structural engineering design calculations.
   h. Information, details, and requirements for installation and support of duct and torque values for flange bolting.
   i. Name of manufacturer.
2. Supports: Comply with Section 40 05 15, Piping Support Systems.
a. Anchorage and bracing drawings, load criteria, and cutsheets, as required by Section 01 88 15, Anchorage and Bracing, for ducting systems and supports.
3. Expansion Joints/Flexible Connectors:
   a. Type and model.
   b. Materials of construction.
   a. Allowable movements in all three directions.
   b. Name of manufacturer.
4. Butterfly Dampers and Blast Gates:
   a. Statement of resins and reinforcing proposed for use.
   b. Pressure, vacuum, and temperature rating.
   c. Materials of construction.
   d. Total weight including operator.
   e. Drawings showing overall dimensions and connection size.
   f. Type and model.
   g. Name of manufacturer.

B. Informational Submittals:

1. Qualifications:
   a. Fabricator: List of references substantiating experience.

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b. Installer: Manufacturer's certification that installer is qualified for installation work.

2. Anchorage and bracing calculations or loading information as required in Section 01 88 15, Anchoring and Bracing, for ducting systems and supports.
   a. Anchorage, bracing, and support design criteria and calculations:
      1) Stamped by a civil or structural engineer licensed in the State of Oregon.
      2) Conform to manufacturer's requirements as well as design criteria provided in Structural General Notes on the Drawings and other referenced standards.
3. Manufacturer's installation instructions.
4. Dampers and Blast Gates: AMCA 500-D leakage test results by AMCA-approved laboratory.
5. Field Duct Slope Verification Report.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator: Minimum 5 years' experience.
2. Installer: Minimum 5 years' experience.
3. Joint Installer: Manufacturer certified.

1.05 SERVICE CONDITIONS:

A. System Maximum Pressure: 6 inches of water column.

B. System Maximum Vacuum: 12 inches of water column.

C. Location: Outside or inside as indicated.

D. Ambient Temperature: 10 degrees F to 120 degrees F.

E. Seismic Requirements: See General Structural Notes on the Drawings.

F. Wind and Snow Loads: See General Structural Notes on the Drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Do not ship ducting by nesting small diameter components inside larger diameter components.
2. Protect flanged sections by bolting to wooden blinds 2 inches greater than outside diameter of flange.

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3. For nonflanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.
4. Crate materials whenever practical prior to shipment.
5. Firmly fasten and pad components shipped to prevent shifting or flexing of components while in transit.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Make field joints only when ambient temperature is above 55 degrees F and below 100 degrees F.

PART 2 PRODUCTS

2.01 MATERIALS

A. Resin:

1. Resin System: Premium corrosion-resistant, fire-retardant vinylester, or other qualified thermosetting resin, such as Derakane 510-B-400, Cor VE 8401, AOC Vipel K022, Reichold Dion Impact 9303-54 "or-equal." Resin to be selected by fabricator, subject to approval of Engineer, and suitable for intended service with no fillers or thixotropic agents.
2. Liner Resin: Premium grade and corrosion resistant.
3. Structural wall resin may be of different chemical resistance, subject to conditions of service and approval of Engineer.
4. Flame Spread Index: ASTM E84, less than 25; fire retardant additives used only in structural layer.
5. Smoke Generation: ASTM E84, rating of less than 10.
6. Color: Use no dyes, pigments, or colorants, except in exterior gel coat Exterior gel coat shall be green to match existing.

B. Reinforcement:

1. Veil: Chemical surfacing mat, Type C (chemical) glass, 10 mils thick, with finish and binder compatible with lay-up resin.
2. Corrosion Barrier: Resin-rich interior surface of nominal 100 mils to 120 mils thick, using chopped strand mat backing the veil. Use no additive in corrosion barrier.
3. Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.
4. Continuous Roving for Chopper Gun Spray-Up: Type E glass.
5. Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
6. Continuous Roving for Filament Winding: Type E glass with silane type finish.

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C. Fasteners:

1. Bolts: ASTM A193/A193M, Type 316 stainless steel, ANSI coarse thread series, Grade B 8M hex head.
2. Nuts: ASTM A194/A194M, Type 316 stainless steel, Grade 8M.
3. Washers: ASME B18.22.1, flat, Type 316 stainless steel.

2.02 DUCTWORK

A. Design Requirements:

1. Conform to ASTM D3982 and/or SMACNA Thermoset FRP Duct Construction Manual.
2. Duct manufacturer's design for round section, including duct wall thickness and stiffeners.
   a. Round duct to be fabricated per SMACNA filament wound (Type X) composites laminate Table 5-6.
3. Provide duct with extra wall thickness as required to support duct at elevated spans and to withstand moments resulting from cantilever arrangement, where shown on the Drawings.
4. Corrosion liner and barrier thicknesses shall not be included in ductwork structural calculations.
5. Round duct shall have a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum service. Rectangular duct design criteria shall be submitted to the Engineer for review and approval. Rectangular duct design shall be based on maximum 1 percent side wall deflection.

2.03 FABRICATION

A. Physical Properties: Meet or exceed requirements of ASTM D3982 and ASTM C582.

B. Fittings and special sections shall be reinforced, or their shell thickness increased where combined stresses because of internal pressure and bending will exceed maximum stress. Shell thickness or reinforcing shall be as required to keep combined stresses below maximum recommended.

C. Flanged connections or bell and spigot wrapped connections shall be used as required.

D. Squareness of ends, fittings, elbows, and butt joints shall meet or exceed requirements of ASTM D3982.

E. Keep use of flanges to a minimum; butt joints are preferred method of joining sections of duct.

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F. Butt joints shall only be permitted in duct sections that are accessible for inside overlay. Internal overlay to consist of two layers of 1-1/2-ounce per square foot of fiberglass mat followed by one layer of surfacing veil, as a minimum.

G. Flanges for Duct-to-Duct Connections and Duct Wall Thicknesses: ASTM D3982, rated for specified pressure and vacuum.

H. Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, valves, or dampers are to correspond to ASME B16.5, Class 150 or ASME B16.1, Class 125. All other flanges shall comply with ASTM D3982 Table 1.

I. Furnish gussets on flanged nozzles from ducts.

J. Back Face of Flanges: Spot-faced, flat, and parallel to flange face, and of sufficient diameter to accept ANSI metal washer under bolt head or nut.

K. Laminate:

1. Reinforce inner surface of ducts with resin-rich surfacing veil 10 mils thick to 20 mils thick.
2. Construct interior layer of resin reinforced with at least two plies of chopped strand mat; thickness at least 100 mils.
3. Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.
4. Structural Layer:
   a. Fabricated using either hand lay-up construction per ASTM 3982 or filament wound. Structural layer shall not be less than the following thicknesses:

Diameter (inches)	Thickness (inches)
6 - 20	1/8
22 - 28	3/16
30 - 58	1/4

L. Duct and Fittings:

1. Type: Contact molded or filament wound, meeting requirements of ASTM D3982.
2. Joints: Butt wrapped except flanged at connections to expansion joints, butterfly valves, blast gates, or mechanical equipment.

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3. Fittings: Plain end or flanged, manufacturer's standard sizes. Comply with ASTM D3982 with chemical resistance equal to or greater than the duct.
4. Gaskets: EPDM, 3/16-inch thick, full-face, Type A Durometer of 50-60.
5. Flanges shall have minimum thickness in accordance with ASTM D3982, rated for specified pressure and vacuum.
6. Transitions: Glass-fiber reinforced, with wall stiffness equal to that of duct, designed using pipe design criteria. Maximum deflection of side shall be less than 1 percent of width of that side at design internal pressure. Shop-installed reinforcing (such as, ribs or angles) shall be used if required to meet deflection requirements.
7. Elbow fittings shall have centerline radius of 1.5 times duct diameter unless indicated otherwise or if Site conditions dictate less. Elbow fittings shall have smooth nonsegmented radius unless indicated otherwise.

M. Cure products to at least 90 percent of minimum Barcol hardness specified by resin manufacturer.

N. Marking:

1. Identify each duct component with fabricator's name, resin, minimum thickness, and manufacture date.
2. Use permanent marking. Seal decals and labels into laminate exterior with resin.
3. For piece marking used for installation, use oil-based paint for easy removal.

O. Sample and Test Ports:

1. Field-installed or factory-installed as shown on the Drawings.
2. Materials of construction FRP or PVC.
3. Port configuration shall allow free passage of Dwyer 160 series pitot tube.
4. Provide ports at inlet and outlet of each fan or as shown on the Drawings. Locate to allow for pressure testing and air sampling.
5. Provide ports for each branch connection upstream of each balancing damper. Locate to allow for flow rate measurement pressure testing and air sampling.
6. Where possible, locate port on side of duct. Test ports shall not be located in bottom 90-degree arc of duct.

P. Manufacturers:

1. ECS Environmental Solutions.
2. Daniel Company.

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3. Spundstrand.
4. “Or-equal.”

Q. Supports:

1. Supports for FRP ductwork shall be provided per Section 40 05 15, Piping Support Systems.
2. Maximum Duct Deflection: 1/2 inch, including accommodation for water accumulation.
3. Support Spacing:
   a. 24-Inch Diameter and Larger: 20 feet, maximum.
   b. 20-Inch Diameter and Smaller: 15 feet, maximum.
4. Where fixed collars or lugs are shown on the Drawings for fixed type supports, Supplier shall provide such duct elements for meeting imposed loads while meeting design criteria stipulated herein and shall coordinate with duct support supplier.
5. Where duct supports induce localized distributed loads on ductwork, ductwork shall be designed to accommodate such loads while meeting design criteria stipulated herein.
6. Duct support material as shown on the Drawings.
7. Extended Span Lengths:
   a. Where extended span lengths are shown on the Drawings, Supplier shall design self-supporting ducting to meet maximum duct deflection specified herein.
   b. Special stiffening systems shall be submitted for approval.
   c. Provide structural calculations to support stiffening system and proposed wall thicknesses as called out in Article Submittals.

2.04 EXPANSION JOINTS/FLEXIBLE CONNECTIONS

A. General:

1. Provide where indicated on the Drawings or as required for proper duct installation. Flanged type expansion joints and flexible connections unless specifically indicated to be plain end (slip-on) type on the Drawings.
2. Type: W-design configuration with integral flanges suitable for service with FRP duct. Corners on rectangular expansion joints shall be molded and free of splices.
3. Material: Fabric-reinforced EPDM resistant to UV light; continuous wrapping of material shall not be permitted.
4. Backing Rings: 3/8 inch thick, 2 inches wide, Type 316 stainless steel to match drilling pattern of connecting flange.
5. Length: 12 inches minimum, flange-to-flange.
6. Extension: 1-inch.

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7. Compression: 4 inches.
8. Lateral Offset: 3 inches.
9. Thickness: 1/4-inch, minimum.
10. Flanges shall be a minimum of 1/4-inch thick.
11. Slip-on type expansion joints and flexible connections shall be sized to fit tightly on the outside diameter of the duct, secured in place by stainless steel worm screw type adjustable clamps to provide gas-tight connection.

B. Manufacturer and Product: Holz Rubber Company, Inc.; Style 945.

2.05 BUTTERFLY DAMPERS

A. Dampers:

1. Single-blade type, complete with channel-type frame, close-fitting axle, and bearings.
2. Same inside diameter as connecting ductwork.
3. Axles not less than 3/4-inch in diameter and shall be continuous through damper.
4. When used for isolation service, dampers shall be furnished with blade seal and shaft seal.
5. When used for balancing only, dampers shall be furnished with full circumference molded in blade stop.
6. Isolation dampers shall have maximum leakage rate of 6.93 cubic feet per minute per square foot of damper area, at a differential pressure of 12 inches wc. AMCA leakage tests shall be furnished as part of the submittal.
7. Materials:
    a. FRP materials for dampers shall be same resin as used in ductwork.
    b. Requirements for flame spread and smoke development shall be same as required for ductwork.
8. Construction:
    a. Frames: Fiberglass reinforced plastic with resin as described herein.
    b. Blades: Fiberglass reinforced plastic with resin as described herein. Blade thickness and stiffeners as required to meet design conditions.
    c. Axles: Continuous FRP rod with resin as described herein. Axle to extend 6 inches beyond frame.
    d. Bearings: Molded PTFE.
    e. Blade Stops: FRP with resin as described herein.
    f. Blade Seals: Neoprene.

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g. Shaft Seals: Neoprene.
h. Flanges: As specified to match ductwork flanges.

B. Lever Actuators:

1. Provide for dampers 24-inch diameter and smaller:
   a. Hand quadrant type.
   b. Constructed of Type 316 stainless steel.
   c. Locking quadrant suitable for positioning blade at intermediate position.

C. Manufacturers:

1. ECS Environmental Solutions.
2. Daniel Company.
3. Spundstrand.
4. “Or-equal.”

2.06 SOURCE QUALITY CONTROL

A. Factory Inspection: Inspect fabrications for required construction, intended function and conformance with referenced standards.

B. Inspection of products is required prior to shipment, unless specifically waived in writing by Engineer.

C. Notify Engineer 1-week prior to estimated date of inspection.

D. Repairs authorized by Engineer shall be reinspected before final acceptance, unless specifically waived.

PART 3 EXECUTION

3.01 GENERAL

A. Install ductwork in accordance with manufacturer’s recommendations using specified gaskets, hardware, and accessories.

B. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance, and with internal surfaces smooth.

C. Ductwork shall be free of vibration when in operation. Necessary vibration isolation devices shall be provided and installed by Contractor.

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D. Install plumb and straight and in proper alignment. For straight duct runs, unless otherwise indicated on the Drawings, slope ductwork at 1/8-inch per foot minimum in direction of flow or 1/4-inch per foot minimum in opposite direction of flow to allow internal condensation to drain to drainage points.

E. Provide drain connections at low point locations whether shown on the Drawings or not. Drain pipe shall include P-trap or valve as shown on the Drawings.

F. Necessary provisions shall be taken to provide for adequate expansion and contraction of ductwork and fittings.

G. Antiseize thread compound shall be applied to nuts and bolts.

H. Proper alignment and grade of ductwork shall be maintained by use of laser beam equipment or surveying instruments. Surveying instruments shall be utilized for verifying laser equipment accuracy because of thermal deflection from differences between ground temperature and air temperature within duct.

I. Provide flanges and flexible connectors where shown on the Drawings, at each duct to equipment connection to facilitate installation and removal.

J. Install duct so 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.

3.02 PREPARATION

A. Verify dimensions and conditions in field.

B. Layout routing in straight lines parallel to building lines.

C. Coordinate support locations with layout and joints.

3.03 INSTALLATION

A. FRP Ductwork:

1. Cut, fit, and install in accordance with duct manufacturer’s recommendations. SMACNA manual may be used for guidance, but duct manufacturer’s recommendations shall take precedence.
2. Seal cut edges and field-drilled holes with compatible resin.
3. Install plumb and straight and in proper alignment.
4. Provide for expansion and contraction of ductwork and fittings.

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5. Flange bolts shall be tightened to torque values specified by manufacturer. Install flat washer under each nut and bolt head.

B. Field Joints:

1. Provide material in kit form; one kit for one joint.
2. Make joints only when ambient temperature is above 55 degrees F and below 100 degrees F.
3. Made by manufacturer certified installer.

C. Dampers:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on the Drawings and in accordance with manufacturer's installation instructions.
3. Install with damper shaft in horizontal position.
4. Install square and level.
5. Handle damper using sleeve or frame. Do not lift damper using blades or jackshaft.
6. Confirm damper blades and hardware operate freely without obstruction.
7. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
8. Provide gasketed damper frames to eliminate leakage between duct and damper frames.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

D. Manual Dampers:

1. Provide balancing and isolation dampers as indicated on the Drawings.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

E. Expansion Joints/Flexible Connectors Installation: Install such that flexible molded boot is not concave or otherwise twisted or deformed during normal operating conditions.

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F. Ductwork Hangers and Supports:

1. Supports: As specified in Section 40 05 15, Piping Support Systems.
2. Install seismic restraints on ductwork systems and sway bracing as described in SMACNA Guidelines for Seismic Restraints of Mechanical Systems and as required by the Building Code for seismic zone indicated.

3.04 PROTECTION OF INSTALLED WORK

A. Cover open ends of installed ductwork systems to prevent dust, foreign objects, and water from entering ductwork.

B. Do not use ductwork systems for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.05 FIELD DUCT SLOPE VERIFICATION TESTING

A. After ductwork has been installed, duct supports and attachments tightened, all duct sloping shall be visually confirmed for compliance with contract document requirements.

B. Contractor shall use measurement equipment such as survey devices and lasers as approved by Owner and Engineer.

C. Final slope measurements shall be reported in a report submitted for approval as required in Article Submittals.

3.06 FIELD TESTING

A. Field test ductwork after installation and before concealment or burying, with air test to 90 percent of maximum working pressure or with fan running at design conditions for a period of 4 hours. Leaks shall be corrected, and duct retested until no further leaks appear.

1. FRP Ductwork:
   a. Suction Side of Fan (Vacuum): Use smoke stick or smoke emitter and pass along every field joint and flanged connection while system is operating under normal operating conditions. Smoke stick or smoke emitter to be passed along entire duct perimeter. Provide temporary enclosure to prevent impact because of wind, rain, and other outdoor environmental conditions. Observation of smoke entering ducting shall be evidence of gross leakage and shall be corrected by methods approved by Engineer.

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b. Discharge Side of Fan (Pressure): Apply soap bubble mixture to every field joint and flanged connection; examine for leakage and correct as necessary by methods approved by Engineer.

3.07 ADJUSTING

A. After duct leakage testing, provide complete air balancing of entire system as described in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.08 CLEANING

A. Blow ductwork clean using system fans; purged continuously for not less than 48 hours at a flow rate not less than design flow rate. If required, system fan shall be throttled on inlet side to prevent motor overload. Temporary screen shall be installed on system fan inlet to protect fan from entering debris.

B. Dampers shall be smooth, clean, and free of dirt when installed.

END OF SECTION

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SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

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

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.03 DESIGN REQUIREMENTS

A. Provide anchorage and bracing design drawings, calculations, and related information where required under Section 01 88 15, Anchorage and Bracing.

B. Provide seismic certification per requirements of Section 01 45 33, Special Inspection, Observation, and Testing, where required in that section for electrical equipment listed.

1.04 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Electrical service components.
   b. Nameplates, signs, and labels.
2. Anchorage and bracing drawings and catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.

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B. Informational Submittals: Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing, for loads in Section 01 61 00, Common Product Requirements.

1.05 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by 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.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.06 ENVIRONMENTAL CONDITIONS

A. Refer to the Area Classification and Materials Selection Table on the Drawing G-0085 for environmental conditions identified by facility area.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range stated in Section 01 61 00, Common Product Requirements.

2.02 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with Section 09 90 00, Painting and Coating, light gray color finish as approved by Engineer.

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2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws:

1. Stainless steel.
2. Adhesive: Single-part, room temperature vulcanizing adhesive suitable for the environment and materials installed. Use adhesive on NEMA 4 or NEMA 4X enclosures only.

C. Color: Black, engraved to a white core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 3/16-inch.
2. Other Electrical Equipment: 1/4-inch.

2.04 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on the Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

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

D. Keep openings in boxes and equipment closed during construction.

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E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING, BRACING, AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for Project design criteria provided in Section 01 61 00, Common Product Requirements, to meet the requirements of Section 01 88 15, Anchorage and Bracing.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Homerun circuits shown on the Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:

1. General
   a. Raceways shall be sized per General Circuit and Raceway Schedule and do not exceed 40 percent fill.
   b. Changes shall be documented on the Record Drawings.
2. Analog control circuits from devices in same general area to same destination.
   a. No power or ac discrete control circuits shall be combined in same conduit with analog circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
   c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Engineer.
3. Discrete control circuits from devices in the same general area to the same destination.
   a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
4. Power circuits from loads in same general area to same source location, such as panelboard.
   a. Do not combine power circuits without authorization of Engineer.

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3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark panelboards and local control panels to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for warning signs.

B. Available Fault Current Signs:

1. Install label on electrical equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
   a. Equipment name or identification.
   b. Available fault current at the equipment.
   c. Date the fault current calculations were performed.
2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.
3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.

C. Multiple Power Supply Sign: Install permanent plaque at each electrical equipment that is fed by multiple power sources, identifying the panel and circuit number of each supply.

D. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Panelboard nameplates shall include equipment designation, service voltage, and phases.

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3.05 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on panelboards, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor’s convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

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SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

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. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   b. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C12.1, Code for Electricity Metering.
   c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 810, Standard for Capacitors.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.

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h. 1059, Standard for Terminal Blocks.
i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Timers.
   g. Fuses.
   h. Magnetic contactors.
   i. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0-Volt to 600 Volts: Six of each type and each current rating installed.
2. Indicating lamps or LED bulbs, three of each type and color.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15 amps to 800 amps.
3. Voltage Ratings: 120V ac, 240V ac, 277V ac, 480V ac, and 600V ac.
4. Suitable for mounting and operating in any position.
5. UL 489.

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B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in OPEN position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a CENTER position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Equal to rating of existing equipment.

E. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

F. Connections:

1. Supply (line side) at either end.
2. Mechanical wire lugs, except crimp compression lugs where shown.
3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.

G. Enclosures for Independent Mounting:

1. See Article Enclosures.
2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.

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3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps rms symmetrical with Class R, Class J, or Class L fuses installed.

D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions: 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Enclosures: See Article Enclosures.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

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2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1-Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
   a. Bussmann; Type LPS-RK (600 volts) and Type LPN-RK (250 volts).
   b. Littelfuse; Type LLS-RK (600 volts) and Type LLN-RK (250 volts).

C. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10-amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littlefuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: Push-to-test, LED, full voltage.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbutton and selector switch lockable in OFF position where indicated.

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F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64-inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

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J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A600 (600 volts).

C. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2-second to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

E. Manufacturers and Products:

1. Eaton/Cutler-Hammer; D26 Type M.
2. General Electric Co.; Type CR120B.
3. Square D; Type X.

2.08 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

C. Solid-state electronic, field convertible ON/OFF delay.

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from 1-second to 60 seconds, unless otherwise indicated on the Drawings.

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G. Manufacturers and Products:

1. Square D Co.; Type XO.
2. Eaton/Cutler-Hammer; Type D26MR.
3. General Electric Co.; Type CR120.

2.09 RESET TIMER

A. Drive: Synchronous motor, solenoid-operated clutch.

B. Mounting: Semiflush panel.

C. Contacts: 10 amps, 120 volts.

D. Manufacturers and Products:

1. Eagle Signal Controls; Bulletin 125.
2. Automatic Timing and Controls; Bulletin 305.

2.10 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0-hour to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush panel.

D. Manufacturers and Products:

1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal Controls; Bulletin 705.

2.11 MAGNETIC CONTACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated As shown.
4. Poles: As shown.

D. Control: As shown.

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E. Auxiliary Contacts: One normally OPEN and one normally CLOSED rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

G. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Class A201.
2. General Electric Co.; CR 353.
3. Square D Co.; Class 8910.

2.12 PHASE MONITOR RELAY

A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

B. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

2.13 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/ A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Stainless Steel Framing Channel: Rolled, Type 304 stainless steel, 12-gauge minimum.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

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2.14 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Type: Refer to the Area Classification and Materials Selection Table on the Drawing G-0085 for enclosure type required by facility area.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, unless otherwise shown.

B. Install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas, unless otherwise shown.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type: Refer to the Area Classification and Materials Selection Table on the Drawing G-0085 for channel type to be used in each facility area.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.

END OF SECTION

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SECTION 26 05 05
CONDUCTORS

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. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
2. Insulated Cable Engineer's Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
   c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
3. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
5. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
6. UL:
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

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g. 854, Standard for Safety for Service-Entrance Cables.
h. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
i. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.
   c. Cable fault detection system.
2. Manufactured Wire Systems:
   a. Product data.
   b. Rating information.
   c. Dimensional drawings.
   d. Special fittings.
3. Busway:
   a. Product data.
   b. Rating information.
   c. Dimensional drawings.
   d. Special fitting.
   e. Equipment interface information for equipment to be connected to busways.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. 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 UL shall conform to those standards and shall have an applied UL listing mark.

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PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type: Stranded copper.

C. Insulation: THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer’s name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

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3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Southwire.

C. 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 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors, black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

D. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.

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3. Dimension: 0.32-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand, tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

E. Type 5, 18 AWG, Multitwisted Shielded Pairs, with a Common Overall Shield, Instrumentation Cable: Designed for use as instrumentation, process control, and computer cable, meeting NEMA WC 57 requirements.

1. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, in accordance with ASTM B8.
   b. Tinned copper drain wires.
   c. Pair drain wire size AWG 20, group drain wire size AWG 18.
   d. Insulation: 15-mil PVC.
   e. Jacket: 4-mil nylon.
   f. Color Code: Pair conductors, black and red with red conductor numerically printed for group identification.
   g. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer.
2. Cable Shield: 2.35-mil, double-faced aluminum/synthetic polymer, overlapped for 100 percent coverage.
3. Cable Sizes:

Number of Pairs	Maximum Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
4	0.50	45
8	0.68	60
12	0.82	60
16	0.95	80
24	1.16	80
36	1.33	80
50	1.56	80

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4. Manufacturers:
    a. Okonite Co.
    b. Alpha Wire Corp.
    c. Belden.

2.03 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.
2. 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 5 and Category 5e.
3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
    a. 30-mil, elastomer.
    b. Manufacturers and Products:
        1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
        2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

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B. Identification Devices:

1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturers and Products:
      1) Raychem; Type D-SCE or Type ZH-SCE.
      2) Brady, Type 3PS.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
   a. Chemical-resistant white tag.
   b. Size: 1/2-inch by 2 inches.
   c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. UL 486C.
   b. Plated steel, square wire springs.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.

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4. Self-Insulated, Set Screw Wire Connector:
    a. Two piece compression type with set screw in brass barrel.
    b. Insulated by insulator cap screwed over brass barrel.
    c. Manufacturers:
        1) 3M Co.
        2) Thomas & Betts.
        3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
    a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
    b. Manufacturers and Products:
        1) Thomas & Betts; Color-Keyed.
        2) Burndy; Hydent.
        3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
    a. Manufacturers and Products:
        1) Thomas & Betts; Locktite.
        2) Burndy; Quiklug.
        3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
    a. Thomas & Betts; SHRINK-KON.
    b. Raychem; RNF-100 and ES-2000.

G. Data Cable Accessories: Terminators, connectors, and junctions necessary for a complete ethernet IP system.

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2.06 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.07 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer’s recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer’s recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

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G. 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 18 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

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 area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

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3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.

C. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. 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.

D. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.

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6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

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4. Cable Protection:
    a. Under Infinite Access Floors: May install without bundling.
    b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2-inch in diameter.
    c. Maintain integrity of shielding of instrumentation cables.
    d. Ensure grounds do not occur because of damage to jacket over shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).
3. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data for the following:
      1) Compression connectors.
      2) Exothermic weld connectors

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Materials and equipment manufactured within scope of standards published by UL:
   a. Confirm conformance with UL standards.
   b. Supply with an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

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2.02 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Use low-smoke, low emission process.
3. Manufacturers and Product:
   a. NVent ERICO Products, Inc; Cadweld and Cadweld Exolon.
   b. ThermOweld.

B. Compression Type:

1. Compress-deforming irreversible type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and anti-seizing compound and sealed.
5. Manufacturers and Products:
   a. Burndy Corp.; Hyground Compression.
   b. Thomas and Betts Co.; EZGround Compression.
   c. NVent ILSCO.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Grounding in compliance with NFPA 70 and IEEE C2.

B. Bond each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

C. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

D. 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.

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E. 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.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Connect ground conductors to raceway grounding bushings.

C. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

D. Connect enclosure of equipment containing ground bus to that bus.

E. Bolt connections to equipment ground bus.

F. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

G. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

H. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

C. Motors 10 hp and Above: Use furnished ground lug in motor connection box. If none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

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D. Circuits 20 Amps or Above: Tap motor frame or equipment housing. Install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 CONNECTIONS

A. General:

1. Abovegrade Connections: Install compression-type connectors.
2. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

3.05 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.06 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.

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3.07 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

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SECTION 26 05 33
RACEWAY AND BOXES

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 and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor’s Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
   e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.

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j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
k. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 1, Standard for Safety for Flexible Metal Conduit.
   b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
   c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
   d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
   e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
   f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
   g. 651, Standard for Safety for Schedule 40 and Schedule 80 Rigid PVC Conduit and Fittings.
   h. 651A, Standard for Safety for Type EB and Type A Rigid PVC Conduit and HDPE Conduit.
   i. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
   j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
   k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
   l. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
   m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s Literature:
   a. Rigid galvanized steel conduit.
   b. PVC-coated rigid galvanized steel conduit.
   c. Flexible metal, liquid-tight conduit.
   d. Conduit fittings.
   e. Device boxes for use in hazardous areas.
   f. Junction and pull boxes used at or below grade.
   g. Large junction and pull boxes.
   h. Terminal junction boxes.
2. Seismic 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. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's certification of training for PVC-coated rigid galvanized steel conduit installer.

1.03 QUALITY ASSURANCE

A. 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 scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

B. PVC-Coated, Rigid Galvanized Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

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-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

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C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

2.02 FITTINGS

A. Rigid Galvanized Steel Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers and Products:
      1) Appleton; Series BU-I.
      2) O-Z/Gedney; Type HB.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers and Products:
      1) Appleton; Series GIB.
      2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Manufacturers and Products:
      1) Appleton, Series HUB-B.
      2) O-Z/Gedney; Series CH.
      3) Meyers; ST Series.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products:
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.

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2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.

8. Drain Seal:
   a. Manufacturers and Products:
      1) Appleton; Type EYD.
      2) Crouse-Hinds; Type EYD or Type EZD.
9. Drain/Breather Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type ECDB.
      2) Crouse-Hinds; ECD.
10. Expansion Fitting:
   a. Manufacturers and Products:
      1) Deflection/Expansion Movement:
         a) Appleton; Type DF.
         b) Crouse-Hinds; Type XD.
      2) Expansion Movement Only:
         a) Appleton; Type XJ.
         b) Crouse-Hinds; Type XJ.
         c) Thomas & Betts; XJG-TP.
11. Cable Sealing Fitting:
   a. To form watertight nonslip cord or cable connection to conduit.
   b. For Conductors with OD of 1/2-inch or Less: Neoprene bushing at connector entry.
   c. Manufacturers and Products:
      1) Appleton; CG-S.
      2) Crouse-Hinds; CGBS.

B. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
   a. Robroy Industries.
   b. Ocal.
8. Expansion Fitting:
   a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.

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C. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
   a. Thomas & Betts; Series 5331.
   b. O-Z/Gedney; Series 4Q.

2.03 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron.
2. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products:
   a. Crouse-Hinds; Type FS or Type FD.
   b. Appleton; Type FS or Type FD.
   c. Killark.

C. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron.
3. Coating:
   a. Exterior Surfaces: 40-mil PVC.
   b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
   a. Robroy Industries.
   b. Ocal.

2.04 JUNCTION AND PULL BOXES

A. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

B. Large Sheet Steel Box:

1. NEMA 250, Type 1, gasketed.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

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C. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 316 stainless steel.
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.
   c. Wiegman.

D. Large Steel Box:

1. NEMA 250 Type 1 gasketed, 12.
2. Box: 14-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide gray finish as approved by Engineer.
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.
   c. Wiegman.

2.05 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

2.06 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.

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B. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
   a. Raychem.
   b. 3M.

C. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturer and Product: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways. Where feasible following existing conduit routings.

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K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Paint threads and cut ends, before assembly of fittings, galvanized conduit, or PVC-coated galvanized conduit, installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

M. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

N. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

O. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 REUSE OF EXISTING CONDUITS

A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.

1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
2. Conduit is sized per the NEC.
3. Conduit is of the type specified in Contract Documents.
4. Conduit is supported as specified in Contract Documents.

B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4-inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Refer to the Area Classification and Materials Selection Table on the Drawing G-0085 for conduit application identified by facility area.

3.04 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.

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B. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

D. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

E. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Corrosive-Sensitive Areas:
    a. Seal conduit passing room walls.
    b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
3. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.

3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 50 percent extra space for future conduit.

C. Application/Type of Conduit Strap:

1. Rigid Steel Conduit: Zinc-coated steel, pregalvanized steel or malleable iron.
2. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
3. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

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D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
    a. Dry, Noncorrosive Areas: Galvanized.
    b. Wet, Noncorrosive Areas: Stainless steel.
    c. Corrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. 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.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

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3.08 PVC-COATED RIGID STEEL CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.

C. Provide PVC boot to cover exposed threading.

3.09 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 12 enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 12 boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
4. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.

C. Motor Control Center, and Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

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3.10 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
   c. Do not straddle CMU block or other construction joints.
2. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on the Drawings.

E. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.

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c. Hollow Masonry Units: Toggle bolts.
d. Steelwork: Machine screws.

3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

F. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

G. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.11 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
5. Install pull boxes where necessary in raceway system to facilitate conductor installation.
6. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
7. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

C. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.

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3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

D. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.12 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.13 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
3. Install tags at each terminus for concealed raceways.
4. Provide noncorrosive wire for attachment.

3.14 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

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SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
   d. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

A. Action Submittals:

1. Short circuit study.
2. Protective Device Coordination Study: Submit within 90 days after approval of short circuit study.
3. Arc Flash Study: Submit initial study with protective Device Coordination Study. Submit final study prior to equipment energization.
4. Arc flash warning labels; submit sample with initial study.
5. Electronic files of final studies including all engineering software input files, output reports, and libraries.

1.03 QUALITY ASSURANCE

A. Short circuit and protective device coordination and arc flash studies shall be prepared by a professional electrical engineer registered in the State of Washington.

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1.04 SEQUENCING AND SCHEDULING

A. Initial complete arc flash study shall be submitted and accepted prior to energization of the electrical equipment.

B. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.

C. Final short circuit, protective device coordination, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.

D. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on the Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows.
2. ETAP.
3. Easy Power.
4. “Or-equal.”

C. Perform complete fault calculations for each existing source combination: Source combination may include present and future power company supply circuits, large motors, or generators.

D. Utilize proposed load data for study obtained from Contract Documents.

E. Existing System and Equipment:

1. Extent of existing system to be included in study is limited to system elements that affect new system and equipment.
2. Include fault contribution of existing motors and equipment in study.
3. Include impedance elements that affect new system and equipment.
4. Include protective devices in series with new equipment.

F. Device coordination time-current curves for low voltage distribution system; include individual protective device time-current characteristics.

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1.06 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors.
3. Use bus impedances based on copper bus bars.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN and XHHW conductors.
6. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Typical calculation.
3. Tabulations of calculated quantities.
4. Results, conclusions, and recommendations.
5. Selected base per unit quantities.
6. One-line diagrams.
7. Source impedance data, including electric utility system and motor fault contribution characteristics.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Motor control centers.
2. Branch circuit panelboards.
3. 480V Local Control Panel.

D. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Adequacy of panelboard bus bars to withstand short circuit stresses.
3. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.

E. Tabulations:

1. General Data:
   a. Short circuit reactances of rotating machines.
   b. Cable and conduit material data.
   c. Bus data.
   d. Transformer data.
   e. Circuit resistance and reactance values.

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2. Short Circuit Data:
    a. Fault impedances.
    b. X to R ratios.
    c. Asymmetry factors.
    d. Motor contributions.
    e. Short circuit kVA.
    f. Symmetrical and asymmetrical fault currents.
3. Equipment Evaluation:
    a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
    b. Maximum fault current available.

F. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

G. Suggest changes and additions to equipment rating and/or characteristics.

H. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

I. Revise data for “as-installed” condition.

1.07 PROTECTIVE DEVICE COORDINATION STUDY

A. General:

1. Prepare in accordance with IEEE 242.
2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
    a. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to 4 to 6.
    b. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
    c. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
    d. Apply motor protection methods that comply with NFPA 70.

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B. Plot Characteristics on Curve Sheets:

1. Low-voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
2. Pertinent transformer full-load currents at 100 percent.
3. Transformer magnetizing inrush currents.
4. Transformer damage curves; appropriate for system operation and location.
5. ANSI transformer withstand parameters.
6. Significant symmetrical and asymmetrical fault currents.
7. Motor overload relay settings.
8. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

C. Tabulate Recommended Protective Device Settings:

1. Relays:
   a. Current tap.
   b. Time dial.
   c. Instantaneous pickup.
2. Circuit Breakers:
   a. Adjustable pickups.
   b. Adjustable time-current characteristics.
   c. Adjustable time delays.
   d. Adjustable instantaneous pickups.
   e. I^2t In/Out.

D. Written Summary:

1. Scope of studies performed.
2. Summary of protective device coordination methodology.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of coordination study.
6. Appendix of complete relay and circuit breaker electronic setting files.
7. Comments or suggestions.

1.08 ARC FLASH STUDY

A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.

B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

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C. Base Calculation:

1. For each major part of electrical power system, determine the following:
   a. Flash hazard protection boundary.
   b. Limited approach boundary.
   c. Restricted approach boundary.
   d. Incident energy level.
   e. Glove class required.

D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.
2. Bus voltage.

E. Produce arc flash evaluation summary sheet listing the following additional items:

1. Bus name.
2. Upstream protective device name, type, settings.
3. Bus line-to-line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Equipment type.
10. Gap.
11. Arc flash boundary.
12. Working distance.
13. Incident energy.

F. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 8 cal/cm2. Propose approaches to reduce energy levels.

G. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:

1. Equipment manufacturer’s information used to prepare study.
2. Assumptions made during study.
3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.

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5. Arc flash warning labels printed in color on thermally bonded adhesive backed UV and weather-resistant labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

A. Arc flash warning labels printed in color on thermally bonded adhesive backed, UV- and weather-resistant labels. An example label is located following end of section in Figure 1.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Engineer in writing of required major equipment modifications.

D. Provide arc flash warning labels on equipment as specified in this section.

3.02 SUPPLEMENT

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

1. Figure 1: Example Arc Flash Label.

END OF SECTION

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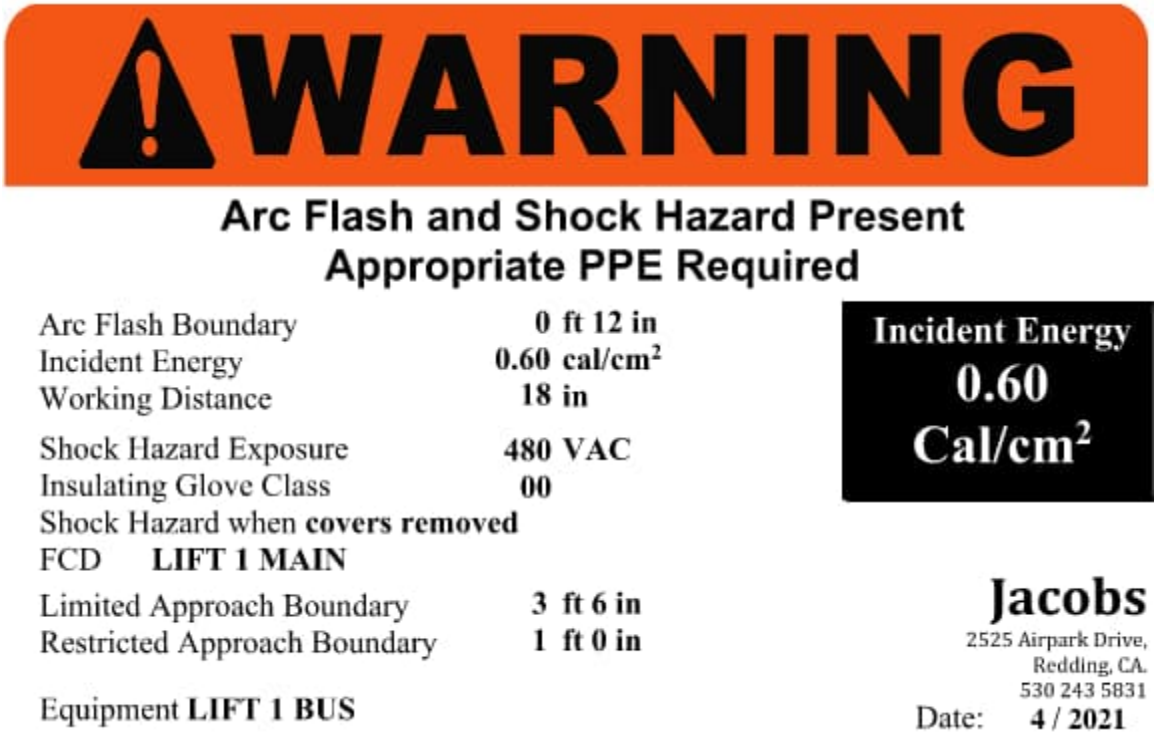

Figure 1
Example Arc Flash Label

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SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

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):
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
   b. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   c. C2, National Electrical Safety Code.
   d. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.
3. National Electrical Manufacturers Association (NEMA): AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
4. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
6. National Institute for Certification in Engineering Technologies (NICET).
7. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Testing firm qualifications.
   b. Schedule for performing inspection and tests.
   c. List of references to be used for each test.
   d. Sample copy of equipment and materials inspection form(s).
   e. Sample copy of individual device test form.
   f. Sample copy of individual system test form.

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2. Energization Plan:
    a. Prior to initial energization of electrical distribution equipment; include the following:
        1) Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
        2) Staged sequence of initial energization of electrical equipment.
        3) Lock-Out-Tag-Out plan for each stage of the progressive energization.
        4) Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test.
4. Operation and Maintenance Data:
    a. In accordance with Section 01 78 23, Operation and Maintenance Data.
    b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings:
    a. At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
        1) Protective relays.
        2) Intelligent overload relays.
        3) Adjustable frequency drives.
        4) Power metering devices.
        5) Uninterruptible power supplies.
        6) Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.

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6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

1. Scheduled with Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer’s tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

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C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers and other applicable devices in accordance with values established by the coordination study as specified in Section 26 05 70, Electrical Systems Analysis.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

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/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Engineer of working clearances not in accordance with NFPA 70.

N. 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.

O. 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 dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.

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6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:Check voltage amplitude and balance between phases for loaded and unloaded conditions.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer’s instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer’s instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

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B. Electrical Tests:

1. Include the following items performed in accordance with manufacturer's instruction:
   a. Insulation Resistance Tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
      2) Each phase of each bus section.
      3) Phase-to-phase and phase-to-ground for 1 minute.
      4) With breakers OPEN.
      5) With breakers CLOSED.
      6) Control wiring except that connected to solid state components.
      7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.
9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1-minute, and 10 minutes.

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c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
e. Insulation resistance test results to compare within 1 percent of adjacent windings.

2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specification.
   e. Proper circuit identification.
2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.

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2. Continuity test by ohmmeter method to ensure proper cable connections.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1-minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.

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6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer’s published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center and panelboard assemblies for proper connection and tightness.
2. Effective transformer core and equipment grounding.
3. Accessible connections to grounding electrodes for proper fit and tightness.

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B. Electrical Tests:

1. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.25-ohm.

3.09 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1/2 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Insulation resistance test on insulated bearings in accordance with manufacturer’s instructions.
3. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

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3.10 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
    a. Closure attempt of device when door is in OPEN position.
    b. Opening attempt of door when device is in ON position.
8. Check nameplates for proper identification of:
    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbuttons.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
10. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked OPEN devices.
    b. Opening attempt for locked CLOSED devices.
11. Verify performance of each control device and feature furnished as part of motor control center.
12. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
13. Exercise active components.
14. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
15. Compare overload heater rating with full-load current for proper size.
16. Compare motor protector and circuit breaker with motor characteristics for proper size.

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B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Bus section phase-to-phase and phase-to-ground for 1-minute on each phase.
   c. Contactor phase-to-ground and across open contacts for 1-minute on each phase.
   d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts CLOSED and protective devices OPEN.
   e. Test values to comply with NETA ATS, Table 100.1.
2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal board and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1-megohm minimum insulation resistance.
4. Operational test by initiating control devices to affect proper operation.

END OF SECTION

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SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements such as, application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 2111, Standard for Safety for Overheating Protection for Motors.

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1.03 DEFINITIONS

A. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Part 30 and Part 31.

B. Inverter Ready Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Part 31.4.4.2.

C. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

D. ODP: Open drip-proof enclosure.

E. TEFC: Totally enclosed, fan-cooled enclosure.

F. TENV: Totally enclosed, nonventilated enclosure.

G. VPI: Vacuum pressure impregnated.

H. WPI: Open weather protected enclosure, Type I.

I. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.
    c. No load current.
    d. Guaranteed minimum full load efficiency and power factor.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.
11. Description, ratings, and wiring diagram of motor thermal protection.

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12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. MagneTek.
2. Siemens Energy and Automation, Inc., Motors and Drives Division.
3. Baldor.
4. U.S. Electrical Motors.
5. TECO-Westinghouse Motor Co.
6. Toshiba International Corp., Industrial Division.
7. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

E. Lifting lugs on motors weighing 100 pounds or more.

F. Operating Conditions:

1. Maximum ambient temperature not greater than 40 degrees C.
2. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

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2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor, Inverter Ready Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-Duty Motors: 1 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating:

1. Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3

C. Suitable for full voltage starting.

D. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

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2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class B or Class F at nameplate horsepower and designated operating conditions.

2.09 ENCLOSURES

A. Conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

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D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on the Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
4. For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer’s standard lubrication 100 hp and smaller.
   c. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.
   c. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Inverter Duty Rated Motors Larger than 50 hp, Bearing Isolation: Provide electrically isolated bearings to prevent stray current damage.

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2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.
2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
   a. Motors for constant speed application 25 hp through 100 hp. Motors for adjustable speed application 40 hp and larger.
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
   d. Leads extending to separate terminal box for motors 100 hp and larger.

C. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.

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3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

D. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Inverter Duty Motor:

1. Motor Supplied Power by Adjustable Voltage and Adjustable Frequency Drives: Inverter duty rated in accordance with NEMA Part 30 and Part 31.
2. Provide winding insulation rated 1,600 peak volts, minimum.
3. Meet or exceed NEMA MG 1 corona inception voltage rating.
4. Provide one insulated bearing.
5. Suitable for operation over entire speed range indicated.
6. Provide forced ventilation where speed ratio is greater than published range for motor provided.
7. Shaft Grounding Device, Motors Larger than 20 hp: Furnish with shaft grounding brush or conductive micro fiber shaft grounding ring solidly bonded to grounded motor frame in accordance with manufacturer's recommendations.
    a. Manufacturers:
        1) Grounding Brush: Sohre Turbomachinery, Inc.
        2) Grounding Ring: EST-Aegis.

C. Inclined Motors:

1. Motors suitable for operation only in horizontal position not acceptable.
2. Provide bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.
3. Provide lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.

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3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
   a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
   b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

END OF SECTION

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SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

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

1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. C57.96, Guide for Loading Dry Type Transformers.
   b. C57.12.91, Test Code for Dry Type Distribution and Power Transformers.
   c. C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin-Encapsulated Windings.
3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. UL:
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data, including efficiency.
4. Schematic and connection diagrams.
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: Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

PART 2 PRODUCTS

2.01 GENERAL

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Dry-type, self-cooled, two-winding, with copper windings.

C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Efficiency: Meet or exceed DOE 2016 efficiency requirements.

E. Maximum Sound Level per NEMA ST 20:

1. 40 decibels for 0 kVA to 9 kVA.
2. 45 decibels for 10 kVA to 50 kVA.

F. Overload capability: Short-term overload per IEEE C57.96.

G. Wall Bracket: For three-phase units, 15 kVA to 30 kVA.

H. Vibration Isolators:

1. Rated for transformer’s weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.

I. Manufacturers:

1. ABB.
2. Schneider Electric/Square D.
3. Eaton.

2.02 GENERAL PURPOSE TRANSFORMER

A. Insulation Class and Temperature Rise: Manufacturer’s standard.

B. Core and Coil: Encapsulated for three-phase units 3 kVA to 15 kVA.

C. Enclosure: NEMA 250, Type 3R stainless steel.

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D. Voltage Taps:

1. Three-Phase, 3 kVA to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer’s instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 30 kVA.

END OF SECTION

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SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

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

1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. PB 1, Panelboards.
   c. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. UL:
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.
   d. Voltage, frequency, and phase ratings.
   e. Enclosure type.
   f. Bus and terminal bar configurations and current ratings.
   g. Provisions for circuit terminations with wire range.

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h. Short circuit current rating of assembled panelboard at system voltage.
i. Features, characteristics, ratings, and factory settings of auxiliary components.
j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton/Cutler-Hammer.
2. ABB.
3. Square D Co.
4. Siemens.

2.02 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this section.

B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

C. Wire Terminations:

1. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
2. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.

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3. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.

D. Load Current Ratings:

1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
2. Where indicated “continuous” or “100 percent,” selected components and protective devices shall be rated for continuous load current at value shown.

E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than as shown on the Drawings.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.

B. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.

C. Provisions for Future Overcurrent Device:

1. Provide space, mountings, and bus connections such that like device may be installed without additional hardware.
2. Panel openings shall be closed with individual removable cover for each provision for future device.
3. Unless otherwise indicated, “spaces” in panelboards shall be fully equipped provision for future like devices.
4. Provisions for future devices shall be suitable devices rated no less than 60 amperes.

D. Branch Protective Devices:

1. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
2. Provide a nameplate for each circuit, blanks for spares.

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2.04 CIRCUIT BREAKERS

A. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle. Circuit breakers shall comply with Section 26 05 04, Basic Electrical Materials and Methods.

B. Bus Connection: Bolt-on circuit breakers.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.

D. Unacceptable Substitution:

1. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
2. Do not use tandem or dual circuit breakers in normal single-pole spaces.

2.05 ENCLOSURES

A. General:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Provide surface-mount panelboard from trim with same dimensions as box front.

B. NEMA 250 Type 4X Branch Panelboard Enclosure:

1. Secure front trim to box with concealed trim clamps.
2. Overlap flush panelboards front trims with box nominal 3/4 inch on all sides.
3. Provide door in panelboard front trim, with concealed hinges, to access protective device operating handles.
4. Provide multi-point latching for doors over 30 inches in height.
5. Door Lock: Secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
6. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

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2.06 BUSSING AND TERMINAL BARS

A. Bus:

1. Material: Copper, full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

B. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder and grounding electrode.

C. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.

D. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.07 SPECIAL FEATURES

A. General: Where indicated on the Drawings or schedules, provide special features as specified.

B. Surge Protection Devices:

1. Comply with Section 26 43 00, Surge Protection Devices.
2. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer’s recommendation.
3. Provide factory mounting within panelboard utilizing UL-recognized mounting device.

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PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.

G. Mount flush panels uniformly flush with wall finish.

H. Provide typewritten circuit directory for each panelboard.

I. Provide engraved identification for each protective device.

END OF SECTION

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SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which shall be followed for this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
   b. ICS 1, Industrial Control and Systems: General Requirements.
   c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
   d. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
   e. ICS 18, Motor Control Centers.
   f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 98, Enclosed and Dead-Front Switches.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 845, Motor Control Centers.

1.02 DEFINITIONS

A. N.C.: Normally Closed.

B. N.O.: Normally Open.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized Bill of Material.
3. Dimensions.

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4. Front Panel Elevations.
5. Protective Devices: Copies of time-current characteristics.
6. Operational description.
7. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
8. Typed Tabulation:
    a. Motor name; tag (equipment) numbers as shown on the Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Overload model number and setting.
    f. Protective device trip settings.
    g. Manufacturer’s solid state starter switch or dip switch or program settings.
    h. Attach above typed, tabulated data to a copy of starter manufacturer’s overload relay or setting selection tables for starters provided.
9. Control diagrams.
10. One-line diagrams.
11. Schematic (elementary) diagrams.
12. Outline diagrams.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s installation instructions.
3. Factory test reports, certified.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Provide products manufactured within scope of UL that conform to UL Standards and have applied UL Listing Mark.

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PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide materials, equipment, and accessories specified in this section compatible with the existing GE Industrial Systems' MCC, in which the units will be installed within.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit.
4. Mount within starter unit.

E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Equipment to be fully rated.

G. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer's standard.

2.03 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.
2. Voltage Rating: As shown.
3. Short Circuit Rating: As shown on the Drawings.

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4. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
5. NEMA ICS 18, Part 3.
    a. Class: I.
    b. Type: B.

B. Motor Controller Unit:

1. Construction:
    a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.
    b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
    c. Readily interchangeable with starters of similar size.
    d. Pull-apart unit control wiring terminal boards capable of accepting up to two 14 AWG wires minimum.
2. Starters:
    a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
    b. Rating: Horsepower rated at 600-volt, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
    c. Three-phase, non-reversing, unless specified otherwise.
    d. Disconnect Type: Motor circuit protector.
    e. Padlockable operating handle when de-energized with up to three-lock capability.
    f. Unit door interlocked to prevent opening when disconnect is in closed position.
    g. Mechanical interlocked to prevent placing disconnect in ON position when unit door is OPEN.
    h. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.
3. Thermal Motor Overload Protection:
    a. Inverse-time-limit characteristic.
    b. Heater: Bimetallic overload, adjustable trip, or directly heated melting alloy, ratchet principle type element.
    c. Relay Trip: Standard, Class 20.
    d. Manual reset.
    e. Provide in each ungrounded phase.
    f. Mount within starter unit.
    g. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.

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4. Control:
    a. Disconnecting Device: Pull-apart terminal blocks capable of de-energizing external source control circuits in unit.
    b. Control Devices: As indicated on the Drawings and as specified in Section 26 05 04, Basic Electrical Materials and Methods.
    c. Control Wiring:
        1) Copper, 14 AWG, minimum.
        2) Permanent sleeve type markers with wire numbers applied to each end of wires.
        3) Terminate wires using insulated locking fork or ring type crimp terminals.
        4) Terminate current transformer leads on shorting type terminal blocks.

C. Feeder Protective Device Unit:

1. Construction: As specified in Paragraph Motor Controller Unit.
2. Molded Case Circuit Breaker:
    a. In accordance with UL 489.
    b. Feeder protective device.
    c. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.
    d. Indicate tripping by operating-handle position.
    e. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

D. Nameplates:

1. As specified in Section 26 05 02, Basic Electrical Requirements.
2. Provide for each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

2.04 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.

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4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
5. Control Circuits and Devices:
   a. Energize circuit at rated voltage.
   b. Operate control devices.
   c. Perform continuity check.
6. Instruments, Meters, Protective Relays, and Equipment:
   a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.
   b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.
7. Perform dielectric tests on primary circuits and equipment, except potential transformers.
   a. Tests: Phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1-second at 2,640 volts.
8. Verify equipment passed tests and inspection.
9. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer’s written instructions and recommendations.
2. Coordinate terminal connections with installation of secondary feeders.
3. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
   a. Motor served by tag number and equipment name.
   b. Nameplate horsepower.
   c. Motor code letter.
   d. Full load amperes.
   e. Service factor.
   f. Installed overload relay catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
2. Adjust to approximately 11 times motor rated current.

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3. Determine motor rated current from motor nameplate following installation.

C. Thermal Overload Relay:

1. Select and install overload relays and apply settings after actual nameplate full-load current rating of motor has been determined.
2. Initial Settings: In accordance with manufacturer’s recommendation.

END OF SECTION

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SECTION 26 29 23
LOW-VOLTAGE ADJUSTABLE FREQUENCY DRIVE SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Industries Alliance (EIA): 359-A-1, Special Colors.
2. Hydraulic Institute Standards (HIS).
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.
   c. WC 57, Standard for Control, Thermocouple Extensions, and Instrumentation Cables.
5. National Fire Protection Association (NFPA): 79, Electrical Standard for Industrial Machinery.

1.02 DEFINITIONS

A. Terms that may be used in this section:

1. AFD: Adjustable frequency drive.
2. CMOS: Complementary metal oxide semiconductor.
3. CSI: Current source inverter.
4. EMU: Energy monitoring unit.
5. GTO: Gate turn-off thyristor.
6. MPR: Motor protection relay.
7. MTBF: Mean time between failure.
8. PWM: Pulse width modulation.
9. ROM: Read only memory.
10. RTD: Resistance temperature detector.
11. RTU: Remote Telemetry Unit.
12. Rated Load: Load specified for equipment.
13. Rated Speed: Nominal rated (100 percent) speed specified for equipment.

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14. TDD: Total demand distortion.
15. THD: Total harmonic distortion.
16. TTL: Transistor transistor logic.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Composite drive/motor efficiency (CE) is defined as ratio of motor shaft kW to drive input kW. AFD system minimum requirements:
   a. At 60-Hz drive output and 100 percent load, CE equals 92 percent.
   b. At 50-Hz drive output and 60 percent load CE equals 89 percent.
   c. At 40-Hz drive output and 30 percent load CE equals 84 percent.
   d. At 30-Hz drive output and 12.5 percent load CE equals 77 percent.
2. Rated Continuous Operation Capacity: Not less than 1.15 times full load current rating of driven motor, as indicated on motor nameplate, and suitable for continuous operation at continuous overload which may be imposed on motor by driven pump operating over specified speed range.
3. Furnish harmonic filters, line reactors, isolation transformers, or higher pulse converter arrangements required to meet current/voltage distortion and line notching limits.
4. Furnish series reactors, harmonic filters, or other devices necessary for proper system operation. Furnish necessary devices and circuits to prevent operation of one drive from adversely affecting operation of other drives supplied from same transformer or same bus.

B. Design Requirements:

1. Drive system consisting of adjustable frequency controller, drive motor, auxiliary items, and components necessary for complete operating system.
2. Other equipment is being powered from same bus as adjustable frequency drives. Ensure proper operation of drives and other loads under normal conditions.
3. Drive System: Convert incoming three-phase, 60-Hz ac power to variable voltage, adjustable frequency output for adjustable speed operation of a standard ac induction squirrel-cage motor, using pulse-width-modulation (PWM) technique to produce adjustable frequency output.
4. System rated for continuous industrial duty and suitable for use with NEMA MG 1, Design B motors.
5. Incoming: Provide positive means of disconnecting incoming power, and overcurrent protection for drive system.

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6. Incoming Line Reactor: Design to minimize harmonic distortion on incoming power feeder.

1.04 SUBMITTALS

A. Action Submittals:

1. Overall drive system operating data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0 percent, 40 percent, 60 percent, 80 percent, 100 percent, and 110 percent of rated speed.
2. Individual and total harmonic content (voltage and current) reflected in driven equipment's sourced MCC bus, at 70 percent and 100 percent of rated speed. Use TDD and THD factors as defined in IEEE 519 to designate total harmonic content.
3. AFD output pulse maximum peak voltage, pulse rise time, and pulse rate of rise including justification for proposed deviation from specified values. Include motor manufacturer's certification motor insulation will withstand long-term overvoltages caused at motor terminals due to specified output pulse data or proposed deviation from this data.
4. Data on shelf life of "dc link" capacitor.
5. Complete system rating, including nameplate data, continuous operation load capability throughout speed range of 0 percent to 120 percent of rated speed.
6. Complete adjustable frequency controller rating coordinated with motor full load nameplate current rating; list controller special features being supplied.
7. Controller, reactor, and harmonic filter (if applicable) dimensional drawings; information on size and location of space for incoming and outgoing conduit.
8. Maximum heat dissipation from enclosure.
9. Layout of controller face showing pushbuttons, switches, instruments, and indicating lights.
10. Complete system operating description.
11. Complete system schematic (elementary) wiring diagrams.
12. Complete system interconnection diagrams between controller, drive motor, and related components or controls external to system, including wire numbers and terminal board point identification.
13. One-line diagram of system, including component ratings.
14. Description of diagnostic features being provided.
15. Descriptive literature for control devices such as relays and timers.
16. Itemized bill-of-materials listing system components.
17. Specific description of provisions, such as filtering and harmonic suppression, being made to ensure proper system operation.

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18. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Statement of Supplier qualifications.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory functional test reports.
6. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE 112, Test Method B, showing rated load, rated speed efficiency meeting or exceeding specified values; motors not as specified will be rejected.
7. Field test reports.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
9. Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
11. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Supplier: Minimum 5 years' experience in furnishing similar size and type adjustable frequency, controlled speed, drive systems.

1.06 EXTRA MATERIALS

A. Furnish a complete set of components likely to fail in normal service for each drive unit, including but not limited to:

1. Plug-in subassemblies, or PCB cards.
2. SCRs.
3. One complete power bridge and one spare printed circuit card for each modular, plug-in type card in controller.

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PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Components and accessories specified in this section shall be products of:

1. Eaton Cutler Hammer.
2. Danfoss.
3. Siemens Robicon.
4. Allen-Bradley.
5. ABB.
6. Toshiba.
7. Square D.

2.02 SERVICE CONDITIONS

A. Ambient Operating Temperature: 32 degrees F to 104 degrees F.

B. Storage Temperature: Minus 40 degrees F to 158 degrees F.

C. Humidity: 0 percent to 95 percent relative (noncondensing).

D. Frequency Stability: Plus or minus 0.1 percent of maximum frequency.

2.03 COMPONENTS

A. Drive Units:

1. Incorporate switching power supply operating from dc bus, to produce PWM output waveform simulating sine wave and providing power loss ride through of 2 milliseconds at full load, full speed.
2. Current-limiting semiconductor fuses for protection of internal power semiconductors.
3. Employ diode bridge rectifier providing constant displacement power factor of 0.95 minimum at all operating speeds and loads.
4. Use transistors for output section, providing a minimum 97 percent drive efficiency at full speed, full load.
5. Employ dc power discharge circuit so that after removal of input power dc link capacitor voltage level will decay below 50 volts dc within 1 minute after de-energizing following NEMA CP 1 and NFPA 79. Design dc link capacitor for a MTBF of 5 years.
6. Operate with open circuited output.
7. Input Voltage: 480V ac plus or minus 10 percent.
8. Output Voltage: 0-volt to 480 volts, three-phase, 0Hz to 66-Hz, minimum.

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9. Maximum peak voltage of PWM AFD output pulse of 1,000 volts, with pulse rise time of not less than 2 microseconds, and maximum rate of rise of 500 volts per microsecond. Maximum frequency of PWM AFD output pulse (carrier) frequency of 3,000-Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish insulation systems on motors suitable for proposed values.
10. Motor Audible Noise Level: When operating throughout speed range of PWM AFD, no more than 3 dBA above that designated in NEMA MG 1 for same motor operated at constant speed with a 60-Hz supply voltage.
11. Short-Time Overload Capacity: 125 percent of rated load in rms current for 1 minute following full load, full speed operation.
12. Equipment Short-Circuit Rating: Suitable for connection to system with maximum source three-phase, bolted fault, short-circuit available of 42,000 amps rms symmetrical at 480 volts.
13. Furnish drives with output current-limiting reactors mounted within equipment enclosure.
14. Diagnostics:
    a. Comprehensive for drive adjustment and troubleshooting:
        1) Memory battery backup; 100-hour minimum during power loss.
        2) Status messages will not stop drive from running but will prevent it from starting.
        3) Fault Condition Messages and History:
            a) First fault protection function to be activated, ability to store six successive fault occurrences in order. Minimum faults numerically:
                (1) Overcurrent (time and instantaneous).
                (2) Overvoltage.
                (3) Undervoltage (dc and ac).
                (4) Overtemperature (drive, motor windings, motor bearing, pump bearing).
                (5) Serial communication fault.
                (6) Short-circuit/ground fault (motor and drive).
                (7) Motor stalled.
                (8) Semiconductor fault.
                (9) Microprocessor fault.
                (10) Single-phase voltage condition.
15. Drive Protection:
    a. Fast-acting semiconductor fuses.
    b. Overcurrent, instantaneous overcurrent trip.
    c. Dc undervoltage protection, 70 percent dropout.
    d. Dc overvoltage protection, 130 percent pickup.
    e. Overtemperature, drive, inverter, converter, and dc link components.

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f. Overtemperature, motor, and pump.
g. Single-phase protection.
h. Reset overcurrent protection (manual or automatic reset).
i. Active current limit/torque limit protection.
j. Semiconductor fault protection.
k. Short-circuit/ground fault protection.
l. Serial communication fault protection.
m. Microprocessor fault.
n. Surge protection for transient overvoltage (6,000 volts, 80 joule surge, tested per IEEE C62.41).
o. Visual display of specific fault conditions.

16. Operational Features:
    a. Use manufacturer's standard unless otherwise indicated.
    b. Sustained power loss.
    c. Momentary power loss.
    d. Power interruption.
    e. Power loss ride through (0.1-second).
    f. Start on the fly.
    g. Electronic motor overload protection.
    h. Stall protection.
    i. Slip compensation.
    j. Automatic restart after power return (ability to enable/disable function).
    k. Critical frequency lockout (three selectable points minimum, by 1.5-Hz steps in 10-Hz bands, to prevent resonance of system).
    l. Drive maintenance system software for complete programming and diagnostics.
    m. Ground fault protection, drive, and motor.
    n. Operate with no motor connected to output terminals.

B. Rectifier: Three-phase 6-pulse full wave diode bridge rectifier to provide constant dc voltage to drive's dc bus.

C. Furnish series choke and capacitors on dc bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.

D. Controller: Microprocessor-controller PWM inverter to convert to dc voltage to variable voltage, adjustable frequency, three-phase ac output. Output voltage shall vary proportionally with frequency to maintain constant ratio of volts to hertz up to 60-Hz; above 60-Hz, voltage shall remain constant with drive operating in constant horsepower output mode.

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E. Enclosure:

1. NEMA 250, Type 1, gasketed, freestanding, enclosure for mounting against wall, completely front accessible, and hinged doors. Properly sized to dissipate heat generated by controller within limits of specified operating conditions (including ambient temperature and ambient airflow). Enclosure not to exceed dimensions shown on the Drawings.
2. Cable termination compartment door interlocked main circuit breaker, defeatable (lockable in the open position), emergency stop pushbutton, alphanumeric keypad and display, and operator's controls. Components and controls specified in Section 26 05 04, Basic Electrical Materials and Methods.
3. Wire drive from above for power and control wiring.
4. Size forced-ventilation for periodic operation to cool each unit with maximum room ambient temperature of 95 degrees F. Furnish redundant fans such that if one fan fails remaining fans furnish adequate ventilation for drive when operating at maximum capacity. Furnish filters on ventilation intakes.
5. Wiring:
    a. Bundle stranded copper wiring neatly with nylon tie wraps or with continuous plastic spiral binding.
    b. Label each terminal for permanent identification of leads.
    c. Identify each wire at each end with imprinted mylar adhesive-back wire markers.
    d. Incorporate in as-installed wiring diagrams for wire and terminal numbers shown.
    e. Wiring across door hinge, use 19-strand, NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
    f. Wire connections internal to panels by crimp-on terminal types.
    g. For multiple enclosure systems, complete interconnection wiring with gasketed enclosure openings for wiring.
    h. Multipoint plug receptacles for control wiring crossing equipment shipping splits.
6. Selector switches, indicating lights, potentiometers, instruments, protective devices, and major system components identified by means of mechanically attached, engraved, laminated nameplates.

F. Operator Interface:

1. Controls:
    a. Mount drive local control on front door of enclosure and include control switch and membrane type keypad for the following operator functions:
        1) Start (when in LOCAL mode).
        2) Stop (when in LOCAL mode).

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3) Speed increase (when in LOCAL mode).
4) Speed decrease (when in LOCAL mode).
5) Parameter mode selection (recall programmed parameters).
6) LOCAL/OFF/REMOTE control selection (in remote, furnish for remote RUN command digital input and speed increase/decrease via remote 4 mA to 20 mA analog signal).
7) Fault reset, manual for faults, except loss of ac voltage which is automatic upon return.
8) RUN/preset speed.
9) Parameter lock, password or key switch lockout of changes to parameters.
10) Start disable, key switch or programmed code.

2. Control circuit disconnect shall de-energize circuits in units that are not de-energized by main power disconnect device.
3. Control power and operator controls shall be sourced from internal control power transformer. Furnish power for motor space heaters rated 120 volts.
4. Arrange component and circuit such that failure of a single component cannot cause cascading failure(s) of other component(s).
5. Alphanumeric Display:
   a. During normal operation and routine test, the following parameters shall be available:
      1) Motor current (percent of drive rated current).
      2) Output frequency (Hertz).
      3) Output voltage.
      4) Running time.
      5) Local/remote indicator.
      6) Status of digital inputs and outputs.
      7) Analog input and output values.
      8) Output motor current per leg.
      9) All test points.
6. Adjustable Parameters:
   a. Set drive operating parameters and indicate in numeric form. Potentiometers may not be used for parameter adjustment. Minimum setup parameters available:
      1) Frequency range, minimum, maximum.
      2) Adjustable acceleration/deceleration rate.
      3) Volts per Hertz (field weakening point).
      4) Active current limit/torque limit, 0 percent to 140 percent of drive rating.
      5) Adjustable voltage boost (IR compensation).
      6) Preset speed (adjustable, preset operating point).
      7) Provision for adjustment of minimum and maximum pump speed to be furnished as function of 4 mA to 20 mA remote speed signal.

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G. Signal Interface:

1. Digital Input:
   a. Accept a remote RUN command contact closure input.
   b. High temperature contact closure input from field mounted motor temperature monitoring relay.
2. Digital Output: Furnish three discrete output dry contact closures rated 5 amps at 120 volts ac.
   a. DRIVE RUNNING.
   b. DRIVE FAULT (with common contact closure for all fault conditions).
   c. DRIVE IN REMOTE MODE.
3. Analog Input: When LOCAL/OFF/REMOTE switch is in REMOTE, control drive speed from remote 4 mA to 20 mA dc signal.
   a. Make provisions for adjustment of minimum and maximum motor speed which shall result from this signal.
   b. Factory set this adjustment to comply with operating speed range designated in driven equipment specifications.
   c. Frequency resolution shall be 0.1 percent of base speed.
4. Analog Output: Furnish two 4 mA to 20 mA dc signals for actual frequency, actual load.
5. Communication Interface: RJ45, compatible with ethernet IP.

H. Accessories:

1. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.
4. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.

2.04 FACTORY FINISHING

A. Enclosure:

1. Primer: One coat of rust-inhibiting coating.
2. Finish:
   a. Interior: One coat white enamel.
   b. Exterior: Manufacturer’s standard

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2.05 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all control panels actually furnished.

C. Record test data for report.

D. Functional Test: Perform manufacturer's standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each controller.
2. Inspect controller for electrical supply termination connections, interconnections, proper installation, and quiet operation.
3. Record test data for report.

B. Performance Test:

1. Conduct on each controller.
2. Perform under actual or approved simulated operating conditions.
3. Test for continuous 12-hour period without malfunction.
4. Demonstrate performance by operating continuous period while varying application load, as input conditions allow, to verify system performance.
5. With plant load connected to normal utility source, measure the following to show parameters within specified limits:
   a. Total and individual current harmonic distortion, up to and including 35th harmonic, at the sourced MCC bus, under following load conditions:
      1) AFDs running at full load and half load.
   b. Power factor at input side of each drive. Documented verification that power factor is maintained at 95 percent as speed of drive goes down from 100 percent to 33 percent.
6. Record test data for report.

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C. Test Equipment:

1. Use Dranetz, Model No. 626-PA, harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results.
2. Provide diagnostic plug-in test card complete with instructions, multiposition selector switch, and meters or built-in diagnostic control panel or ROM-based processor for monitoring ac, dc, and digital signals to assist in troubleshooting and startup of drive.

END OF SECTION

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SECTION 26 42 01
PIPE BONDING AND TEST STATIONS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
2. American National Standards Institute (ANSI).
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Water Works Association (AWWA):
   a. C110, Ductile-Iron and Gray-Iron Fittings for Water.
   b. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 inches (100 mm) and Larger - Shop Applied.
   c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 inches Through 144 inches (100 mm Through 3,600 mm).
   d. C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   e. C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
5. American Wood Preservers' Association (AWPA):
   a. C2, Lumber, Timber, Bridge Ties, and Mine Ties-Preservative Treatment by Pressure Processes.
   b. P9, Standards for Solvents and Formulations for Organic Preservative Systems.
6. ASTM International (ASTM):
   a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   c. B418, Standard Specification for Cast and Wrought Galvanic Zinc Anodes.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C150, Standard Specification for Portland Cement.
   f. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   g. F436, Standard Specification for Hardened Steel Washers.

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7. Association for Materials Protection and Performance (AMPP) formerly NACE International (NACE): SP0169, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
8. Concrete Reinforcing Steel Institute (CRSI).
9. National Electrical Manufacturers Association (NEMA):
    a. C80.1, Electrical Rigid Steel Conduit (ERSC).
    b. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
    c. WC 70, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
10. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
11. NSF International (NSF).
12. The Society for Protective Coatings (SSPC):
    a. SP 1, Solvent Cleaning.
    b. SP 10, Near-White Blast Cleaning.

1.02 DEFINITIONS

A. Electrical Isolation: Condition of being electrically isolated from other metallic structures (including, but not limited to, piping, reinforcement, casings) and the environment as defined in NACE RP0169.

B. Electrically Continuous Pipeline: Pipeline that has a linear electrical resistance equal to or less than the sum of the resistance of the pipe plus the maximum allowable bond resistance for each joint as specified in this section.

C. Ferrous Metal Pipe: Pipe made of steel or iron, or pipe containing steel or iron as a principal structural material, except reinforced concrete pipe.

D. Foreign Owned: Buried pipe or cable not specifically owned or operated by Owner.

E. Lead, Lead Wire, Joint Bonds, Pipe Connecting Wires, Cable: Insulated copper conductor; the same as wire.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog cuts and information for products proposed for use.
2. Qualifications of the Cathodic Protection Specialist and Cathodic Protection Technician.
3. Factory test reports for isolation fittings.

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B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Factory test reports for isolation fitting.
3. Field Test Reports, including results of insulator testing, and results from testing associated with Paragraph Metallic Pipe Isolation From Structures.
4. Pipe isolation from reinforcing steel test results, before and after concrete pour. Submit as they become available.

1.04 QUALITY ASSURANCE

A. Obtain services of qualified Cathodic Protection Specialist to inspect, adjust, and evaluate effectiveness of cathodic protection system. Cathodic Protection Specialist shall be person accredited or certified by AMPP/NACE International at level of Corrosion Specialist or Cathodic Protection Specialist (such as, NACE International CP Level 4). Cathodic Protection Specialist shall have not less than 5 years' experience inspecting pipeline cathodic protection systems.

1. Cathodic Protection Technician shall be person accredited or certified by AMPP/NACE International at level of Cathodic Protection Technician (such as, NACE International CP Level 2). Cathodic Protection Technician shall have not less than 5 years' experience testing cathodic protection systems and be under direct supervision of Cathodic Protection Specialist.
2. Cathodic Protection Specialist shall attend final Cathodic Protection System Activation Survey.

1.05 SCHEDULING

A. Specified weld-in fittings may have long delivery times. Contact manufacturers and obtain commitments for delivery before scheduling installation.

PART 2 PRODUCTS

2.01 WIRES

A. Conform to applicable requirements of NEMA WC 70.

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B. Joint Bond:

1. General: Single-conductor, stranded copper wire with 600-volt HMWPE insulation. Supply joint bonds complete with formed copper sleeve on each end of wire.
2. Push-On, Mechanical, or Flanged Joints: 2 AWG wires, 18 inches long.
3. Flexible Coupling Joints: 2 AWG wires, 24 inches long, with two 12-inch-long XHHW insulated 12 AWG wire pigtails, as manufactured by Erico Products Inc. (Cadweld), Cleveland, OH.

2.02 PIN BRAZING

A. General:

1. Pin Brazing materials consist of Cable Lugs, Brazing Pins, Ceramic ferrule, Brazing Gun, Pin Holder, and Pin Brazing Kit.
2. Pin Brazing materials and equipment shall be product of a single manufacturer. Interchanging materials of different manufacturers is not acceptable.

B. Pin Brazing Materials Manufacturers: Sidetrack, Ängelholm, Sweden.

C. Pin Brazing Coating:

1. Thermite Weld Caps: Prefabricated weld cap with coating and suitable primer, such as Handy Cap II with Royston Primer 747, as manufactured by Royston Laboratories, Inc.
2. Use products recommended by pipe or fitting coating manufacturer to repair spot damage at thermite weld connections not covered by standard pipeline coating repair procedure or thermite weld cap.

2.03 ANCILLARY MATERIALS

A. Mastic Coating: TC Mastic (Brush Applied) as manufactured by Tapecoat Co., Evanston, IL.

B. Wire Connectors: One-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co. or Thomas and Betts.

C. Compression Connectors:

1. For in-line, tap, and multisplice furnish “C” taps made of conductive wrought copper, sized to fit wires being spliced.
2. Manufacturer and Product: Burndy; Type “YC.”

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D. Electrical Wire Splice Coating:

1. Electrical Tape:
   a. Linerless rubber, high voltage splicing tape and vinyl electrical tape suitable for moist and wet environments.
   b. Manufacturer and Products: 3M Products; Scotch 130 C and Scotch 88.
2. Epoxy Coating:
   a. Two-part epoxy insulating encapsulating resin suitable for moist and wet environments.
   b. Manufacturer and Products: 3M Scotchcast Products; 3M Wye and Inline Resin Splice Kits.

2.04 INSULATING JOINTS

A. Insulating Joints: Dielectric unions, flanges, or couplings.

1. Materials shall be resistant for the intended exposure, operating temperatures, and products in the pipeline.

B. Flange Insulating Kits:

1. Flanges: For steel pipe flanges, oversize bolt holes as specified in Section 40 27 00, Process Piping—General. For ductile iron pipe flanges, provide standard hole diameters.
2. Fasteners: In accordance with AWWA C207 or AWWA C110, for steel pipe or ductile iron pipe, respectively. Minimum bolt length shall be the sum of the mating flanges maximum thicknesses, sealing gasket, insulating and steel washer thickness, and depth of the nut plus 1/8-inch minimum before torquing. Since insulating sleeves may not fit over unthreaded portions of fasteners, bolts shall be cut thread full body or threaded rod as required to meet inside diameter dimensions of insulating sleeves specified herein.
3. Gaskets: Full-face Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
4. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
5. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
6. Steel Washers: Hardened steel, ASTM F436, 1/8-inch thick.
   a. Provide two washers per bolt for flange diameters equal to or less than 36-inch diameter.
   b. Provide four washers per bolt for flange diameters larger than 36-inch diameter.

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7. Manufacturers and Products:
    a. PSI, Houston, TX; Linebacker.
    b. Advance Products and Systems, Lafayette, LA; Trojan.
    c. Lamons, Houston, TX; Isoguard.

2.05 FUNCTIONAL TEST EQUIPMENT

A. Test Equipment:

1. Before construction begins, obtain test equipment necessary for electrical continuity testing and the following equipment:
    a. Item 1200, Aboveground Miller Insulation Checker (M.I.C.).
        1) Manufacturer: MC Miller Co., Inc., Sebastian, Florida.
    b. Model 702, Buried Insulation Checker.
        1) Manufacturer: Gas Electronics Co., Seymour, MO.
    c. Model 77 Series III, Digital Multimeter, with case and test leads.
        1) Manufacturer: Fluke Corporation, Everett, WA.
    d. Two Model 6B copper-copper sulfate reference electrodes.
        1) Manufacturer: Tinker and Rasor, San Gabriel, CA.
    e. One quart of copper sulfate antifreeze solution.
    f. One-half pound of copper sulfate crystals.

B. Store test equipment at Site and maintain in accurately calibrated, working condition. Test equipment shall be available to Engineer for testing purposes. Upon completion of Project, test equipment listed above shall be turned over to Owner in clean, accurate, and fully functional condition, along with operating manuals, test wires, and cases supplied with equipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Construct system of pipe joint bonds to form an electrically continuous piping network.

3.02 PIPE JOINT BONDING

A. Electrically bond joints of buried steel and iron pipe, including vault and manhole piping and fittings, and including restrained joints, except joints specified to be threaded, welded, or insulated.

B. Install two joint bond wire assemblies at each joint that requires bonding.

C. Use Pin Brazing process for electrical connection of wires to pipe and fittings.

D. Test each bonded joint for continuity prior to backfilling.

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3.03 WIRE CONNECTIONS

A. Provide crimp tool and die recommended by manufacturer for wire and tap connector size.

B. Pin Brazing:

1. Use pin brazing method for electrical connection of copper wire to ductile iron surfaces. Observe proper safety precautions, procedures, material selection, and surface preparation recommended by manufacturer of pin brazing system.
2. Remove coatings, dirt, and contaminants from pipe surface by filing or grinding with a non-resinous grinding wheel.
3. Make pin brazed connection as specified by the manufacturer.
4. After connection has cooled, visually inspect and physically test wire connection by tapping with hammer; remove and replace defective connections.
5. After weld is made, coat finished connection with specified pin braze connection coating. Clean connection with denatured alcohol and apply putty sealant around connection and exposed wire to fill and conform to surfaces. Finish with specified cover sheet material.

3.04 WIRE INSULATION REPAIR

A. Handle wires with care. Splices for damage to wire insulation shall be required by spirally wrapping (50 percent overlap, minimum) with two coats of high-voltage rubber splicing tap and two layers of vinyl electrical tape. Optional use of two-part epoxy resin splice kit. Make wire splices with suitable sized compression connectors or mechanically secure and solder with rosin cored 50/50 solder. Splices shall be approved by Engineer.

3.05 INSULATED JOINTS

A. Install insulated joints to electrically isolate pipeline from other structures as specified in Section 40 27 00, Process Piping—General.

B. Align and install insulating joints as shown on the Drawings and according to manufacturer’s recommendations.

C. Do not use fastener lubricants that contain graphite or metallic compounds that will interfere with the insulating capability of the completed joint.

D. Test the completed insulating joint as specified herein.

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3.06 FIELD QUALITY CONTROL

A. Electrical Continuity Testing:

1. Provide necessary equipment and materials and make electrical connections to pipe as required to test continuity of bonded joints.
2. Conduct continuity test on buried joints that are required to be bonded. Test electrical continuity of joint bonds after bonds are installed but before backfilling of pipe.
3. Cathodic Protection Specialist will monitor tests of bonded joints.
4. Test electrical continuity of completed joint bonds using either a digital low resistance ohmmeter or by Calculated Resistance Method, at Contractor's option.
    a. Digital Low Resistance Ohmmeter Method:
        1) Provide the following equipment and materials:
            a) One Biddle Model 247001 digital low resistance ohmmeter. (Megger International now manufactures Biddle Instruments).
            b) One set of 10-amp duplex heavy-duty fixed-point current and potential hand spikes, Biddle Model No. 241002, cable length as required or one set of duplex helical current and potential hand spikes, Biddle Model No. 241001, cable length as required.
            c) One calibration shunt rated at 0.001 ohm, 100 amperes, Biddle Model No. 249004 or MCM Miller 0.001-ohm, 100 amperes shunt.
        2) Test Procedure:
            a) Measure resistance of joint bonds with low resistance ohmmeter in accordance with manufacturer's written instructions.
            b) Use helical hand spikes to contact pipe on each side of joint, without touching thermite weld or bond.
            c) Clean contact area to bright metal by filing or grinding and without surface rusting or oxidation.
            d) Record measured joint bond resistance on test form described herein.
            e) Repair damaged pipe coating.

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b. Calculated Resistance Method:
   1) Provide the following equipment and materials:
      a) One dc ammeter (meter or clamp-on) with full scale reading of 100 amperes and a minimum resolution of 1-ampere or a 100-ampere shunt with a voltmeter as specified herein.
      b) One high resistance electronic voltmeter with a dc low range of 200 millivolts full scale to a dc high range of 20 volts full scale and capable of a minimum resolution of 1-millivolt (two voltmeters are required if a shunt is used).
      c) One knife switch, safety switch, or time-controlled relay suitable for test current.
      d) Two electrical probes for the voltmeter.
      e) Insulated wire suitable for carrying the test current, length as required.
      f) One dc power supply with a steady capacity of 50 amperes minimum; storage batteries are not an acceptable power supply.
      g) Test Procedure: Either tightly clamp or thermite weld current wire connections to the pipe. Determine wire size for the test current, and do not exceed 1,000 feet in length.
c. Apply a minimum direct current of 50 amperes.
d. Measure voltage drop across each joint with voltmeter by contacting pipe on each side of joint. Voltmeter connections to bond wire or thermite welds will not be acceptable.
e. Measure current applied to test span and voltage drop across joint simultaneously.
f. Record measured voltage drop and current for each joint of test form described herein and calculate bond resistance in accordance with the following formula:

$$R = \frac{E}{I}$$

Where:

R = Resistance of the joint bond.
E = Measured voltage drop across the joint, in volts.
I = Test current applied to the pipe test span, in amperes.

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5. Joint Bond Acceptance:
   a. Joint Bond Resistance: Less than or equal to the maximum allowable bond resistance values in Table 1.

Table 1

Joint Type	Max. Allowable Resistance	
	1 Bond/Joint	2 Bonds/Joint
Push-On, Mechanical, or Flanged	0.000325 ohm	0.000162 ohm
Flexible Coupling	0.000425 ohm	0.000212 ohm
Concrete Cylinder	0.000200 ohm	0.000100 ohm

   b. Replace joint bonds that exceed the allowable resistance. Retest replacement joint bonds for compliance with bond resistance.
   c. Repair defective joint bonds discovered during energizing and testing.
   d. Use hammer to sharply hit completed weld to knock off slag and physically test completed exothermic connection. Pull on bond wire to ensure there is solid connection.
   e. Visually inspect and physically inspect condition of joint bond welds for solid type connection and appearance with wire being completely encapsulated in well-formed, solid weld.
   f. Where wire is not fully encapsulated in weld metal, an additional exothermic weld is necessary. Clean surface of first existing weld and place second charge directly over first weld to fully encapsulate wire.
   g. Porous weld with visible honeycombs, pores, or hollow tubes shall not be evident. If honeycombed or porous welds are observed, replace bond wire at location, regardless of whether bonds meet specified measured resistance criteria or not.
   h. In some instances, extremely hot weather with continued elevated surface temperatures (above 110 degrees F to 120 degrees F) may slightly influence measured resistance of joint bond. When testing during extremely hot weather, record surface temperature with contact type pyrometer during these times for direct comparison to measured resistance values. Record measured temperature and actual measured resistance value. Contact Engineer for direction.
6. Record Tests of Each Bonded Pipeline:
   a. Description and location of pipeline tested.
   b. Starting location and direction of test.
   c. Date of test.
   d. Joint type.
   e. Test current and voltage drop across each joint and calculated bond resistance (Calculated Resistance Method only).

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f. Measured joint bond resistance (Digital Low Resistance Ohmmeter method only).
g. Record test information on a form that includes information listed above.

B. Testing of Exothermic Welds and Pin Brazed Connections: Test exothermic welds and pin brazed connections for adherence to pipe or casing. Use minimum 22-ounce hammer for adherence testing by striking blow to weld or pin brazed connection while steadily pulling on wire. Do not unnecessarily cold-work wire near weld during installation or testing. Take care to avoid hitting wires. Remove and reweld or repin braze welds that break loose or show signs of separating, as determined by Engineer.

C. Electrical Isolation Testing:

1. Pipe penetrations tested for electrical isolation from rebar and wire ties before pouring concrete.
2. Electrical shorts mitigated prior to pouring concrete. Testing shall be performed again after concrete is poured.
3. Electrical isolation verified and if electrical isolation cannot be achieved, propose modifications to cathodic protection system to resolve problem.

D. Insulated Joint Testing:

1. Provide Engineer with 3 days' advance notice before beginning tests.
2. Cathodic Protection Specialist or Cathodic Protection Technician shall monitor the tests.
3. Test each joint after assembly with insulator tester in accordance with manufacturer's written instructions.
4. For insulating flanges, test and record insulating values of each bolt in addition to the completed flange.
5. Replace damaged or defective insulation parts.
6. Correct defects identified during testing.

3.07 SUPPLEMENT

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

1. Joint Bond Continuity Test Schematic.

END OF SECTION

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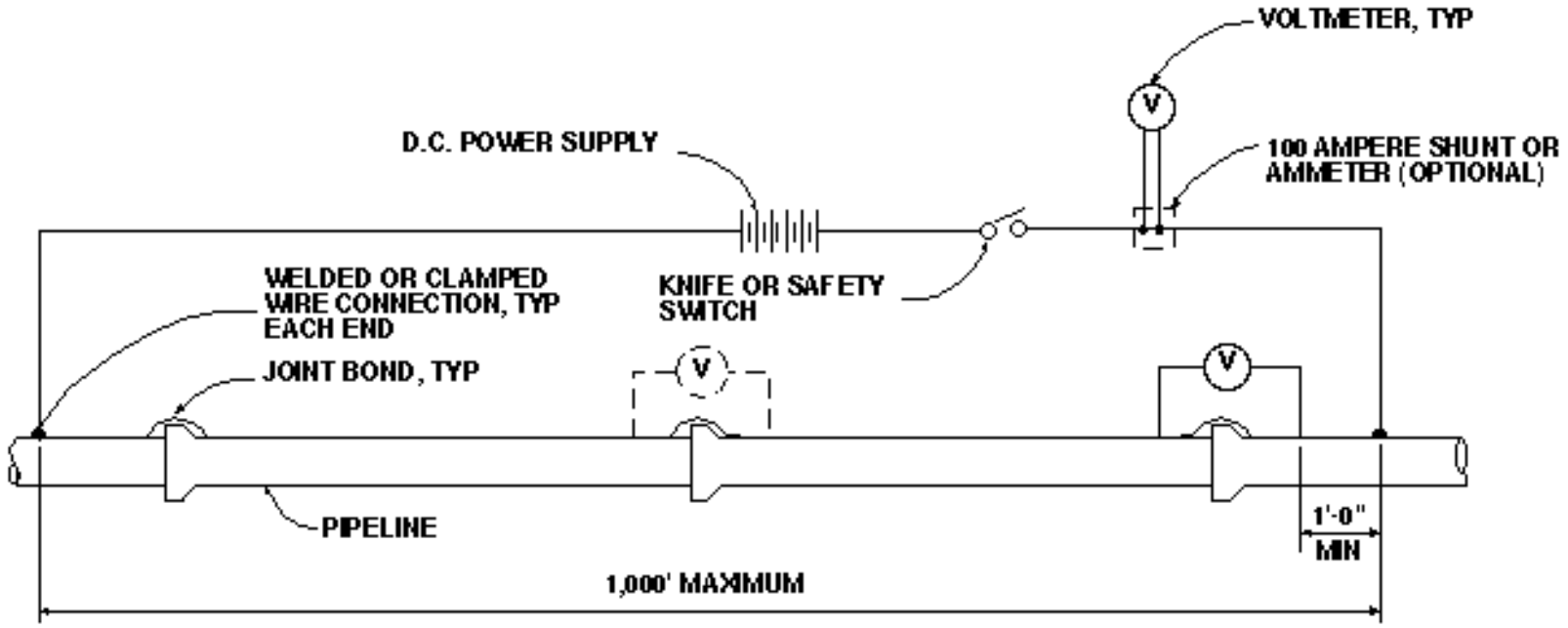

JOINT BOND CONTINUITY TEST SCHEMATIC

DTE195.SP 10M-17-95/mbb

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SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Department of Defense: MIL-STD-220C, Test Method Standard – Method of Insertion Loss Measurement.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and less) AC Power Circuits.
   c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and less) AC Power Circuits.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 497A, Standard for Secondary Protectors for Communications Circuits.
   b. 1283, Standard for Electromagnetic Interference Filters.
   c. 1449, Standard for Surge Protective Devices.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
2. Electrical single-line diagram showing location of each SPD.
3. Manufacturer’s UL certified test data and nameplate data for each surge protective device (SPD).

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1.03 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.

B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Eaton, SPD Series.

B. Square D, Surelogic.

C. Advanced Protection Technologies, Inc.

D. CITEL, MDS Series.

2.02 GENERAL

A. Unless indicated otherwise, provide direct bus-connected and factory-installed SPDs inside distribution equipment.

B. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.

C. Connect SPDs through a fused switch or circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.

D. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.

E. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.

F. Power Filter: Include a high-frequency extended range power filter for each SPD complimentary listed to UL 1283 as an electromagnetic interference filter.

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G. Provide SPDs with the following monitoring and diagnostics:

1. LED-type indication lights to show normal and failed status of each protected phase.
2. Surge event counter.
3. Form C dry contact which operates when unit fails.

H. Provide UL Type 2 SPDs.

I. EMI/RFI Noise Suppression: -50dB attenuation at 100 kHz, tested per MIL-STD 220C.

J. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	800	800	800	1200
480Y/277	1200	1200	1200	2000

2.03 PANELBOARD SPD

A. Provide SPD meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.

B. Surge Current Capacity:

1. Branch: 80 kA per phase; 40 kA per mode.

C. Maximum Continuous Operating Voltage (MCOV): Not less than 125 percent of the nominal system voltage.

D. Nominal Discharge Current (I_N): 10 kA.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Provide SPDs when indicated on the Drawings or in the equipment specifications.

B. Provide factory-installed SPDs as integral components to new switchgear, switchboards, motor control centers, panelboards and transfer switches. Externally mounted SPDs are not acceptable for new distribution equipment.

END OF SECTION

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SECTION 31 23 13
SUBGRADE PREPARATION

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. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lb/feet^3 (600 kN-m/m^3)).
   b. D1556/D1556M, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   c. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 feet-lbf/feet^3 (2,700 kN-m/m^3)).
   d. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, dewatering, excavation to grade, and scarification and compaction of subgrade.

C. Proof-Rolling: Test rolling of subgrade by heavily load vehicle or roller to identify areas that will not support the future loading without excessive settlement or rutting.

D. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

E. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

F. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

G. Unsuitable Material: Subgrade material unsuitable for the project consisting of rubble, debris, vegetation, and undocumented fill.

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1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 23 19.01, Dewatering; and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Owner's Representative and geotechnical Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Scarify and compact upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D698, Method 95 percent relative density.

B. Subgrade rutting or pumping during compaction because of excessive water buildup, indicate that groundwater dewatering efforts or moisture conditioning efforts are ineffective. Discontinue compaction until requirements specified in Section 31 23 19.01, Dewatering, are met.

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3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. In-place density test in accordance with ASTM D1556/D1556M or ASTM D6938. Test as follows:

1. One test every 1,000 square feet of subgrade.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact.
2. Overexcavate as specified in Section 31 23 16, Excavation, and replace with Granular Fill as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Overexcavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

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SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan and narrative, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.
   d. Numbers, types, and sizes of equipment proposed to perform excavations.
   e. Anticipated difficulties and proposed resolutions.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

C. Excavation Support: Install and maintain, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

D. Use of explosives are not permitted.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

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3.04 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, Demolition, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk for clearing and grubbing debris.

END OF SECTION

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SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Discharge permits.
3. Water Level Elevations Observed in Observation Wells: Submit same day measured.
4. Settlement Benchmark Elevations: Submit weekly record.
5. Stamped Calculations by an engineer in the State of Oregon for the dewatering system.

1.02 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system, including extraction wells, piezometers and observation wells, conveyance piping, pumps, sedimentation control facilities, discharge locations, and other components necessary to facilitate sufficient dewatering.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components, stamped by an engineer in the State of Oregon.

B. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan. Do not commence excavation until revised and amended Water Control Plan has been received and approved.

C. Review of Contractor’s Water Control Plan (original and any subsequent revisions) shall be only for compliance with specific stated requirements for its content and that it is stamped by a licensed engineer as specified and not for accuracy of content or for adequacy of the Plan, both of which shall be solely the responsibility of Contractor.

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PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, including artesian and perched groundwater and until backfilled to final grade.

B. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To allow required compaction of subgrade.
3. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
4. To relieve artesian pressures and resultant uplift of excavation bottom.
5. To allow excavation and construction of structures free of water.
6. To prevent instability of faces of excavation.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

D. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

E. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

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3.04 MONITORING FLOWS

A. Monitor volume of water pumped each calendar day from excavations. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.05 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove and dispose of solids from treatment facilities per federal, state, and local regulations and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.06 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

3.07 REMEDIATION OF GROUNDWATER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the Work or as satisfactory to each well owner.

END OF SECTION

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SECTION 31 23 23
FILL AND BACKFILL

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. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lbf/feet^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 feet-lbf/feet^3 (2,700 kN-m/m^3)).
   g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

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B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area:

1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   a. 1-foot outside outermost edge at base of foundations or slabs.
   b. 1-foot outside outermost edge at surface of roadways or shoulder.
   c. 0.5-foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

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L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Standard Specifications: When referenced in this section, shall mean Oregon Department of Transportation, Standard Specifications for Construction, 2024 Edition.

1.03 SUBMITTALS

A. Action Submittals:

1. Samples: Imported material taken at source.

B. Informational Submittals:

1. Manufacturer’s data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

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PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests: As necessary to locate acceptable sources of imported material.

2.02 EARTHFILL

A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.05 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.06 GRANULAR FILTER MATERIAL

A. As specified for 3/4-inch minus dense-graded crushed aggregate in the Standard Specifications.

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B. Clean, hard, durable gravel, free from foreign materials and washed.

C. Maximum 8 percent by weight passing No. 200 sieve.

2.07 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.08 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.09 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2-inch particle size.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.

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3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698, Method.

B. Around Structures: Place granular fill against structures to lines and grades shown, with allowance for topsoil thickness where shown. Place in loose lifts not exceeding 8 inches. Compact within 5 feet of walls with at least two passes of the appropriate hand-operated compaction equipment.

3.03 SITE TESTING

A. Gradation:

1. One sample from each 1,500 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

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B. In-Place Density Tests:

1. In accordance with ASTM D6938. During placement of materials, test as follows:
   a. Granular Fill: One test per every second lift.

3.04 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
2. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
3. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Engineer’s opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.05 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base Courses.

END OF SECTION

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SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lbf/feet^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 feet-lbf/feet^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

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1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded:

1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
    a. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
    b. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

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1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s descriptive literature for marking tapes and tracer wire.

B. Informational Submittals:

1. Catalog and manufacturer’s data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.
4. Product Data:
   a. Trench stabilization material.
   b. Bedding and pipe zone material.
   c. Granular drain.
   d. Granular backfill.
   e. Earth backfill.
   f. Sand(s).
   g. Geotextile.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. As specified in Section 31 32 19.16, Geotextile.

2.02 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 6 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Non-detectable Tape.
   c. Presco; Non-detectable Tape.

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B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 6 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.03 TRACER WIRE

A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.

B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.

C. Manufacturers:

1. Copperhead Industries, LLC.
2. Performance Wire & Cable Inc.
3. Pro-line Safety Products Company.

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2.04 TRENCH STABILIZATION MATERIAL

A. Base Rock:

1. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.
2. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

B. Granular Backfill:

1. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.
2. Maximum Particle Size:1-inch.
3. Dry sand, accepted by Engineer, may be provided for trenches above maximum groundwater level.

2.05 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
    a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
    b. Individual Particles: Free of sharp edges.
    c. Maximum Size Particle: Pass a No. 4 sieve.
    d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

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2.06 EARTH BACKFILL

A. Earthfill as specified in Section 31 23 23, Fill and Backfill.

B. Free from roots or organic matter, refuse, boulders and material larger than 1/2 cubic foot, or other deleterious materials.

2.07 PROCESSED EARTH BACKFILL

A. Class A Backfill: Earth backfill, meeting the following additional requirement.

1. Free of boulders and cobbles that would be retained on 6-inch screen, and portion retained on 3/4-inch sieve to less than 30 percent.

2.08 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 pounds per square inch and 150 pounds per square inch at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fly Ash (Pozzolan): Class F or Class C fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Test in accordance with ASTM C1012/C1012M to verify sulfate resistance is acceptable.
4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.09 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.10 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.11 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.

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2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. As specified in Section 31 23 19.01, Dewatering.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 GEOTEXTILE INSTALLATION

A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:

1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
3. Provide 24-inch minimum overlap at joints.

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3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness:

1. Pipe 15 Inches and Smaller: 4 inches.
2. Pipe 18 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1-inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.06 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.

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3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor. Take care to avoid damaging pipe and pipe coating.

3.07 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, shown on the Drawings. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
2. Nondetectable Marking Tape: Install with metallic piping.

3.08 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 3 feet.

C. Install splices in accordance with manufacturer’s instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

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D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, hydrant, and pipeline marker. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve box cover with the word “TRACER.” Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

E. Test continuity of tracer wire using electronic pipe locator in presence of Engineer.

3.09 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Earth Backfill:

1. Place in lifts not exceeding thickness of 9 inches.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
4. In other areas fill trench section as shown.

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3.10 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 12 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.11 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.12 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

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SECTION 32 11 23
AGGREGATE BASE COURSE(S)

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. C29/C29M, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88/C88M, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131/C131M, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C136/C136M, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.
   f. D75/D75M, Standard Practice for Sampling Aggregates.
   g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-lb/feet^3 (600 kN-m/m^3)).
   h. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 feet-lb/feet^3 (2700 kN-m/m^3)).
   i. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   j. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   k. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   l. D2844/D2844M, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   n. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   o. D5195, Standard Test Method for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.

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p. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

B. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

C. Completed Lift: Compacted with uniform cross-section thickness.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

F. Standard Specifications: When referenced in this section, shall mean Oregon Department of Transportation Standard Specifications for Construction 2024.

G. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 BASE COURSE

A. As specified for 3/4-inch Dense-Graded Aggregate, in Section 02630, of the Standard Specifications.

B. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

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2.02 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. In accordance with Section 00641, of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. In accordance with Section 00641, of the Standard Specifications.

B. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

C. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.

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2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
   a. Use leveling course or surfacing material as keystone.
   b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
   c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Surfacing Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of, base and surfacing course after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by ASTM D1557.

B. Roll each layer of material until material does not creep under roller before subsequent layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

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E. Place and compact each lift to the required density before succeeding lift is placed.

F. Remove floating or loose stone from surface of preceding course before placing course.

G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base: Within plus or minus 0.04-foot of grade shown at any individual point.

C. Surfacing Course: Within 0.04-foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01-foot from crown and grade specified.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide testing laboratory at least 48 hours’ advance notification prior to testing.
2. Show proof that areas meet specified requirements before identifying density test locations.
3. Sample of Aggregates: ASTM D75/D75M.

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4. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 2
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117 and ASTM C136/C136M	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D1557, Method D	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

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SECTION 33 05 16.13
PRECAST CONCRETE UTILITY STRUCTURE

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges, Division 1 Section 3, Division I Design-Loads (Part A, Part B, Part C).
2. ASTM International (ASTM):
   a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   d. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   f. C858, Standard Specification for Underground Precast Concrete Utility Structures.
   g. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
3. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910.27, Fixed Ladders.
   b. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed drawings showing complete information for fabrication including, but not limited to:
      1) Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement.
      2) Layout dimensions and identification of each precast unit.
      3) Welded connections indicated by AWS standard symbols.
      4) Details of connections, joints, accessories, and openings or inserts.
      5) Watertight joint details.

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6) Location and details of anchorage devices.
7) Access door details.

b. Product Data:
1) Precast concrete items; show materials of construction by ASTM reference and grade.
2) Joint sealants.
3) Antislip coating.
4) HS-20 traffic rated.

B. Informational Submittals:

1. Manufacturer's data for lifting devices for handling and erection.
2. Manufacturer's certification that vault design and manufacture comply with referenced ASTMs (for example, ASTM C857 and ASTM C858).
3. Vault design calculation shall be signed by a civil or structural engineer registered in the State of Oregon.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store each unit in a manner that will prevent cracking, distortion, warping, straining and other physical damage, and in a manner to keep marking visible.

B. Lift and support each unit only at designated lifting points and supporting points as shown on the Shop Drawings.

PART 2 PRODUCTS

2.01 VAULT MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Oldcastle Precast.
2. Jensen Precast.
3. Hanson Pipe and Precast.

2.02 PRECAST CONCRETE VAULTS

A. Design Requirements:

1. In the event of a conflict between or among standards, the more stringent standard shall govern.
2. Comply with ASTM C858, except as modified herein.
3. Reinforcing Steel:
a. Deformed Bars: ASTM A615/A615M, Grade 60.
b. Welded Wire Fabric: ASTM A497/A497M.

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4. Nominal Dimensions: As shown on the Drawings.
5. Construction: Rigid type and behave monolithically. Do not use panel-type vaults.
6. Design Loads: As determined by ASTM C857, and by using Site specific values below.
    a. Unit Weight of Soil: 110 pounds per cubic foot.
    b. Active Earth Pressure Coefficient: 0.33
    c. Groundwater Level: At finish grade surface.
    d. Live Loads: AASHTO HS20-44 truck loading plus impact.
    e. Designed to avoid flotation with a factor of safety equal to 1.2.
7. Design shall accommodate additional stresses or loads that may be imposed during factory precasting, transporting, erection, and placement.
8. Blockouts for penetrations shall be as shown on Drawings.
9. Sealant:
    a. Nonswelling preformed joint sealants to provide a lasting, watertight bond.
    b. Manufacturer and Product: Henry Company; RAM-NEK.
10. Mortar: Comply with ASTM C387/C387M, Type S or use Type I grout as specified in Section 03 62 00, Grouting.

B. Mark each member or element to indicate location in the structure, top surface, and date of fabrication.

2.03 ACCESSORIES

A. Pipe Connections to Vault: Flexible joint; Kor-N-Seal flexible rubber boot with stainless steel accessories.

B. Hatches and doors refer to Section 05 50 00, Metal Fabrications.

PART 3 EXECUTION

3.01 GENERAL

A. Possible Settlement: If subgrade is encountered that may require removal to prevent structure settlement, notify Engineer. Engineer will determine depth of over excavation and means of stabilizing subgrade prior to structure installation.

B. Place 6-inch minimum thickness of imported crushed aggregate material on undisturbed earth or modified subgrade; thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Article Excavation and Backfill.

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3.02 EXCAVATION AND BACKFILL

A. Remove and keep water clear from excavation during construction.

B. Excavation: As specified in Section 31 23 16, Excavation.

C. Backfill: As specified in Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.

3.03 INSTALLATION

A. Concrete Base:

1. Place on prepared subgrade.
2. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Carefully inspect precast sections to be joined.
2. Thoroughly clean ends of sections to be joined.
3. Do not use sections with chips or cracks.

C. Joints:

1. Fill joints between precast sections per manufacturer’s recommendation.
2. Joints shall be watertight to prevent entrance of groundwater.

D. Setting Precast Vault: Install vault to elevations shown on Drawings.

E. Watertight construction below grade with no open cracks or spalls. Cracking and defective areas of concrete shall be repaired per requirements of Section 03 30 00, Cast-in-Place Concrete.

3.04 PIPE CONNECTION TO VAULT

A. Install products in accordance with manufacturer’s instructions.

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.
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):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. 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 all 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. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a registered professional engineer in the state of Oregon.

1.05 DESIGN REQUIREMENTS

A. General:

1. Contractor responsible for the design, sizing, and location of piping support systems throughout facility, whether shown or not.
2. Piping supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 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.
3. 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.

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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 the Area Classification and Material Selection Table located on the Drawings.

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.

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.

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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. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

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 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.

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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 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

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2.07 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.

2.08 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.

2.09 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.

2.10 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.

2.11 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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2.12 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.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05 50 00, Metal Fabrications.
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: As specified in Section 05 50 00, Metal Fabrications.
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.
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.

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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-inch.
   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-inch 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.
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.

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C. Standard Attachments:

1. 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.
2. Steel Beams: I-beam clamp or welded attachments.
3. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
5. 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.

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.

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 Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. 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. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   d. B16.9, Factory-Made Wrought Buttwelding Fittings.
   e. B16.11, Forged Fittings, Socket-Welding and Threaded.
   f. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   g. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   h. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, Class 300, Class 600, Class 900, Class 1500, and Class 2500.
   i. B16.25, Buttwelding Ends.
   j. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Class 150 and Class 300.
   k. B31.3, Process Piping.
   l. B36.10M, Welded and Seamless Wrought Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.
6. 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.

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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.

7. 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.
8. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   c. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
   d. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
   e. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   f. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   g. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   h. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
   i. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 pounds per square inch Tensile Strength.
   j. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   k. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   l. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   m. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   n. A536, Standard Specification for Ductile Iron Castings.
   o. A563, Standard Specification for Carbon and Alloy Steel Nuts.

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p. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
q. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
r. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
s. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
t. B32, Standard Specification for Solder Metal.
u. B88, Standard Specification for Seamless Copper Water Tube.
v. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, Schedule 80, and Schedule 120.
w. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
x. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
y. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
aa. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

9. FM Global (FM).
10. 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.

1.02 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. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.

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5. Thrust Restraints:
    a. Design for test pressure shown in Piping Schedule.
    b. Allowable Soil Pressure: 1,000 pounds per square foot.
    c. Low Pressure Pipelines:
        1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
        2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.03 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. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
5. Pipe Corrosion Protection: Product data.
6. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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.

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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. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
9. CWI inspection records and NDE test records.
10. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
11. Torquing requirements and procedures, including torque values, for flanged piping assemblies.

1.04 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).
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.

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B. Quality Assurance: Provide services of Special inspection to be provided by Owner and performed by 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.

1.05 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.

B. Piping materials and accessories designed for contact with public drinking water systems shall meet the requirements of NSF 61.

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2.02 PIPING

A. As specified on Piping Data Sheet(s) and 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.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturer: Fernco Joint Sealer Co.

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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. Polyethylene Encasement (Bagging):

1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1-inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

C. 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.
5. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
   a. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
   b. Steel Washers: Hardened steel, ASTM F436, 1/8-inch thick.
      1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
      2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.
6. 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 THRUST TIES

A. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.07 VENT AND DRAIN VALVES

A. Pipeline 2 Inches Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2 Inches Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.08 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.

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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.

2.09 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

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 or PVDF-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.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.

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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. Weld Quality: Meet requirements of governing welding codes.

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.

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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.

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.

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4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

H. 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.

I. 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. 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 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes: Provide flexible mechanical compression joints for pressure pipe.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

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B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line Except PVC: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4-inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.

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4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on the Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on the Drawings for encasement requirements.

B. Where concrete encased piping crosses structure expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 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. Buried: Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with high build epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

B. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

C. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

D. 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.

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2. Buried:
    a. Ferrous Metal and Stainless Steel Components: Coat with high build epoxy as specified in Section 09 90 00, Painting and Coating.
    b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
    c. Flexible Couplings and Similar Items: Wrap with wax tape.
    d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with epoxy and wrap entire valve in polyethylene encasement.

E. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

F. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

G. Wax Tape: Apply in accordance with manufacturer's instructions and Section 09 90 00, Painting and Coating.

H. Insulating Flanges, Couplings, and Unions:

1. Applications:
    a. Dissimilar metal piping connections.
    b. Connections to existing metallic 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.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

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3.10 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.

3.11 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.

3.12 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.

3.13 PIPE IDENTIFICATION

A. As specified in Section 10 14 00, Signage.

3.14 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.
4. Maintenance of records and preparation of reports in a timely manner.

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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.
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.

3.15 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.16 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, and Glass-Lined Ductile Iron Pipe and Fittings
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings

END OF SECTION

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SECTION 40 27 00.01 CEMENT-MORTAR AND GLASS-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. Glass: ASTM B1000.

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SECTION 40 27 00.01 CEMENT-MORTAR AND GLASS-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 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, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, except from glass-lined pipe, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties. Branch connections, 3 inches and smaller from glass-lined pipe shall be made with glass-lined tee with a flanged branch for adapting to branch piping. Modifications to glass-lined pipe shall not be allowed in the field.

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SECTION 40 27 00.01 CEMENT-MORTAR AND GLASS-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.
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 Type 316 stainless steel 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 and Sewage 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 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Buttwelded Pipe, Schedule 40S: ASTM A312/A312M, Grade TP304/304L or Grade TP316/316L dual marked, seamless, pickled and passivated. Threaded Pipe, Schedule 80S: ASTM A312/A312M, Grade TP304/304L or Grade TP316/316L dual marked, seamless, pickled and passivated.
	3" through 24"	Schedule 10S: ASTM A312/A312M, Grade TP304/304L or Grade TP316/316L, dual marked, seamless or welded pickled and passivated.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Fittings	1-1/2" & smaller	Threaded: Forged ASTM A182/A182M, Grade F304 or F316, conforming to MSS SP-114 Class 1000.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304/304L-S or Grade WP316/316L-Sdual marked, conforming to ASME B16.9, annealed, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" through 24"	Butt-Welded: ASTM A403/A403M, Grade WP304/304L or 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.
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.

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SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Flanges	All	Stainless Steel: AWWA C228, Class SD, 304/304L or 316/316L or ASTM A182/A182M, Grade F304/304L or 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 4 or Grade F316, CL 3000, integral ground seats, AAR design meeting the requirements of MSS SP-83.
Bolting	All	Flanges: AWWA C228, Type 316 stainless steel, ASTM A193/A193M Grade B8M, Class 2 heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts. Torque bolts per gasket manufacturer recommendations. Anywhere mating flange on equipment is cast iron or plastic: Carbon steel ASTM A307 Grade B hex head or stud bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendation.
Gaskets	All Flanges	Flanged Water 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: 100 percent virgin PTFE Teflon tape.

END OF SECTION

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SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454 conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts and Type 316 stainless steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations.

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SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inchethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent weld cement for PVC pipe joints in chemical service shall be free of silica filler and shall be certified by the manufacturer to be suitable for the intended service, IPS Weld-On 724 “or-equal”. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

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.
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 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	ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. 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 01
PROCESS PIPING SPECIALTIES

EQUIPMENT AND COMPONENT NUMBER(S)

PL-001: Pig Launcher 1 (Primary Sludge System).
PL-002: Pig Launcher 2 (Primary Sludge System).
PL-003: Pig Launcher 3 (Primary Sludge System).
PR-7200: Pig Receiver 1 (Primary Sludge System).

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. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   d. Manual M11, Steel Pipe—A Guide for Design and Installation.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.

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b. Weld procedure qualifications.
c. Load proof-testing report of prototype restraint for any size coupling.

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

2.02 CONNECTORS

A. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 pounds per square inch gauge, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Garlock; Style 204.
   b. Unisource Manufacturing, Inc.; Style 1501.
   c. Proco Products, Inc.; Series 220.

B. Bulkhead Fitting 1/2-inch to 4 inches:

1. Bulkhead fitting body with left-handed buttress threads. Hexagon-shaped outside diameters for both the body flange and nut.
2. Materials and Construction:
   a. Body and Nut: PVC Type 1, Grade 1.
   b. Gasket: EPDM or FPM.
3. Pressure Rating 150 pounds per square inch at 70 degrees F non-shock.
4. End Connections: Socket x socket.

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5. Manufacturer and Product:
    a. Hayward; BFAS Series.
    b. Spears.

C. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ANSI 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 pounds per square inch gauge at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
    a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
    b. Metraflex; Model MN.
    c. Senior Flexonics Pathway, Inc.; Expansion Joints.

2.03 COUPLINGS

A. General:

1. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 pounds per square inch.
2. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
3. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
    a. Ductile Iron Pipe:
        1) Dresser Piping Specialties; Style 128.
        2) Smith-Blair, Inc.; Style 912.

C. Restrained Flange Adapter:

1. Pressure Rating:
    a. Minimum Working Pressure Rating: Not less than 150 pounds per square inch.

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b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.

2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

D. Restrained Dismantling Joints:

1. Pressure Rating:
   a. Minimum working pressure rating shall not be less than rating of the connecting flange.
   b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 131.
   b. Smith Blair, Inc.; Model 975.

E. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, "or-equal."

F. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

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5. Pressure Rating: 125 pounds per square inch, minimum, at 70 degrees F.
6. Manufacturers and Products:
    a. OPW; Kamlock.
    b. Ryan Herco; 1300 Series.

2.04 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 pounds per square inch internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
    a. Body: Malleable or ductile iron.
    b. Straps: Galvanized steel.
    c. Hex Nuts and Washers: Steel.
    d. Seal: Rubber.
5. Manufacturers and Products:
    a. Smith-Blair; Series 313 or 366.
    b. Dresser; Style 91.

2.05 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16-inch.
2. Seep Ring:
    a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
    b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
    c. Continuously fillet weld on each side all around.
3. Factory Finish:
    a. Galvanizing:
        1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
        2) Electroplated zinc or cadmium plating is unacceptable.
    b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

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B. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.06 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 pounds per square inch.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.

2.07 PIG LAUNCHER AND RECEIVERS: PL-001, PL-002, PL-003, PR-7200.

A. Quantity:

1. Launchers, Line Size, Flow Stream, and Location:
   a. 6-Inch, PS at Lower Primary Pump Station No. 1.
   b. 6-Inch, PS at Lower Primary Pump Station No. 2.
   c. 6-Inch, PS at Lower Primary Pump Station No. 3.
2. Receiver, Line Size, Flow Stream and Location: 6-Inch, PS at Solids Facility Sludge Blending Tank.

B. Carbon steel body, ASME B31.3 Design, Class 150 flanges, trap barrel at least 2 inches larger diameter than the line size.

C. Nozzles: Sizes and location as shown on the Drawings.

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D. Hinged Access Port: Nevis Pipeline Products Swing Bolt Style Closure – Series AD with Viton Seal, CAD plated bolting, and ASME VII Code Division 1. Weld end termination design code shall be ASME B31.3.

E. Features: Provide snubber for pig launcher and receivers.

F. Coating: Provide surface prep and paint inside with System No. 2 and outside with System No. 4 in accordance with Section 09 90 00, Painting and Coating.

G. Manufacturer:

1. Flowmore Services.
2. “Or-equal.”

2.08 MISCELLANEOUS SPECIALTIES

A. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 pounds per square inch nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 screen area to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

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C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.
2. Install a second flexible joint, whether or not shown.
   a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer’s instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
   a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
   b. Clean pipe surface before placing closure collars.
   c. Wet nonmetallic pipe thoroughly prior to pouring collars.
   d. Prevent concrete from entering pipe.
   e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
   f. Make entire collar in one placement.
   g. After concrete has reached initial set, cure by covering with well-moistened earth.

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3.04 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.05 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Do not remove pipe coating. If damaged, repair before joint is made.
4. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Concrete Encased Couplings: Flexible coupling.

3.06 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.07 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process Piping—General.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

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3.08 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.09 FIELD FINISHING

A. Field finish in accordance with Section 09 90 00, Painting and Coating.

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 Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   c. C542, Electric Motor Actuators for Valves and Slide Gates.
   d. C550, Protective Interior Coatings for Valves and Hydrants.
   e. C606, Grooved and Shouldered Joints.
2. ASTM International (ASTM):
   a. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   b. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   c. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   d. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   e. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
   f. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
   g. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
   h. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
   i. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   j. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
3. Factory Mutual Global (FM).
4. Food and Drug Administration (FDA).
5. International Association of Plumbing and Mechanical Officials (IAPMO).

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6. Manufacturers Standardization Society (MSS):
    a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
    b. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
    c. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
7. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
8. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
9. UL.
10. 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.
    c. Power and control wiring diagrams, including terminals and numbers.
    d. For each power 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.
    f. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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. Electric actuators; full compliance with AWWA C542.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

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4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. 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 or in Supplements.

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.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on the 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),

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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. 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.

2.05 VALVES

A. Globe Valves:

1. Type V200 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T, NPT threaded end.
      2) Crane Co.; Figure 7TF, NPT threaded end.
      3) Milwaukee; Model 1590T, soldered ends.
      4) NIBCO; Figure S-235-Y, soldered ends.

B. Ball Valves:

1. Type V301 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Two-piece, full port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-

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coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.

b. Manufacturers and Products:
   1) Threaded:
      a) Conbraco Apollo; 77-100.
      b) Nibco; T-585-70.
   2) Soldered:
      a) Conbraco Apollo; 77-200.
      b) Nibco; S-585-70.

2. Type V302 Actuator Ready Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 71-140.
      2) Milwaukee; 20BSOR-02.
3. Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:
   a. Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, 125 psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.
   b. Meets OSHA Regulation 29 CFR Part 1910.147 requirements.
   c. Manufacturers and Products:
      1) Conbraco Apollo; 75-100-41.
      2) Nibco; T-580-70-SV/T-585-70-SV.
4. Type V304 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece, full port, NPT threaded ends, bronze body and end pieces, hard chrome plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded Ends:
         a) Conbraco Apollo; 82-100.
         b) Nibco; T-595-Y.
         c) Stockham; T-395 Series.

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2) Solder Ends:
   a) Conbraco Apollo; 82-200.
   b) Nibco; S-595-Y.
   c) Stockham; S-395 Series.

5. 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 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76F-100 Series.
      2) Nibco; T-585-S6-R-66-LL.
6. Type V308 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Two-piece, standard port, NPT threaded ends, ASTM A351/A351M GR CF8M stainless steel body and end pieces, actuator mounting pad, Type 316 stainless steel ball and stem, vented ball, reinforced PTFE seats and seals, adjustable packing nut, blowout-proof stem, rated 1,500 psig WOG minimum, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 76-100.
      2) Nibco; T-580-S6-R-66-LL.
      3) Milwaukee; 20SSOR-02.
7. Type V330 PVC Ball Valve 3 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
8. Type V331 Actuator Ready PVC Ball Valve 3 Inches and 4 Inches:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union ball valve with flanged ends drilled to ASME B16.1. Provide actuator mount kit conforming to ISO 5211.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.

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9. Type V340 Actuator Ready PVC Three-Way Ball Valve 1/2 Inch to 6 Inches:
    a. Rated 150 psi at 70 degrees F non-shock, with ASTM D1784 Type I, Grade 1 PVC, L-port as required for the application, PTFE seat, double O-ring stem, blowout-proof design with socket, threaded, or flanged end connections. Top mounting flange or low profile actuation mounting kit conforming to ISO 5211.
    b. Manufacturers and Products:
        1) Hayward Gordon; LNH Series Lateral three-way True Union Ball Valve.
        2) Spears; True Union 2000 Industrial three-way Horizontal Diverter Valve.

C. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
    a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.
    b. Manufacturers and Products:
        1) Pratt; Ballcentric.
        2) DeZurik; Style PEC.
        3) Milliken; Millcentric Series 603.
2. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
    a. Nonlubricated type rated 175 psig 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. For buried service, provide external epoxy coating.
    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

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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.

3. Type V406 Full Port Eccentric Plug Valve 2.5 Inches to 12 Inches:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1, in accordance with AWWA C111 for buried service mechanical joint ends, and in accordance with AWWA C606 for grooved ends.
   b. Plug ductile iron with round or rectangular port of no less than 100 percent of connecting pipe area and coated with rubber, 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. For buried service, provide external epoxy coating.
   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) Flanged or Mechanical Ends:
         a) Milliken; Millcentric Series 601.
         b) Pratt; Ballcentric Fig 601FP & 600FP.

D. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and the 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.

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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.
10) Valves to be in full compliance with NSF/ANSI 61.

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.

2. Type V520 Solid Polyvinyl Chloride Butterfly Valve 1-1/2 Inches to 8 Inches:
a. Wafer body type, pressure rated 150 psi at 70 degrees F CWP, solid ASTM D1784, Type I, Grade 1, PVC body and contoured PVC or polypropylene valve disc, stainless steel valve stem, Viton seat, lever operator.
b. Manufacturers and Product:
1) ASAHI/America; Type 57.
2) Spears.

E. Check and Flap Valves:

1. Type V600 Check Valve 2 Inches and Smaller:
a. All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 125-pound SWP, 200-pound WOG.
b. Manufacturers and Products:
1) Stockham; Figure B-319, threaded ends.
2) Milwaukee; Figure 509, threaded ends.
3) Stockham; Figure B-309, soldered ends.
4) Milwaukee; Figure 1509, soldered ends.

2. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.

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b. Manufacturers and Products:
   1) Nibco; Chemtrol Tru Union.
   2) ASAHI/America.
   3) Spears; True Union.

F. Self-Regulated Automatic Valves:

1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
   a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated minimum.
   b. Size/Rating:2 inch, maximum of 50 gpm, with inlet pressure of 60 psig. Outlet pressure set as shown on the Valve Schedule located on the Drawings.
   c. Manufacturers and Products:
      1) Fisher; Type 75A.
      2) Watts; Series 223.
2. Type V740 Air and Vacuum Valve 1/2 Inch to 16 Inches:
   a. 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.
   b. Rated 150psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512. Operating pressure isas listed on the valve schedule on the Drawings.
   c. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 140 or 150.
      2) Val-Matic Valve; Series 100.

G. Miscellaneous Valves:

1. Type V925 Sampling Valve:
   a. Type 316 stainless steel wetted parts, hand operated iron crank, piston to extend to inner surface of vessel or pipe, sealed by two compressible replaceable Teflon rings, one above discharge port and other below discharge port,3/4-inch NPT inlet and 3/4-inch NPT outlet.
   b. Manufacturers and Products:
      1) Strahman Valves, Inc.; Piston Type Sampling Valve.
      2) Fetterolf Corporation; Rod-Seal Sampling Valve.
2. Type V940 Solenoid Valve 1/4 Inch to 2 Inches:
   a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (when de-

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energized) as indicated on the valve schedule located on the Drawings.

b. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.

c. Manufacturers:
   1) ASCO.
   2) Skinner.

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.
   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. Electric Operators, 120 Volts:

1. General:
   a. Unit shall be low profile to reduce amount of required space and weigh 15 pounds or less.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of the valve.
   c. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
2. Operator Operation, General:
   a. Suitable for full 90-degree rotation of quarter-turn valves.

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b. Manually override handwheel.
c. Mechanical valve position indication.

3. Electronic Control:
   a. Torque Limiting Switches: Two single pole, double throw mechanical switches. Switches operate at any point in valve travel.
   b. Jammed-valve detection and protection.
   c. Motor over-temperature detection and protection.
   d. Travel limit switches, single pole double throw.
4. Open-Close (O/C) Service:
   a. Duty cycle for intermittent ON-OFF operation shall be 25 percent.
   b. Operator shall power to OPEN and power to CLOSE.
   c. Local Indication and Control:
      1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
      2) Integral OPENED and CLOSED indication lights.
      3) Integral LOCAL-OFF-REMOTE (L-O-R).
      4) Integral OPEN maintained switch which causes the valve to stroke full OPENED, even if OPEN switch is released, while L-O-R switch is in LOCAL.
      5) Integral CLOSE maintained switch which causes valve to stroke full CLOSED, even if CLOSED switch is released, while L-O-R switch is in LOCAL.
   d. Remote Indication and Control:
      1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
      2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
      3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
   e. Local Indication and Control:
      1) Integral mechanical valve POSITION indication, 0 percent to 100 percent OPENED.
      2) Integral OPENED and CLOSED indication lights.
      3) Integral LOCAL-OFF-REMOTE (L-O-R).
      4) Integral OPEN momentary switch which causes valve to stroke towards OPENED, as long as OPEN switch is held, while L-O-R switch is in LOCAL.
      5) Integral CLOSE momentary switch which causes valve to stroke towards CLOSED, as long as CLOSED switch is held, while L-O-R switch is in LOCAL.
      6) Position valve proportionally 0 to 100 percent OPEN with external 4 mA to 20 mA dc signal while in REMOTE.

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f. Remote Indication and Control:
   1) Relay contact that closes when valve is capable of being controlled remotely (L-O-R switch in REMOTE) for connection to and monitoring by plant control system.
   2) Limit switch that closes when valve is fully OPENED for connection to and monitoring by plant control system.
   3) Limit switch that closes when valve is fully CLOSED for connection to and monitoring by plant control system.
   4) Current Position Transmitter, 4 mA dc to 20 mA dc signal in proportion to 0 percent to 100 percent OPENED, with 0.5 percent accuracy and 0.5 percent repeatability, capable of driving a 750-ohm load, for connection to and monitoring by Plant Control System.

5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule on the Drawings.
6. Manufacturer:
   a. EIM; HQ Series.
   b. Bray; Series 70.

C. Electric Motor Actuators, 480 Volts:

1. General:
   a. Comply with latest version of AWWA C542.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   c. Controls integral with actuator and fully equipped as specified in AWWA C542.
   d. Stem protection for rising stem valves.
2. Actuator Operation—General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule on the Drawings.
3. Open-Close(O/C)/Throttling(T) Service:
   a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
   b. Actuator suitable for throttling operation of valve at intermediate positions.

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c. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
   1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
   2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
   3) Auxiliary contact that closes in REMOTE position.
d. OPEN and CLOSED indicating lights.
e. Integral reversing motor starter with built-in overload protection.

4. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule on the Drawings.
6. Manufacturers:
   a. AUMA; Series SA.
   b. Rotork Controls; Series IQ3.
   c. Flowserve Limitorque; QX Series.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator, bearing valve tag number shown on the Valve Schedule on the Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

C. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.

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4. Manufacturers and Products:
    a. Clow Corp.; Figure F-5680.
    b. Walworth Co.; Figure 804.
    c. DeZurik Corp.; Series W or LWG.

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.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. 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.
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.
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).

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2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).

4. Butterfly Valves: 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 swing check valve with shaft in horizontal position.
   c. 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.

E. 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.

F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

G. 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 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.

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G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 FIELD FINISHING

A. Field finish in accordance with Section 09 90 00, Painting and Coating.

END OF SECTION

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SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. 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.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

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. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
3. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
4. Items that do not require testing include:
   a. Equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
5. Test Pressure: As indicated on Piping Schedule located on the Drawings.

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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.

3.02 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 60 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.

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.

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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.
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.

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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 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 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. 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.

D. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

F. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.05 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.

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6. Signed by Contractor 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 40 91 00, Instrumentation and Control Components.

B. Role Definitions:

1. PIC Systems Integrator: Responsible for physical installation and procurement of PIC system components.
2. Engineer: Responsible for design documentation and SCADA software development.

C. 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. Programmable controllers.
3. Computers and networks for Human Machine Interface (HMI).
4. Applications Software: Provided by Engineer for PLCs and HMIs. Work related to supporting this activity includes:
    a. Early delivery of programming equipment to Engineer’s office.
        1) Setup and demonstration testing of programming equipment at Engineer’s office.
    b. Delivery of PLCs, and HMI equipment to staging site provided by Contractor.
    c. Demonstration testing at staging site.
    d. Assistance with onsite checkout of applications software.
    e. For additional related requirements refer to:
        1) Article Sequencing and Scheduling in this section.
        2) Sections that cover the equipment for which Engineer will provide applications software.

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f. Staging Site: Engineer's office to be used for development and testing of applications software. Coordinate with engineer for exact location. See Section 01 50 00, Temporary Facilities and Controls, for additional staging site requirements.

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.
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.

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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. DCU: Distributed Control Unit.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. HVAC: Heating, Ventilating, and Air Conditioning.
5. I&C: Instrumentation and Control.
6. I/O: Input and Output.
7. O&M: Operation and Maintenance.
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RTU: Remote Terminal Unit.
13. SCADA: Supervisory Control and Data Acquisition.
14. SLDC: Single Loop Digital Controller.
15. SSDT: Staging Site Demonstration Test.

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.

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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. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

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, DCUs, SLDC, and fieldbus devices.

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1.04 SYSTEM DESCRIPTION

A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included in Contract Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.

B. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings, except for panel wiring diagrams, loop wiring diagrams, and interconnecting wiring diagrams that have been prepared by Engineer and included in Contract Drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
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.

C. 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.

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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) Chemical feed pump and feeder speed/stroke controls.
      3) Automatic samplers.
      4) Motor control centers.
      5) 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.

1.05 SUBMITTALS

A. 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. Electronic Copies: Required, unless otherwise noted for specific items.
      1) Manufacturers' Standard Documents: Adobe Acrobat PDF.

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2) Documents created specifically for Project:
a) Text and Graphics: Microsoft Word.
b) Lists: Microsoft Excel, unless otherwise noted for specific items.
c) Drawings: AutoCAD.

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.

B. 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: Hard copy and Microsoft Excel.
d. Provided by PIC Systems Integrator.
2. Catalog Cuts:
a. I&C components, electrical devices, and mechanical devices:
1) Catalog information, marked to identify proposed items and options.
2) Descriptive literature.
3) External power and signal connections.

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4) Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
5) Provided by PIC Systems Integrator.

3. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
   b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	**Initially Completed By**
Tag Number	Engineer
Loop Number	Engineer
Description	Engineer
Manufacturer and complete model number	Contractor
Size and scale range	Engineer
Setpoints	Engineer
Reference P&IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings	Engineer
Instrument detail number	Engineer

   c. Submit updated version of Instrument List.
   d. Electronic Copies: Microsoft Excel.
   e. Provided by PIC Systems Integrator.
4. 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:
      1) Specific features and configuration data for each component, including but not limited to:
         a) Tag Number.
         b) Component type identification code and description.
         c) Location or service.
         d) Service conditions.
         e) Manufacturer and complete model number.
         f) Size and scale range.

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g) Setpoints.
h) Materials of construction.
i) Options included.
j) Power requirements.
k) Signal interfaces.
l) Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

c. Electronic Copies: Microsoft Excel.
d. Provided by PIC Systems Integrator.

5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
   d. Provided by PIC Systems Integrator.
6. Preliminary Panel Elevation Drawings:
   a. Provide prior to submitting Panel Construction Drawings:
      1) Scale Drawings: Show dimensions and location of front of panel devices.
      2) Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
      3) Submit electronic copies of Drawings.
      4) Provided by PIC Systems Integrator.
7. 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.

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f. Submit electronic copies of Drawings.
g. Provided by PIC Systems Integrator.

8. Detailed Wiring Diagrams:
   a. Refer to Drawings for Detailed Wiring Diagrams including:
      1) Panel Wiring Diagrams for discrete control and power circuits.
      2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
      3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
   b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.
   c. Submit electronic copies of Drawings.
   d. Provided by PIC Systems Integrator.
9. 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. 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.

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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.
f. Ground wires, surge protectors, and connections.
g. Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
h. Provided by PIC Systems Integrator.

10. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
    a. Conform to the minimum requirements of ISA S5.4.
    b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraph 2 and Subparagraph 6.
    c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
    d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
       1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
       2) Identify the component by tag and description.
       3) Identify panel and component terminal numbers.
    e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
    f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
    g. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
    h. Show:
       1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
       2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

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3) Tabular summary on each analog loop diagram:
a) Transmitting Instruments: Output capability.
b) Receiving Instruments: Input impedance.
c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
d) Total loop impedance.
e) Reserve output capacity.
4) Circuit and raceway schedule names.

i. See Drawing N-0022 for example.
j. Provided by PIC Systems Integrator.

11. Communications and Digital Networks Diagrams:
a. Scope: Includes connections to Ethernet network.
b. Format: Network schematic diagrams for each different type of network.
c. Show:
1) Interconnected devices, both passive and active.
2) Device names and numbers.
3) Terminal numbers.
4) Communication Media: Type of cable.
5) Connection Type: Type of connector.
6) Node and device address numbers.
7) Wire and cable numbers and colors.
d. Provided by Engineer.
12. Panel Power Requirements and Heat Dissipation:
a. For control panels tabulate and summarize:
1) Required voltages, currents, and phases(s).
2) Maximum heat dissipations Btu per hour.
3) Calculations.
4) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 90 degrees F.
5) Provided by PIC Systems Integrator.
13. Installation Details: Include modifications or further details required and define installation of I&C components.
14. Spares, expendables, and test equipment.
15. Electronic Copies: Microsoft Excel.
16. 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.

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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.
   3) Provided by Engineer.

17. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
    a. Provided by Engineer.
18. Shop Drawings for Changes Impacting PLC and SLDC Programming:
    a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
    c. Provided by PIC Systems Integrator.
19. Color schedule for control panels.
    a. Provided by PIC Systems Integrator.
20. Applications Software Documentation:
    a. For equipment for which Engineer does not provide applications software provide:
       1) Complete configuration documentation for microprocessor based programmable devices.
       2) For each device, include program listings and function block diagrams, as appropriate, showing:
          a) Functional blocks or modules used.
          b) Configuration, calibration, and tuning parameters.
          c) Descriptive annotations.
       3) Refer to PIC subsections for additional requirements.
       4) Provided by Engineer.

C. 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:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
      1) General:
         a) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.

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b) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.

2) Final versions of Legend and Abbreviation Lists.

3) Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.

4) Provide the following items as defined under heading Action Submittals:
   a) Bill of materials.
   b) Catalog cuts.
   c) Instrument list.
   d) Component data sheets.
   e) Detailed Wiring Diagrams: As-built drawings.
      (1) Panel wiring diagrams.
      (2) Loop diagrams.
      (3) Interconnecting wiring diagrams.
   f) Panel plumbing diagrams.
   g) Applications software documentation.

5) Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
   a) Content for Each O&M Manual:
      (1) Table of Contents.
      (2) Operations procedures.
      (3) Installation requirements and procedures.
      (4) Maintenance requirements and procedures.
      (5) Troubleshooting procedures.
      (6) Calibration procedures.
      (7) Internal schematic and wiring diagrams.
      (8) Component and I/O Module Calibration Sheets from field quality control calibrations.
   b) Provide PDF file will linked index to all manuals.

6) List of spares, expendables, test equipment and tools provided.

7) 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.

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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. Staging Site Demonstration 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 when tests are completed.

c. 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.

d. 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.
6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.

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.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

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B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
   a. Timing: Following Engineer review of PIC Schedule.
   b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
3. Training Coordination Meeting:
   a. Timing: Following Engineer review of preliminary training plan.
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific Owner personnel to attend training.

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:

1. Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
   a. Shop Drawing Reviews by Engineer:
      1) Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
      2) Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
   b. Test Prerequisite: Associated test procedures Submittals completed.
   c. Training Prerequisite: Associated training plan Submittal completed.

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d. PLC and HMI Configuration Training Session 1 Prerequisite: PLC and HMI hardware and software Shop Drawings approved.
e. PLC and HMI Configuring Equipment Delivered to Engineer's office:
    1) Refer to PIC subsections for a definition of this equipment.
    2) Prerequisite: PLC and HMI Configuration Training Session 1 completed.
f. PLC and HMI Configuring Equipment Demonstration Test Prerequisite: PLC and HMI configuring equipment delivered and installed at Engineer's office.
g. PLC and HMI Applications Software Configuring by Engineer at Engineer's Office.
    1) Prerequisite: PLC and HMI configuring equipment demonstration test.
h. Equipment Delivered to Staging Site: Refer to PIC subsections for a definition of this equipment.
    1) Prerequisites:
        a) PLC and HMI applications software configuring by Engineer at Engineer's office completed.
        b) FDT completed.
i. Staging Site Demonstration Test Prerequisite: PLC and HMI staging equipment delivered to staging site.
j. PLC and HMI Applications Software Configuring and Testing by Engineer:
    1) Prerequisite: Staging site demonstration test completed.
k. PLC and HMI Shipment to Site:
    1) General Prerequisites:
        a) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
        b) FDT and SSDT completed.
    2) Additional prerequisite for equipment previously shipped to Engineer's office and staging site: Completion of PLC and HMI application software configuring and testing by Engineer at Staging Site.
l. PLC and HMI Installation Prerequisite: Equipment received at Site.
m. Functional Test Part 1 Prerequisite: PLC and HMI installation complete.
n. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
o. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

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1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 2 years unless otherwise noted in PIC subsections.
2. Start on date of Substantial Completion.
3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
4. PIC Systems Covered: PIC components, PLC, HMI, except for Engineer provided applications software.
5. Materials and labor for preventive maintenance and monthly Site visits.
6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m., 7 days a week.
7. Response Time: Service engineer shall be onsite within 24 hours of request by Owner.
8. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
9. Repair or replace components or software found to be faulty.
10. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
11. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
Annunciator light bulbs	20	10
Annunciator window module	10	5
dc power supplies	20	2
Fuses	20	5

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Description	Percent of Each Type and Size Used	No Less Than
Indicating light bulb	20	10
Relays	20	3
Terminal Blocks	10	10
Hand Switches and Lights	10	5
120V ac Isolation Transformers	10	2
Surge Suppressors	10	2

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.
2. Calibration/test gas for combustible gas detection.
3. Corrosion-inhibiting vapor capsules.
4. pH sensor overhaul kits: Two.
5. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on 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."
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

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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.

D. 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.

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 and on Data Sheets 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.

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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. Computer Room, Air Conditioned:
      1) Temperature: 60 degrees F to 80 degrees F.
      2) Relative Humidity: 40 percent to 60 percent.
      3) NEC Classification: Nonhazardous.
   b. Inside, Air Conditioned:
      1) Temperature:
         a) Normal: 60 degrees F to 80 degrees F.
         b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
      2) Relative Humidity:
         a) Normal: 10 percent (winter) to 70 percent (summer).
         b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   c. Inside:
      1) Temperature: 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   d. Inside, Corrosive:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   e. Outside:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, in Instrument List and 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.

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b. Smaller Panels and Assemblies (that are not freestanding):
   1) Inside, Air Conditioned: NEMA 12.
   2) All Other Locations: NEMA 4X.
c. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: As shown on the 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.

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 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.

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E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on the 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.

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. Hardwired Special Functions: Clarifies functional performance of loop, including abstract of interlocks for hard wired logic, for example in MCCs and control panels.
2. PLC Special Functions: Specifies nonstandard PLC functions. When required for clarification, additional definition is shown by logic diagrams or sequence diagrams on the Drawings.
3. HMI Special Functions: Specifies nonstandard HMI functions.

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2.10 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

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 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures 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 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: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than 18 AWG.
4. Special Signal Circuits: Use manufacturer’s standard cables.
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.

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 05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.

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c. One wire per terminal for field wires entering enclosures.
d. Maximum of two wires per terminal for 18 AWG wire for internal enclosure wiring.
e. Spare Terminals: 20 percent of connected terminals, but not less than 10 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:
      1) PLC Panel.
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.

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 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.

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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. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details on the Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
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: As shown on the Drawings.
2. Instrument Arrangements: As shown on the Drawings.
3. Panel Component Schedule: Refer to Control Panel Schedule in Article Supplements which provides a list by local control panel of major panel-mounted components for each panel. In case of a conflict between this list and Instrument List, Instrument List takes precedence. In case of a conflict between Panel Component Schedule and P&IDs, P&IDs take precedence.
4. 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.
5. 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.

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6. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
7. 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 shown on the Drawings.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.

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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, Southco Type 44.
   c. Handle: “D” ring, foldable 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, air conditioned:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type 316 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:
   a. Hoffman Engineering Co.
   b. H. F. Cox.

E. Breather and Drains:

1. Furnish with NEMA 250, Type 4 and 4X panels:
   a. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

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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.
      4) Provide redundant power supplies with redundancy module.
      5) Provide UPS internal to panel.
         a) Size UPS to meet required loads.
         b) Match site standard.
   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: Refer to Division 26.
   c. Circuit Wiring:
      1) P&IDs and Control Diagrams on Drawings show detailed wiring diagrams that use the following rules for 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 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 mA dc 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) 4 mA to 20 mA 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 100-watt incandescent back-of-panel 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 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI GFCI duplex receptacle:
   c. 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:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black

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Tag Function	Inscription(s)	Color
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

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

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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.
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. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
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 pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.

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14. 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.
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.

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:
    a. Sand panel and remove mill scale, rust, grease, and oil.
    b. Fill imperfections and sand smooth.
    c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
    d. Sand surfaces lightly between coats.
    e. Dry Film Thickness: 3 mils, minimum.
    f. Color: Manufacturer’s standard.

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2.12 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.

2.13 EQUIPMENT GROUPS

A. PLC Equipment Group 1 for Engineer's Office.

B. PLC Equipment Group 2 for Engineer's Office.

2.14 TEST EQUIPMENT AND TOOLS

A. Digital Multimeter:

1. Type: Industrial True RMS Digital Multimeter, CAT IV 600V protection with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
2. Quantity: Two.
3. Manufacturers and Products:
   a. Fluke; Model 87V/E Industrial Electrician Combo Kit.
   b. Greenlee; Model DM-860.
   c. Extech; Model EX530.

B. Clamp-on Ammeter:

1. Type: True RMS Digital Clamp-on meter with 3-1/2-digit display and protective case.
2. Quantity: One.
3. Manufacturers and Products:
   a. TES; Model 3040.
   b. Fluke; Model 337E.
   c. Greenlee; Model CMI-100.
   d. Extech; Model EX830.

C. DC Digital Process Signal Calibrator:

1. Type: Portable, two-channel, with test leads, rechargeable batteries, charger, and carrying case.
2. Quantity: Two.

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3. Manufacturers and Products:
    a. Transmation; Model 1045-01.
    b. Fluke; Model 789.
    c. Extech; Model CMM17.

D. Datalogger:

1. Type: Portable Handheld Multichannel Datalogger, USB communications, Graphical Display, with Analysis Software.
2. Quantity: One.
3. Manufacturers and Products:
    a. Graphtec; Model GL200A.
    b. Omega; Model OM-DAQPRO-5300.

E. Pressure and Electrical Calibrator:

1. Type: Test leads, rechargeable batteries, ac charger, pressure transducer modules, and protective case.
2. Pressure Ranges: Specify pressure ranges.
3. Quantity: One.
4. Manufacturers and Products:
    a. Transmation; Model 1091PLUS-LP.
    b. Fluke; Model 717/718.
    c. Heise; Model PTE-1.

F. Pressure Pump Kit:

1. Type: Hand pump (0 pounds per square inch gauge to 600 pounds per square inch gauge), calibration labels, tubing, fittings, and carrying case.
2. Quantity: One.
3. Manufacturers and Products;
    a. Transmation; Pump Kit 22980P-300.
    b. Fluke; Model 700PTP-1.
    c. Heise; Model TP1-40.

G. Small Tool Kit:

1. Type: Kit of instrument maintenance tools in soft, zipper case.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model JTK-47GC Field Engineer’s Kit.

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H. Large Tool Kit:

1. Type: Kit of instrument maintenance tools in high-density polyethylene case.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model JTK-17LST.

I. Screw Starters:

1. Type: Kits of slotted screw starters with magnetic retrievers.
2. Quantity: One.
3. Manufacturer and Products: Jensen Tools; Model 23B021 and Model 23B023.

J. Terminal Kit:

1. Type: Kit of solderless terminals and cable ties.
2. Quantity: One.
3. Manufacturer and Product: Jensen Tools; Model 23B210.

2.15 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.
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.

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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.
f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
   a. Interconnect and test PIC, except for primary elements and smaller panels.
   b. Exercise and test functions.
   c. Provide stand-alone testing of smaller panels.
   d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope:
   a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
   b. 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 and between PLCs and computers.
6. Operation of communications between the PLC system, single loop controllers (SLC).
7. Loop-Specific Functions: Demonstrate functions shown on P&IDs, control diagrams, and loop specifications:
   a. One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.

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b. One of each type of function in each panel; for example, but not limited to annunciator operation, controller operation, and recorder operation.
c. All required and shown functions for 100 percent of loops.

8. Nonloop-Specific Functions:
   a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
   b. Timing: Include tests for timing requirements.
   c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. 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.
11. 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.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
12. 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.

D. Staging Site Demonstration Test (SSDT):

1. Scope: Demonstrate that the specified PIC equipment and standard software has been properly installed at staging site and is ready for applications software development by Engineer.
2. Refer to PIC subsections for additional details.

2.16 MAINTENANCE OF PROGRAMMING EQUIPMENT

A. Provide for maintenance of programming equipment while at Engineer's office. Repair or replace failed equipment within 2 days of notice by Engineer.

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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 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

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.
   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.

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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.

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.

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C. Leak Tests: During preparation for testing, 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 will be spot checked by Engineer.
        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.
        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.

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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 and recorders, scale and chart ranges.
(2) Transmitters/converters, input and output ranges.
(3) Computing elements' function.
(4) Controllers, action (direct/reverse) and control modes (P, I, D).
(5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
(6) I/O Modules: Input or output.
h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(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.

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d. FDT-Repeat:
   1) Repeat FDT onsite with installed PIC equipment and software.
   2) As listed in PIC subsections, certain portions of FDT may not require retesting.
   3) Use FDT test procedures as basis for this test.
   4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.
e. 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. Repeat of Engineer's SSDT application software tests, except 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 SSDT application software tests.
   d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
4. Functional Test:
   a. Scope: Confirm PIC, including applications software, is ready for operation.
   b. Refer to PIC subsections for additional requirements.
   c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
5. 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 a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.

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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 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. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.
9. 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:

1. 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:
   a. Centrifuges.
   b. Polymer Systems.

C. See Section 01 43 33, Manufacturers' Field Services.

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 videotapes of training sessions.

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B. Management Seminar:

1. Length: 2 days.
2. Location: Owner’s facility.
3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
5. Primary Topics:
    a. PIC Overview: How hardware and software are used for operation and control of facilities.
    b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
    c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
    d. Management-oriented explanation of data management displays and printouts.
    e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
    a. Refer to specific requirements specified in PIC Subsections.
    b. Include review of O&M data and survey of spares, expendables, and test equipment.
    c. Use equipment similar to that provided.
    d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner’s operations personnel on operation of I&C components.
    a. Training Session Duration: 5 instructor days.
    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.

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2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
3) Interfaces with PIC subsystems.

3. Maintenance Training:
   a. Training Session Duration: 5 instructor days.
   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) Replacing lamps, chart paper, and fuses.
      6) I&C components removal and replacement.
      7) 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.

3.08 SUPPLEMENTS

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

1. Loop Specifications.
2. Instrument List.
3. Data Sheets.
4. RIO Equipment List.
5. PCL-10A Equipment List.

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6. PLC Input/Output List.
7. Control Panel Schedule.
8. 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.
9. 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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EXAMPLE LOOP SPECIFICATION

4.01 LOOP 14-5: AERATION BLOWERS FLOW CONTROLS

A. Hardwired Functions:

1. Monitor and control existing blower and provide the following:
   a. Compute square root of each flow signal at FP-14-5.
   b. Compute sum of square root signals at FP-14-5.
   c. Indicate total flow at FP-14-5.
   d. Send inlet vane position to FP-14(3).
   e. Send blower airflow analog signals to PLC-14.
   f. Receive blower airflow setpoint signals from PLC-14.
   g. Provide P&ID flow control of blowers based on local setpoint at FP-14-5 or remote setpoint from PLC-14.

B. PLC Special Functions: Manual/Auto control modes for blowers M-14-5(3). Allow these control modes to be selected for blowers at the same time.

1. Manual: Manual adjustment of blower airflow setpoint.
   a. Setpoint Range: 0 to 200 kcfm.
   b. Initial Setting: 10 kcfm.
2. Auto: DO Control.
   a. Ratio control for plant influent flow FIT-02-3.
      1) Adjustable Ratio Range: 0 to 2 kcfm/mgd.
      2) Initial Setting: 0.5 kcfm/mgd.
   b. P&ID control for aeration tank DO.
      1) DO Setpoint Range: 0 to 12 mg/L.
      2) Initial Setting: 2 mg/L.
   c. DO selectable from any of one of the six tanks, AIT-04(6) or average from six tanks, one per tank.
   d. Compute Aeration Tank airflow demand as product of ration control output and PIC control output when P&ID control is enabled.
3. Log alarms for following conditions:
   a. ZT-14-2(3) is more than 98 percent for more than 5 seconds.
   b. Too Few Blowers On: Two blowers are on and inlet guide vane position ZT-14-2(3) is less than 22 percent for more than 5 seconds.

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Instrument List Summary

Item	Loop No	Tag No	Function	Accessory Tag 1	Accessory Tag 2	Loop Title	Comp Code	Instrument Name	P+ID No	Design Detail	Panel
1	8912A	LT8912A	Level			Dump Truck Loading 1 Level	L29	Level Transmitter, Radar	N-0005	4091-262	PLC-10
2	8912B	LT8912B	Level			Dump Truck Loading 2 Level	L29	Level Transmitter, Radar	N-0005	4091-262	PLC-10
3	891C	LT8912A	Level			Dump Truck Loading 3 Level	L29	Level Transmitter, Radar	N-0005	4091-262	PLC-10
4	8912D	LT8912B	Level			Dump Truck Loading 4 Level	L29	Level Transmitter, Radar	N-0005	4091-262	PLC-10
5	7611	PISH7611	Pressure	PE7611		Thickening Polymer Recirculation Pump	P04	Pressure Gauge with Switch	N-0006	4091-302	PLC-10A
6	7621	PI7621	Pressure	PE7621		Thickening Polymer Recirculation Pump Suction Pressure	P04	Pressure Gauge	N-0006	4091-302	
7	7631	LIT7631	Level	LE7631		Thickening Polymer Tank Level	L10	Level Transmitter, Pressure	N-0006	4091-255	PLC-10A
8	7661	PISH7661	Pressure	PE7661		Dewatering Polymer Recirculation Pump 1	P04	Pressure Gauge with Switch	N-0009	4091-302	PLC-10A
9	7671	PI7671	Pressure	PE7671		Dewatering Polymer Recirculation Pump 1 Suction Pressure	P04	Pressure Gauge	N-0009	4091-302	
10	7532	LIT7532	Level			Dewatering Polymer Tank 1 Level	L29	Level Transmitter, Radar	N-0009	4091-264	PLC-10A
11	7536	LIT7536	Level			Dewatering Polymer Tank 2 Level	L29	Level Transmitter, Radar	N-0009	4091-264	PLC-10A
12	7662	PISH7662	Pressure	PE7662		Dewatering Polymer Recirculation Pump 2	P04	Pressure Gauge with Switch	N-0010	4091-302	PLC-10A
13	7672	PI7672	Pressure	PE7672		Dewatering Polymer Recirculation Pump 2 Suction Pressure	P04	Pressure Gauge	N-0010	4091-302	
14	7542	LIT7542	Level			Dewatering Polymer Tank 3 Level	L29	Level Transmitter, Radar	N-0010	4091-264	PLC-10A
15	7546	LIT7546	Level			Dewatering Polymer Tank 4 Level	L29	Level Transmitter, Radar	N-0010	4091-264	PLC-10A
16	7662	PISH7663	Pressure	PE7663		Dewatering Polymer Recirculation Pump 3	P04	Pressure Gauge	N-0008	4091-302	PLC-10A
17	7672	PI7673	Pressure	PE7673		Dewatering Polymer Recirculation Pump 3 Suction Pressure	P04	Pressure Gauge	N-0008	4091-302	
18	7685	LIT7685	Level	LE7685		Dewatering Polymer Tank 5 Level	L10	Level Transmitter, Pressure	N-0008	4091-256	PLC-10A
19	7631	HS7631	Silence			Thickening Polymer Tank Level	M27	Pushbutton	N-0006	Panel: LCP-7631	PLC-10A
20	7685	HS7685	Silence			Dewatering Polymer Tank 5 Level	M27	Pushbutton	N-0008	Panel: LCP-7685	PLC-10A
21	7530	HS7530	Silence			Dewatering Polymer Tank 1 and 2 Level	M27	Pushbutton	N-0009	Panel: LCP-7530	PLC-10A
22	7540	HS7540	Silence			Dewatering Polymer Tank 3 and 4 Level	M27	Pushbutton	N-0010	Panel: LCP-7540	PLC-10A
23	8912	HS8912	Silence			Dump Truck Loading Level	M27	Pushbutton	N-0005	Panel: LCP-7812	PLC-10
24	7631	LAL7631	Low			Thickening Polymer Tank Level	M31	Warning Light, Indoor/Outdoor	N-0006	Panel: LCP-7631	PLC-10A
25	7631	LAH7631	High			Thickening Polymer Tank Level	M31	Warning Light, Indoor/Outdoor	N-0006	Panel: LCP-7631	PLC-10A
26	7685	LAL7685	Low			Dewatering Polymer Tank 5 Level	M27	Warning Light, Indoor/Outdoor	N-0008	Panel: LCP-7685	PLC-10A
27	7685	LAH7685	High			Dewatering Polymer Tank 5 Level	M27	Warning Light, Indoor/Outdoor	N-0008	Panel: LCP-7685	PLC-10A
28	7532	LAL7532	Low			Dewatering Polymer Tank 1 Level	M27	Warning Light, Indoor/Outdoor	N-0009	Panel: LCP-7530	PLC-10A
29	7532	LAH7532	High			Dewatering Polymer Tank 1 Level	M27	Warning Light, Indoor/Outdoor	N-0009	Panel: LCP-7530	PLC-10A
30	7536	LAL7536	Low			Dewatering Polymer Tank 2 Level	M27	Warning Light, Indoor/Outdoor	N-0009	Panel: LCP-7530	PLC-10A
31	7536	LAH7536	High			Dewatering Polymer Tank 2 Level	M27	Warning Light, Indoor/Outdoor	N-0009	Panel: LCP-7530	PLC-10A
32	7542	LAL7542	Low			Dewatering Polymer Tank 3 Level	M27	Warning Light, Indoor/Outdoor	N-0010	Panel: LCP-7540	PLC-10A
33	7542	LAH7542	High			Dewatering Polymer Tank 3 Level	M27	Warning Light, Indoor/Outdoor	N-0010	Panel: LCP-7540	PLC-10A
34	7546	LAL7546	Low			Dewatering Polymer Tank 4 Level	M27	Warning Light, Indoor/Outdoor	N-0010	Panel: LCP-7540	PLC-10A
35	7546	LAH7546	High			Dewatering Polymer Tank 4 Level	M27	Warning Light, Indoor/Outdoor	N-0010	Panel: LCP-7540	PLC-10A
36	7631	YL7631	Strobe/Horn			Thickening Polymer Tank Level	M32	Strobe/Horn	N-0006	Panel: LCP-7631	PLC-10A
37	7685	YL7685	Strobe/Horn			Dewatering Polymer Tank 5 Level	M32	Strobe/Horn	N-0008	Panel: LCP-7685	PLC-10A
38	7530	YL7530	Strobe/Horn			Dewatering Polymer Tank 1 and 2 Level	M32	Strobe/Horn	N-0009	Panel: LCP-7530	PLC-10A
39	7540	YL7540	Strobe/Horn			Dewatering Polymer Tank 3 and 4 Level	M32	Strobe/Horn	N-0010	Panel: LCP-7540	PLC-10A
40	8912	YL8912	Horn			Dump Truck Loading Level	M32	Strobe/Horn	N-0005		PLC-10
41	7631	LI7631	Level			Thickening Polymer Tank Level	S12	Indicator, Field Mount	N-0006	Panel: LCP-7631	PLC-10A
42	7685	LI7685	Level			Dewatering Polymer Tank 1 Level	S12	Indicator, Field Mount	N-0009	Panel: LCP-7685	PLC-10A
43	7532	LI7532	Level			Dewatering Polymer Tank 2 Level	S12	Indicator, Field Mount	N-0009	Panel: LCP-7530	PLC-10A
44	7536	LI7536	Level			Dewatering Polymer Tank 3 Level	S12	Indicator, Field Mount	N-0010	Panel: LCP-7530	PLC-10A
45	7542	LI7542	Level			Dewatering Polymer Tank 4 Level	S12	Indicator, Field Mount	N-0010	Panel: LCP-7540	PLC-10A
46	7546	LI7546	Level			Dewatering Polymer Tank 5 Level	S12	Indicator, Field Mount	N-0010	Panel: LCP-7540	PLC-10A

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GENERAL	1	Tag Number	P&ID	LIT7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-255	
	5	Equipment Number		TNK-7631	
PROCESS CONDITIONS	6	Fluid		THICKENING POLYMER	
	7	Min. Pressure	Max Pressure	0 PSI	XX PSI
	8	Temperature		Ambient	
	9				
ELEMENT	10	Element Type		Hydrostatic, Piezoresistive	
	11				
	12	Body Rating		NEMA 4X	
	13	Instrument Body Material		Coated Aluminum	
	14	Process Connection		NPS 2" Cl.150 RF, 316/316L, flange ASME B16.5	
	15	Process Connection Material		316 / 316L Stainless Steel	
	16	Measurable Limits			
	17	Ambient Temperature Limits		-4 degF to 158 degF	
	18	Process Temperature Limits		14 degF to 212 degF	
	19				
	20				
DIAPHRAGM SEAL	21	Type		Integral with Element	
	22				
	23				
	24	Diaphragm/Sleeve Material		316L TempC Diaphragm	
	25	Fill Fluid		Silicone Oil, FDA	
	26				
	27				
	28				
	29				
TRANSMITTER	30	Mounting		Local mount with Display	
	31	Enclosure NEMA Rating		NEMA 6P	
	32	Power Supply	Voltage	2 - Wire	Loop Powered 24VDC
	33	Output Signal	Communication Protocol	4 to 20 madc	HART
	34	Instrument Mount		Integral	
	35	Housing Material		Aluminum	
	36				
	37	Electrical Connection		0.5 Inch NPT	
CALIBRATION	38	Calibrated Range		0-XX PSI	
	39	Scaled Output Range		0-XX FT	
	40	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	41	Accuracy	Repeatability	±0.1% of span	
	42				
	43				
OPTIONS	44	Tagging		Affix stainless steel tag with Tag Number	
	45	Approval		CSA C/US General Purpose	
	46				
	47				
	48				
	49	Bluetooth Connection Capability		Include	
PURCHASE	50	Manufacturer/Model		Endress & Hauser, PMP71B	
	51	Part Number		PMP71B-CABAFJH6BD3KEAAADJG2+AAZ1	
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L10 **Level Transmitter, Pressure**	**D3838501 - GRESHAM WWTP BELT PRESS REPLACEMENT**
	LIT7631

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GENERAL	1	Tag Number	P&ID	LIT7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-255	
	5	Equipment Number		TNK-7685	
PROCESS CONDITIONS	6	Fluid		DEWATERING POLYMER	
	7	Min. Pressure	Max Pressure	0 PSI	XX PSI
	8	Temperature		Ambient	
	9				
ELEMENT	10	Element Type		Hydrostatic, Piezoresistive	
	11				
	12	Body Rating		NEMA 4X	
	13	Instrument Body Material		Coated Aluminum	
	14	Process Connection		NPS 2" Cl.150 RF, 316/316L, flange ASME B16.5	
	15	Process Connection Material		316 / 316L Stainless Steel	
	16	Measurable Limits			
	17	Ambient Temperature Limits		-4 degF to 158 degF	
	18	Process Temperature Limits		14 degF to 212 degF	
	19				
	20				
DIAPHRAGM SEAL	21	Type		Integral with Element	
	22				
	23				
	24	Diaphragm/Sleeve Material		316L TempC Diaphragm	
	25	Fill Fluid		Silicone Oil, FDA	
	26				
	27				
	28				
	29				
TRANSMITTER	30	Mounting		Local mount with Display	
	31	Enclosure NEMA Rating		NEMA 6P	
	32	Power Supply	Voltage	2 - Wire	Loop Powered 24VDC
	33	Output Signal	Communication Protocol	4 to 20 madc	HART
	34	Instrument Mount		Integral	
	35	Housing Material		Aluminum	
	36				
	37	Electrical Connection		0.5 Inch NPT	
CALIBRATION	38	Calibrated Range		0-XX PSI	
	39	Scaled Output Range		0-XX FT	
	40	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	41	Accuracy	Repeatability	±0.1% of span	
	42				
	43				
OPTIONS	44	Tagging		Affix stainless steel tag with Tag Number	
	45	Approval		CSA C/US General Purpose	
	46				
	47				
	48				
	49	Bluetooth Connection Capability		Include	
PURCHASE	50	Manufacturer/Model		Endress & Hauser, PMP71B	
	51	Part Number		PMP71B-CABAFJH6BD3KEAAADJG2+AAZ1	
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L10 **Level Transmitter, Pressure**	**D3838501 - GRESHAM WWTP BELT PRESS REPLACEMENT**
	LIT7685

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GENERAL	1	Tag Number	P&ID	LT8912A	N-0005_D3838501
	2	Loop Title		TRUCK LOADING LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-262	
	5				
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatered Solids	
	9	Pressure		Atmospheric	
	10	Temperature		Ambient	
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Integral	
	16	Element Length		3 Inch Horn	
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		316 Stainless Steel	
	19	Process Connection		1 Inch MNPT	
	20	Range		10 Meters	
	21	Beam Angle		XX Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral Transmitter with Remote Indiator	
	25	Enclosure NEMA Rating		NEMA 4X	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Include	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31	Transmitter/Indicator Cable Length		32 Foot Cable	
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Truck	
	36	Vendor Calibration		Not Required	
	37	Accuracy			
	38	Resolution			
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42	Remote Indicator Weather Protection		Include	
	43	Proprietary Mounting Bracket		None	
	44	Remote Indicator		Include	
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR20	
	47	Instrument Part Number		FMR20-CAPCNVCEXR03+R4Z1	
	48	Cantilever		None	
	49	Wall Bracket		None	
	50	RIA15 - Weather Cover		RK01-BB	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LT8912A

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GENERAL	1	Tag Number	P&ID	LT8912B	N-0005_D3838501
	2	Loop Title		TRUCK LOADING LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-262	
	5				
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatered Solids	
	9	Pressure		Atmospheric	
	10	Temperature		Ambient	
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Integral	
	16	Element Length		3 Inch Horn	
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		316 Stainless Steel	
	19	Process Connection		1 Inch MNPT	
	20	Range		10 Meters	
	21	Beam Angle		XX Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral Transmitter with Remote Indiator	
	25	Enclosure NEMA Rating		NEMA 4X	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Include	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31	Transmitter/Indicator Cable Length		32 Foot Cable	
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Truck	
	36	Vendor Calibration		Not Required	
	37	Accuracy			
	38	Resolution			
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42	Remote Indicator Weather Protection		Include	
	43	Proprietary Mounting Bracket		None	
	44	Remote Indicator		Include	
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR20	
	47	Instrument Part Number		FMR20-CAPCNVCEXR03+R4Z1	
	48	Cantilever		None	
	49	Wall Bracket		None	
	50	RIA15 - Weather Cover		RK01-BB	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LT8912A

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GENERAL	1	Tag Number	P&ID	LT8912C	N-0005_D3838501
	2	Loop Title		TRUCK LOADING LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-262	
	5				
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatered Solids	
	9	Pressure		Atmospheric	
	10	Temperature		Ambient	
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Integral	
	16	Element Length		3 Inch Horn	
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		316 Stainless Steel	
	19	Process Connection		1 Inch MNPT	
	20	Range		10 Meters	
	21	Beam Angle		XX Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral Transmitter with Remote Indiator	
	25	Enclosure NEMA Rating		NEMA 4X	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Include	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31	Transmitter/Indicator Cable Length		32 Foot Cable	
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Truck	
	36	Vendor Calibration		Not Required	
	37	Accuracy			
	38	Resolution			
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42	Remote Indicator Weather Protection		Include	
	43	Proprietary Mounting Bracket		None	
	44	Remote Indicator		Include	
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR20	
	47	Instrument Part Number		FMR20-CAPCNVCEXR03+R4Z1	
	48	Cantilever		None	
	49	Wall Bracket		None	
	50	RIA15 - Weather Cover		RK01-BB	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LT8912A

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GENERAL	1	Tag Number	P&ID	LT8912D	N-0005_D3838501
	2	Loop Title		TRUCK LOADING LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-262	
	5				
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatered Solids	
	9	Pressure		Atmospheric	
	10	Temperature		Ambient	
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Integral	
	16	Element Length		3 Inch Horn	
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		316 Stainless Steel	
	19	Process Connection		1 Inch MNPT	
	20	Range		10 Meters	
	21	Beam Angle		XX Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral Transmitter with Remote Indiator	
	25	Enclosure NEMA Rating		NEMA 4X	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Include	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31	Transmitter/Indicator Cable Length		32 Foot Cable	
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Truck	
	36	Vendor Calibration		Not Required	
	37	Accuracy			
	38	Resolution			
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42	Remote Indicator Weather Protection		Include	
	43	Proprietary Mounting Bracket		None	
	44	Remote Indicator		Include	
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR20	
	47	Instrument Part Number		FMR20-CAPCNVCEXR03+R4Z1	
	48	Cantilever		None	
	49	Wall Bracket		None	
	50	RIA15 - Weather Cover		RK01-BB	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LT8912A

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GENERAL	1	Tag Number	P&ID	LIT7532	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-264	
	5	Equipment Number		TNK-7532	
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatering Polymer	
	9	Pressure			
	10	Temperature			
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Drip-Off Antenna	
	16	Element Length			
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		PTFE	
	19	Process Connection		Thread ANSI MNPT1-1/2	
	20	Range		65 Feet	
	21	Beam Angle		23 Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral	
	25	Enclosure NEMA Rating		NEMA 4X / IP65	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Integral	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31				
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Tank	
	36	Vendor Calibration		Not Required	
	37	Accuracy		+/- 0.1 Pct of Range	
	38	Resolution		0.04 inch	
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42				
	43				
	44				
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR60	
	47	Instrument Part Number		FMR60-CAACCDGAA4RGJ+AANFZ1	
	48				
	49				
	50				
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP BELT PRESS REPLACEMENT**
	LIT7532

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GENERAL	1	Tag Number	P&ID	LIT7536	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 2 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-264	
	5	Equipment Number		TNK-7536	
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatering Polymer	
	9	Pressure			
	10	Temperature			
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Drip-Off Antenna	
	16	Element Length			
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		PTFE	
	19	Process Connection		Thread ANSI MNPT1-1/2	
	20	Range		65 Feet	
	21	Beam Angle		23 Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral	
	25	Enclosure NEMA Rating		NEMA 4X / IP65	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Integral	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31				
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Tank	
	36	Vendor Calibration		Not Required	
	37	Accuracy		+/- 0.1 Pct of Range	
	38	Resolution		0.04 inch	
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42				
	43				
	44				
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR60	
	47	Instrument Part Number		FMR60-CAACCDGAA4RGJ+AANFZ1	
	48				
	49				
	50				
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LIT7536

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GENERAL	1	Tag Number	P&ID	LIT7542	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-264	
	5	Equipment Number		TNK-7542	
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatering Polymer	
	9	Pressure			
	10	Temperature			
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Drip-Off Antenna	
	16	Element Length			
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		PTFE	
	19	Process Connection		Thread ANSI MNPT1-1/2	
	20	Range		65 Feet	
	21	Beam Angle		23 Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral	
	25	Enclosure NEMA Rating		NEMA 4X / IP65	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Integral	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31				
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Tank	
	36	Vendor Calibration		Not Required	
	37	Accuracy		+/- 0.1 Pct of Range	
	38	Resolution		0.04 inch	
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42				
	43				
	44				
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR60	
	47	Instrument Part Number		FMR60-CAACCDGAA4RGJ+AANFZ1	
	48				
	49				
	50				
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP BELT PRESS REPLACEMENT**
	LIT7542

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GENERAL	1	Tag Number	P&ID	LIT7546	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 4 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		4091-264	
	5	Equipment Number		TNK-7546	
	6				
	7				
PROCESS CONDITIONS	8	Solid		Dewatering Polymer	
	9	Pressure			
	10	Temperature			
	11				
ELEMENT	12	Antenna Enclosure		NEMA 6P, Floodable	
	13	Ambient Temperature Limits		-40 degF to 176 degF	
	14	Process Temperature Limits		-40 degF to 176 degF	
	15	Element Type		Drip-Off Antenna	
	16	Element Length			
	17	Supporting Pipe (If Any)			
	18	Wetted Materials		PTFE	
	19	Process Connection		Thread ANSI MNPT1-1/2	
	20	Range		65 Feet	
	21	Beam Angle		23 Degrees	
	22				
	23				
TRANSMITTER	24	Mounting		Integral	
	25	Enclosure NEMA Rating		NEMA 4X / IP65	
	26	Output Signal		4 to 20 mA	
	27	Communication Protocol		HART	
	28	Display		Integral	
	29	Bluetooth Connection Capability		Include	
	30	Power Supply	Voltage	2 - Wire	24 VDC
	31				
	32				
	33				
CALIBRATION	34	Calibrated Range		0-XX.0 Ft	
	35	Zero Reference		Bottom of Tank	
	36	Vendor Calibration		Not Required	
	37	Accuracy		+/- 0.1 Pct of Range	
	38	Resolution		0.04 inch	
	39				
OPTIONS	40	Tagging		Stainless Steel Tag with Tag Number	
	41	Transmitter Sun Shield		Include	
	42				
	43				
	44				
	45				
PURCHASE	46	Manufacturer/Model		Endress & Hauser, FMR60	
	47	Instrument Part Number		FMR60-CAACCDGAA4RGJ+AANFZ1	
	48				
	49				
	50				
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

L29 **Level Transmitter, Radar**	**D3838501 - GRESHAM WWTP BELT PRESS REPLACEMENT**
	LIT7546

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GENERAL	1	Tag Number	P&ID	HS7530	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 & 2 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
SWITCH	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Power Supply		2 - Wire	
	9	Voltage		120VAC	
	10	Contact Duration		Momentary	
	11	Contact Block		1 N.O.	
	12	Enclosure NEMA Rating		NEMA 4X	
	13	Enclosure Material		Plastic	
	14	Sound		None	
	15	Illumination		None	
	16	Button Diameter		30.5 mm	
	17	Guards		None	
	18	Button Type		Flush Head	
	19	Color Cap		Black	
	20	Operating Temperature Range		-40 degF to 104 degF	
	21				
	22				
	23				
	24				
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	26				
	27				
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	29				
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	41				
	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-AR2D1	
	51				
	52	Purchase Note			
	53				

M27 **Pushbutton**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	HS7530

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GENERAL	1	Tag Number	P&ID	HS7540	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 & 4 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
SWITCH	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Power Supply		2 - Wire	
	9	Voltage		120VAC	
	10	Contact Duration		Momentary	
	11	Contact Block		1 N.O.	
	12	Enclosure NEMA Rating		NEMA 4X	
	13	Enclosure Material		Plastic	
	14	Sound		None	
	15	Illumination		None	
	16	Button Diameter		30.5 mm	
	17	Guards		None	
	18	Button Type		Flush Head	
	19	Color Cap		Black	
	20	Operating Temperature Range		-40 degF to 104 degF	
	21				
	22				
	23				
	24				
	25				
	26				
	27				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-AR2D1	
	51				
	52	Purchase Note			
	53				

M27 **Pushbutton**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	HS7540

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GENERAL	1	Tag Number	P&ID	HS7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER TANK LEVEL	
	3	Design Detail		Panel Layout for LCP7631	
	4	Area Classification		Non-Hazardous	
	5				
SWITCH	6	Mounting		Panel Mount	
	7	Panel		LCP7631	
	8	Power Supply		2 - Wire	
	9	Voltage		120VAC	
	10	Contact Duration		Momentary	
	11	Contact Block		1 N.O.	
	12	Enclosure NEMA Rating		NEMA 4X	
	13	Enclosure Material		Plastic	
	14	Sound		None	
	15	Illumination		None	
	16	Button Diameter		30.5 mm	
	17	Guards		None	
	18	Button Type		Flush Head	
	19	Color Cap		Black	
	20	Operating Temperature Range		-40 degF to 104 degF	
	21				
	22				
	23				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-AR2D1	
	51				
	52	Purchase Note			
	53				

M27 **Pushbutton**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	HS7631

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GENERAL	1	Tag Number	P&ID	HS7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Design Detail		Panel Layout for LCP7685	
	4	Area Classification		Non-Hazardous	
	5				
SWITCH	6	Mounting		Panel Mount	
	7	Panel		LCP7685	
	8	Power Supply		2 - Wire	
	9	Voltage		120VAC	
	10	Contact Duration		Momentary	
	11	Contact Block		1 N.O.	
	12	Enclosure NEMA Rating		NEMA 4X	
	13	Enclosure Material		Plastic	
	14	Sound		None	
	15	Illumination		None	
	16	Button Diameter		30.5 mm	
	17	Guards		None	
	18	Button Type		Flush Head	
	19	Color Cap		Black	
	20	Operating Temperature Range		-40 degF to 104 degF	
	21				
	22				
	23				
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	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-AR2D1	
	51				
	52	Purchase Note			
	53				

M27 **Pushbutton**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	HS7685

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GENERAL	1	Tag Number	P&ID	HS7812	N-0005_D3838501
	2	Loop Title		DUMP TRUCK LOADING LEVEL	
	3	Design Detail		Panel Layout for LCP7812	
	4	Area Classification		Non-Hazardous	
	5				
SWITCH	6	Mounting		Panel Mount	
	7	Panel		LCP7812	
	8	Power Supply		2 - Wire	
	9	Voltage		24VDC	
	10	Contact Duration		Push	
	11	Contact Block		1 N.O. - 1 N.C.	
	12	Enclosure NEMA Rating		NEMA 4X	
	13	Enclosure Material		Plastic	
	14	Sound		None	
	15	Illumination		None	
	16	Button Diameter		30.5 mm	
	17	Guards		None	
	18	Button Type		Jumbo Head	
	19	Color Cap		Black	
	20	Operating Temperature Range		-40 degF to 104 degF	
	21				
	22				
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	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-FRXT2A	
	51				
	52	Purchase Note			
	53				

M27 **Pushbutton**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	HS7812

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GENERAL	1	Tag Number	P&ID	LAH7532	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
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	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7532

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GENERAL	1	Tag Number	P&ID	LAL7532	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
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	22				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7532

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GENERAL	1	Tag Number	P&ID	LAH7536	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 2 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7536

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GENERAL	1	Tag Number	P&ID	LAL7536	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 2 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
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	41				
	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7536

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GENERAL	1	Tag Number	P&ID	LAH7542	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
	23				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7542

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GENERAL	1	Tag Number	P&ID	LAL7542	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
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	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7542

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GENERAL	1	Tag Number	P&ID	LAH7546	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 4 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
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	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7546

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GENERAL	1	Tag Number	P&ID	LAL7546	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 4 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
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	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7546

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GENERAL	1	Tag Number	P&ID	LAH7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER TANK LEVEL	
	3	Design Detail		Panel Layout for LCP7631	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7631	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
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	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7631

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GENERAL	1	Tag Number	P&ID	LAL7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER TANK LEVEL	
	3	Design Detail		Panel Layout for LCP7631	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7631	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
	23				
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	25				
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	40				
	41				
	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7631

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GENERAL	1	Tag Number	P&ID	LAH7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Design Detail		Panel Layout for LCP7685	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7685	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
	23				
	24				
	25				
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	38				
	39				
	40				
	41				
	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAH7685

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GENERAL	1	Tag Number	P&ID	LAL7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Design Detail		Panel Layout for LCP7685	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7685	
	8	Power Supply		2-Wire	
	9	Voltage		12-130 V AC/DC	
	10	Enclosure NEMA Rating		NEMA 4X	
	11	Operating Temperature Limits		-40 degF to 104 degF	
	12	Housing Material		Plastic	
	13	Guards		None	
	14	Power Module Type		Full Voltage	
	15	Lamp Test Options		Push-to-Test	
	16	Illumination Type		LED	
	17	Lens Color		Amber	
	18	Contact Blocks		1 N.O. - 1 N.C. Reed Switch	
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
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	31				
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	36				
	37				
	38				
	39				
	40				
	41				
	42				
	43				
	44				
OPTIONS	45				
	46				
	47				
	48				
PURCHASE	49	Manufacturer		Allen-Bradley	
	50	Model Number		800H-QRTH2AAR	
	51				
	52				
	53	Purchase Note			

M31 **Warning Light, Indoor/Outdoor**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LAL7685

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GENERAL	1	Tag Number	P&ID	YL7530	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 & 2 LEVEL	
	3	Design Detail		Panel Layout for LCP7530	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Enclosure NEMA Rating		IP67	
	9	Enclosure Material		ABS	
	10	Mounting Thread		M30x1.5	
	11	Strobe Element Type/Color		Orange, Red LED	
	12	Sounder Quantity		1	
	13	Strobe Quantity		2	
	14	Operating Temperature Limits		-40 degF to 122 degF	
	15	Cable		6.5 ft	
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
CONTROL	39	Power Supply		4 - Wire	
	40	Voltage		120 VAC	
	41				
	42				
	43				
	44				
OPTIONS	45	Tagging			
	46	Sun Shield			
	47	Accessories			
	48				
PURCHASE	49	Manufacturer		Banner Engineering	
	50	Model Number		TL50ZORALS3	
	51	Part Number		811126	
	52	Purchase Note			
	53				

M32 **Strobe/Horn**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	YL7530

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GENERAL	1	Tag Number	P&ID	YL7540	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 & 4 LEVEL	
	3	Design Detail		Panel Layout for LCP7540	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Enclosure NEMA Rating		IP67	
	9	Enclosure Material		ABS	
	10	Mounting Thread		M30x1.5	
	11	Strobe Element Type/Color		Orange, Red LED	
	12	Sounder Quantity		1	
	13	Strobe Quantity		2	
	14	Operating Temperature Limits		-40 degF to 122 degF	
	15	Cable		6.5 ft	
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
CONTROL	39	Power Supply		4 - Wire	
	40	Voltage		120 VAC	
	41				
	42				
	43				
	44				
OPTIONS	45	Tagging			
	46	Sun Shield			
	47	Accessories			
	48				
PURCHASE	49	Manufacturer		Banner Engineering	
	50	Model Number		TL50ZORALS3	
	51	Part Number		811126	
	52	Purchase Note			
	53				

M32 **Strobe/Horn**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	YL7540

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GENERAL	1	Tag Number	P&ID	YL7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER TANK LEVEL	
	3	Design Detail		Panel Layout for LCP7631	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7631	
	8	Enclosure NEMA Rating		IP67	
	9	Enclosure Material		ABS	
	10	Mounting Thread		M30x1.5	
	11	Strobe Element Type/Color		Orange, Red LED	
	12	Sounder Quantity		1	
	13	Strobe Quantity		2	
	14	Operating Temperature Limits		-40 degF to 122 degF	
	15	Cable		6.5 ft	
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
CONTROL	39	Power Supply		4 - Wire	
	40	Voltage		120 VAC	
	41				
	42				
	43				
	44				
OPTIONS	45	Tagging			
	46	Sun Shield			
	47	Accessories			
	48				
PURCHASE	49	Manufacturer		Banner Engineering	
	50	Model Number		TL50ZORALS3	
	51	Part Number		811126	
	52	Purchase Note			
	53				

M32 **Strobe/Horn**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	YL7631

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GENERAL	1	Tag Number	P&ID	YL7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Design Detail		Panel Layout for LCP7685	
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7685	
	8	Enclosure NEMA Rating		IP67	
	9	Enclosure Material		ABS	
	10	Mounting Thread		M30x1.5	
	11	Strobe Element Type/Color		Orange, Red LED	
	12	Sounder Quantity		1	
	13	Strobe Quantity		2	
	14	Operating Temperature Limits		-40 degF to 122 degF	
	15	Cable		6.5 ft	
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
CONTROL	39	Power Supply		4 - Wire	
	40	Voltage		120 VAC	
	41				
	42				
	43				
	44				
OPTIONS	45	Tagging			
	46	Sun Shield			
	47	Accessories			
	48				
PURCHASE	49	Manufacturer		Banner Engineering	
	50	Model Number		TL50ZORALS3	
	51	Part Number		811126	
	52	Purchase Note			
	53				

M32 **Strobe/Horn**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	YL7685

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GENERAL	1	Tag Number	P&ID	YL7812	N-0005_D3838501
	2	Loop Title		DUMP TRUCK LOADING LEVEL	
	3	Design Detail			
	4	Area Classification		Non-Hazardous	
	5				
INDICATOR	6	Mounting		Wall Mount	
	7				
	8	Enclosure NEMA Rating		IP67	
	9	Enclosure Material		ABS	
	10	Mounting Thread		M30x1.5	
	11				
	12	Sounder Quantity		1	
	13				
	14	Operating Temperature Limits		-4 degF to 122 degF	
	15	Connection		Integral 4-pin M12	
	16	Inputs		PNP	
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
CONTROL	39	Power Supply		4 - Wire	
	40	Voltage		24 VDC	
	41				
	42				
	43				
	44				
OPTIONS	45	Cordset		BC-M12F4-22-5 (16.4 ft)	
	46	Munting Brackets		LMBE12RA45	
	47				
	48				
PURCHASE	49	Manufacturer		Banner Engineering	
	50	Model Number		TL50AOSQ	
	51	Part Number		85560	
	52	Purchase Note			
	53				

M32 **Strobe/Horn**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	YL7812

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GENERAL	1	Tag Number	P&ID	PISH7611	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER RECIRCULATION PUMP	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Thickening Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-15 PSI	
	15	Dial Size		4 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect	
	19	Movement Dampening		Yes	
	20	Case Material		Stainless Steel	
	21	Window Material		Laminated Safety Glass	
	22	Blowout Protection		Case with Blowout Disk	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7611	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		Inconel 718	
	32	Fill Fluid		Silicone Oil M50	
	33				
SWITCH	34	Type		Electronic Switch (Standard) 2-wire model	
	35	Tag Number		PSH7611	
	36	Operation		Makes	
	37	Electrical Connection		Plug Sidewise	
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration			
	40	Accuracy		Class 1.6	
	41	Repeatability			
	42				
	43				
OPTIONS	44				
	45				
	46				
PURCHASE	47	Gauge Manufacturer		WIKIA	
	48	Gauge Part Number		PGS43.100.C1ZZZPZ-PG310Z-AND-IZ-LM-F50-ZZZZ-ZZZZ	
	49	Seal Manufacturer		WIKIA	
	50	Seal Part Number		Inluded	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PISH7611

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GENERAL	1	Tag Number	P&ID	PI7621	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER RECIRCULATION PUMP	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Thickening Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-30 PSI	
	15	Dial Size		4.5 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect (Stem Mount)	
	19	Movement Dampening		Glycerin/Water	
	20	Case Material		Black Thermoplastic	
	21	Window Material		Tempered Safety Glass	
	22	Blowout Protection		Case Back	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7621	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		316/316L SS	
	32	Fill Fluid		Silicone	
	33	Flushing Connection		Yes	
	34	Gasket Material		Kilinger C4401	
	35	Instrument Connection		Direct Thread	
	36				
	37				
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	40	Accuracy			
	41	Repeatability			
	42				
	43				
OPTIONS	44	Tagging		Stainless steel tag with Tag Number	
	45				
	46				
PURCHASE	47	Gauge Manufacturer		Reotemp	
	48	Gauge Part Number		PT45A1A*P16-W-T	
	49	Seal Manufacturer		Reotemp	
	50	Seal Part Number		W516*MSSS-8KDTD-ASGSTS	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PI7621

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GENERAL	1	Tag Number	P&ID	PISH7661	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 1	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dwatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-15 PSI	
	15	Dial Size		4 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect	
	19	Movement Dampening		Yes	
	20	Case Material		Stainless Steel	
	21	Window Material		Laminated Safety Glass	
	22	Blowout Protection		Case with Blowout Disk	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7611	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		Inconel 718	
	32	Fill Fluid		Silicone Oil M50	
	33				
SWITCH	34	Type		Electronic Switch (Standard) 2-wire model	
	35	Tag Number		PSH7611	
	36	Operation		Makes	
	37	Electrical Connection		Plug Sidewise	
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration			
	40	Accuracy		Class 1.6	
	41	Repeatability			
	42				
	43				
OPTIONS	44				
	45				
	46				
PURCHASE	47	Gauge Manufacturer		WIKIA	
	48	Gauge Part Number		PGS43.100.C1ZZZPZ-PG310Z-AND-IZ-LM-F50-ZZZZ-ZZZZ	
	49	Seal Manufacturer		WIKIA	
	50	Seal Part Number		Inluded	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PISH7661

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GENERAL	1	Tag Number	P&ID	PI7671	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 1	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dewatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-30 PSI	
	15	Dial Size		4.5 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect (Stem Mount)	
	19	Movement Dampening		Glycerin/Water	
	20	Case Material		Black Thermoplastic	
	21	Window Material		Tempered Safety Glass	
	22	Blowout Protection		Case Back	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7621	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		316/316L SS	
	32	Fill Fluid		Silicone	
	33	Flushing Connection		Yes	
	34	Gasket Material		Kilinger C4401	
	35	Instrument Connection		Direct Thread	
	36				
	37				
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	40	Accuracy			
	41	Repeatability			
	42				
	43				
OPTIONS	44	Tagging		Stainless steel tag with Tag Number	
	45				
	46				
PURCHASE	47	Gauge Manufacturer		Reotemp	
	48	Gauge Part Number		PT45A1A*P16-W-T	
	49	Seal Manufacturer		Reotemp	
	50	Seal Part Number		W516*MSSS-8KDTD-ASGSTS	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PI7671

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GENERAL	1	Tag Number	P&ID	PISH7662	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 2	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dwatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-15 PSI	
	15	Dial Size		4 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect	
	19	Movement Dampening		Yes	
	20	Case Material		Stainless Steel	
	21	Window Material		Laminated Safety Glass	
	22	Blowout Protection		Case with Blowout Disk	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7611	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		Inconel 718	
	32	Fill Fluid		Silicone Oil M50	
	33				
SWITCH	34	Type		Electronic Switch (Standard) 2-wire model	
	35	Tag Number		PSH7611	
	36	Operation		Makes	
	37	Electrical Connection		Plug Sidewise	
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration			
	40	Accuracy		Class 1.6	
	41	Repeatability			
	42				
	43				
OPTIONS	44				
	45				
	46				
PURCHASE	47	Gauge Manufacturer		WIKIA	
	48	Gauge Part Number		PGS43.100.C1ZZZPZ-PG310Z-AND-IZ-LM-F50-ZZZZ-ZZZZ	
	49	Seal Manufacturer		WIKIA	
	50	Seal Part Number		Inluded	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PISH7662

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GENERAL	1	Tag Number	P&ID	PI7672	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 2	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dewatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-30 PSI	
	15	Dial Size		4.5 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect (Stem Mount)	
	19	Movement Dampening		Glycerin/Water	
	20	Case Material		Black Thermoplastic	
	21	Window Material		Tempered Safety Glass	
	22	Blowout Protection		Case Back	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7621	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		316/316L SS	
	32	Fill Fluid		Silicone	
	33	Flushing Connection		Yes	
	34	Gasket Material		Kilinger C4401	
	35	Instrument Connection		Direct Thread	
	36				
	37				
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	40	Accuracy			
	41	Repeatability			
	42				
	43				
OPTIONS	44	Tagging		Stainless steel tag with Tag Number	
	45				
	46				
PURCHASE	47	Gauge Manufacturer		Reotemp	
	48	Gauge Part Number		PT45A1A*P16-W-T	
	49	Seal Manufacturer		Reotemp	
	50	Seal Part Number		W516*MSSS-8KDTD-ASGSTS	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PI7672

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GENERAL	1	Tag Number	P&ID	PISH7663	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 3	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dwatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-15 PSI	
	15	Dial Size		4 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect	
	19	Movement Dampening		Yes	
	20	Case Material		Stainless Steel	
	21	Window Material		Laminated Safety Glass	
	22	Blowout Protection		Case with Blowout Disk	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7611	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		Inconel 718	
	32	Fill Fluid		Silicone Oil M50	
	33				
SWITCH	34	Type		Electronic Switch (Standard) 2-wire model	
	35	Tag Number		PSH7611	
	36	Operation		Makes	
	37	Electrical Connection		Plug Sidewise	
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration			
	40	Accuracy		Class 1.6	
	41	Repeatability			
	42				
	43				
OPTIONS	44				
	45				
	46				
PURCHASE	47	Gauge Manufacturer		WIKIA	
	48	Gauge Part Number		PGS43.100.C1ZZZPZ-PG310Z-AND-IZ-LM-F50-ZZZZ-ZZZZ	
	49	Seal Manufacturer		WIKIA	
	50	Seal Part Number		Inluded	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PISH7663

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GENERAL	1	Tag Number	P&ID	PI7673	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER RECIRCULATION PUMP 3	
	3	Design Detail		4091-302	
	4	Area Classification		Non-Hazardous	
	5	Line Size (for annular seals)		3 Inch Pipe	
	6				
	7				
PROCESS CONDITIONS	8	Fluid		Dewatering Polymer	
	9	Min Pressure		0 PSI	
	10	Max Pressure		XX PSI	
	11	Temperature		Ambient	
	12				
INDICATOR	13	Type		Bourdon Tube	
	14	Range		0-30 PSI	
	15	Dial Size		4.5 Inches	
	16	Dial Color		White	
	17	Process Connection		0.5-inch NPT	
	18	Mounting		Bottom Connect (Stem Mount)	
	19	Movement Dampening		Glycerin/Water	
	20	Case Material		Black Thermoplastic	
	21	Window Material		Tempered Safety Glass	
	22	Blowout Protection		Case Back	
	23	Wetted Parts		316L SST Tube and Socket	
	24				
	25				
	26				
DIAPHRAGM SEAL -- ANNULAR SEAL	27	Type		Diaphragm	
	28	Tag Number		PE7621	
	29	Process Connection		0.5-inch NPT	
	30	Body Material		316L Stainless Steel	
	31	Diaphragm/Sleeve Material		316/316L SS	
	32	Fill Fluid		Silicone	
	33	Flushing Connection		Yes	
	34	Gasket Material		Kilinger C4401	
	35	Instrument Connection		Direct Thread	
	36				
	37				
CALIBRATION	38	Calibrated Range			
	39	Vendor Calibration		Factory calibrate - Provide calibration certificate	
	40	Accuracy			
	41	Repeatability			
	42				
	43				
OPTIONS	44	Tagging		Stainless steel tag with Tag Number	
	45				
	46				
PURCHASE	47	Gauge Manufacturer		Reotemp	
	48	Gauge Part Number		PT45A1A*P16-W-T	
	49	Seal Manufacturer		Reotemp	
	50	Seal Part Number		W516*MSSS-8KDTD-ASGSTS	
	51				
	52				
	53	Purchase Note		Manufacturer's Standard Warranty	

P04 **Pressure Gauge**	**D3838501 - GRASHAM WWTP** **BELT PRESS REPLACEMENT**
	PI7673

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GENERAL	1	Tag Number	P&ID	LI7532	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 1 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7530	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
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	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7532

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GENERAL	1	Tag Number	P&ID	LI7536	N-0009_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 2 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7530	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7530	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
	23				
	24				
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	42				
	43				
	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7536

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GENERAL	1	Tag Number	P&ID	LI7542	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 3 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7540	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
	23				
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	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7542

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GENERAL	1	Tag Number	P&ID	LI7546	N-0010_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 4 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7540	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7540	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
	23				
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	41				
	42				
	43				
	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7546

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GENERAL	1	Tag Number	P&ID	LI7631	N-0006_D3838501
	2	Loop Title		THICKENING POLYMER TANK LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7631	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7631	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
	23				
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	41				
	42				
	43				
	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7631

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GENERAL	1	Tag Number	P&ID	LI7685	N-0008_D3838501
	2	Loop Title		DEWATERING POLYMER TANK 5 LEVEL	
	3	Area Classification		Non-Hazardous	
	4	Design Detail		Panel Layout for LCP7685	
	5				
INDICATOR	6	Mounting		Panel Mount	
	7	Panel		LCP7685	
	8	Enclosure NEMA Rating		NEMA 4X	
	9	Display Type		LED	
	10	Digits		4	
	11	Operationg Temperature Limits		-4 degF to 140 degF	
	12	Housing Material		Plastic	
	13	Linearization Function			
	14	Voltage		120VAC	
	15	Power Supply		2-Wire	
	16	Universal Input Quantity		1	
	17	Analog Output Quantity		1	
	18	Output Signal Relays		2, 24VDC	
	19	Analog Signal Input and Output		4-20 mA	
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
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	41				
	42				
	43				
	44				
OPTIONS	45	Tagging		Affix stainless steel tag with Tag Number	
	46	Sun Shield		Include	
	47	Interface Cable			
	48				
PURCHASE	49	Manufacturer		PR Electronics	
	50	Model Number		5714D	
	51				
	52				
	53	Purchase Note		Manufacturer’s Standard Warranty	

S12 **Indicator, Field Mount**	**D3838501 - GRESHAM WWTP** **BELT PRESS REPLACEMENT**
	LI7685

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RIO EQUIPMENT LIST

Name	Description	Qty.	Model	Manufacturer	Comments
RIO-7000	REMOTE I/O		RIO	Allen-Bradley	Remote to PLC10
	16 Slot I/O Chassis	*	1756-A4K	Allen-Bradley	
	Power Supplies	*	1756-PA	Allen-Bradley	
	Remote I/O Adapter	*	1756-RIO	Allen-Bradley	For each I/O chassis in this LCP
	Isolated Analog Inputs	*	1756-IF8	Allen-Bradley	
	Isolated Analog Outputs	*	1756-NO8I	Allen-Bradley	
	120V ac Isolated Discrete Inputs	*	1756-IA16	Allen-Bradley	
	General-Purpose 24V ac/dc Discrete Inputs	*	1756-IB16	Allen-Bradley	
	Isolated Relay Discrete Outputs	*	1756-OW16I	Allen-Bradley	

Note 1: Where Allen-Bradley products are listed they are specified as no substitutions allowed.

Note 2: Where asterisk (*) appears in the "Qty." column, refer Article Programmable Logic Controllers for requirements regarding quantity of items to be provided.

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PLC-10A EQUIPMENT LIST

Name	Description	Qty.	Model	Manufacturer	Comments
PLC-10A	Polymer PLC Panel				Remote to PLC10. Panel to become RIO once SCADA upgrade project is complete.
	ControlLogix 5580 Controller	1	1756-L81E	Allen-Bradley	
	16 Slot I/O Chassis	*	1756-A4K	Allen-Bradley	
	Power Supplies	*	1756-PA	Allen-Bradley	
	Remote I/O Adapter	*	1756-RIO	Allen-Bradley	For each I/O chassis in this LCP
	Isolated Analog Inputs	*	1756-IF8	Allen-Bradley	
	Isolated Analog Outputs	*	1756-NO8I	Allen-Bradley	
	120V ac Isolated Discrete Inputs	*	1756-IA16	Allen-Bradley	
	General-Purpose 24V ac/dc Discrete Inputs	*	1756-IB16	Allen-Bradley	
	Isolated Relay Discrete Outputs	*	1756-OW16I	Allen-Bradley	

Note 1: Where Allen-Bradley products are listed they are specified as no substitutions allowed.

Note 2: Where asterisk (*) appears in the "Qty." column, refer Article Programmable Logic Controllers for requirements regarding quantity of items to be provided.

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IO List

Panel	PLC	Loop No	I/O Tag	Loop Title	Zero State	One State	IO Type	Chassis	Slot	Point
ACP-7410	PLC-10	7411	FV7411_CLSD	Non Potable Water Conveyor 1 Inlet Valve		Closed	DI			
ACP-7410	PLC-10	7411	FV7411_OPND	Non Potable Water Conveyor 1 Inlet Valve		Opened	DI			
ACP-7410	PLC-10	7411	FV7411_REM	Non Potable Water Conveyor 1 Inlet Valve	Local	Remote	DI			
ACP-7410	PLC-10	7411	FV7411_CLSE	Non Potable Water Conveyor 1 Inlet Valve		Close	DO			
ACP-7410	PLC-10	7411	FV7411_OPEN	Non Potable Water Conveyor 1 Inlet Valve		Open	DO			
ACP-7410	PLC-10	7421	CON7421_ESTP	Centrifuge Discharge Conveyor 1		Estop	DI			
ACP-7410	PLC-10	7421	CON7421_REM	Centrifuge Discharge Conveyor 1	Local	Remote	DI			
ACP-7410	PLC-10	7421	CON7421_RFWD	Centrifuge Discharge Conveyor 1		Running Forward	DI			
ACP-7410	PLC-10	7421	CON7421_ZSPD	Centrifuge Discharge Conveyor 1		Zero Speed	DI			
ACP-7410	PLC-10	7421	CON7421_RREV	Centrifuge Discharge Conveyor 1		Running Reverse	DI			
ACP-7410	PLC-10	7421	CON7421_OVLD	Centrifuge Discharge Conveyor 1		Overload	DI			
ACP-7410	PLC-10	7421	CON7421_SFWD	Centrifuge Discharge Conveyor 1		Run Forward	DO			
ACP-7410	PLC-10	7421	CON7421_SREV	Centrifuge Discharge Conveyor 1		Run Reverse	DO			
ACP-7410	PLC-10	7441	SV7441_OPEN	Non Potable Water Slenoid Valve Conveyor 1		Open	DO			
ACP-7410	PLC-10	7401	CENT7401_REM	Centrifuge 1	Local	Remote	ETHDI			
ACP-7410	PLC-10	7401	CENT7401_RUN	Centrifuge 1		Running	ETHDI			
ACP-7410	PLC-10	7401	CENT7401_FLT	Centrifuge 1		Fault	ETHDI			
ACP-7410	PLC-10	7401	CENT7401_ON	Centrifuge 1		On	ETHDI			
ACP-7410	PLC-10	7401	CENT7401_GENL	Centrifuge 1		Alarm	ETHDI			
ACP-7410	PLC-10	7401	CENT7401_STRT	Centrifuge 1	Stop	Start	ETHDO			
ACP-7410	PLC-10	7401	CENT7401_FLOW	Centrifuge 1			ETHAI			
ACP-7410	PLC-10	7401	CENT7401_SPAO	Centrifuge 1			ETHAO			
ACP-7410	PLC-10	7451	FV7451_CLSD	Centrifuge Discharge Conveyor 1 Drain Valve		Closed	DI			
ACP-7410	PLC-10	7451	FV7451_OPND	Centrifuge Discharge Conveyor 1 Drain Valve		Opened	DI			
ACP-7410	PLC-10	7451	FV7451_REM	Centrifuge Discharge Conveyor 1 Drain Valve	Local	Remote	DI			
ACP-7410	PLC-10	7451	FV7451_CLSE	Centrifuge Discharge Conveyor 1 Drain Valve		Close	DO			
ACP-7410	PLC-10	7451	FV7451_OPEN	Centrifuge Discharge Conveyor 1 Drain Valve		Open	DO			
ACP-7410	PLC-10	7431	CON7431_ESTP	Centrifuge Transfer Conveyor 1		Estop	DI			
ACP-7410	PLC-10	7431	CON7431_REM	Centrifuge Transfer Conveyor 1	Local	Remote	DI			
ACP-7410	PLC-10	7431	CON7431_RUN	Centrifuge Transfer Conveyor 1		Running	DI			
ACP-7410	PLC-10	7431	CON7431_ZSPD	Centrifuge Transfer Conveyor 1		Zero Speed	DI			
ACP-7410	PLC-10	7431	CON7431_OVLD	Centrifuge Transfer Conveyor 1		Overload	DI			
ACP-7410	PLC-10	7431	CON7431_STRT	Centrifuge Transfer Conveyor 1	Stop	Start	DO			
ACP-7410	PLC-10	7471	FV7471_CLSD	Non Potable Water Centrate Deaerator 1 Inlet Valve		Closed	DI			

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ACP-7410	PLC-10	7471	FV7471_OPND	Non Potable Water Centrate Deaerator 1 Inlet Valve		Opened	DI			
ACP-7410	PLC-10	7471	FV7471_REM	Non Potable Water Centrate Deaerator 1 Inlet Valve	Local	Remote	DI			
ACP-7410	PLC-10	7471	FV7471_CLSE	Non Potable Water Centrate Deaerator 1 Inlet Valve		Close	DO			
ACP-7410	PLC-10	7471	FV7471_OPEN	Non Potable Water Centrate Deaerator 1 Inlet Valve		Open	DO			
ACP-7410	PLC-10	7412	FV7412_CLSD	Non Potable Water Conveyor 2 Inlet Valve		Closed	DI			
ACP-7410	PLC-10	7412	FV7412_OPND	Non Potable Water Conveyor 2 Inlet Valve		Opened	DI			
ACP-7410	PLC-10	7412	FV7412_REM	Non Potable Water Conveyor 2 Inlet Valve	Local	Remote	DI			
ACP-7410	PLC-10	7412	FV7412_CLSE	Non Potable Water Conveyor 2 Inlet Valve		Close	DO			
ACP-7410	PLC-10	7412	FV7412_OPEN	Non Potable Water Conveyor 2 Inlet Valve		Open	DO			
ACP-7410	PLC-10	7422	CON7422_ESTP	Centrifuge Discharge Conveyor 2		Estop	DI			
ACP-7410	PLC-10	7422	CON7422_REM	Centrifuge Discharge Conveyor 2	Local	Remote	DI			
ACP-7410	PLC-10	7422	CON7422_RFWD	Centrifuge Discharge Conveyor 2		Running Forward	DI			
ACP-7410	PLC-10	7422	CON7422_ZSPD	Centrifuge Discharge Conveyor 2		Zero Speed	DI			
ACP-7410	PLC-10	7422	CON7422_RREV	Centrifuge Discharge Conveyor 2		Running Reverse	DI			
ACP-7410	PLC-10	7422	CON7422_OVLD	Centrifuge Discharge Conveyor 2		Overload	DI			
ACP-7410	PLC-10	7422	CON7422_SFWD	Centrifuge Discharge Conveyor 2		Run Forward	DO			
ACP-7410	PLC-10	7422	CON7422_SREV	Centrifuge Discharge Conveyor 2		Run Reverse	DO			
ACP-7410	PLC-10	7442	SV7442_OPEN	Non Potable Water Slenoid Valve Conveyor 2		Open	DO			
ACP-7410	PLC-10	7402	CENT7402_REM	Centrifuge 2	Local	Remote	ETHDI			
ACP-7410	PLC-10	7402	CENT7402_RUN	Centrifuge 2		Running	ETHDI			
ACP-7410	PLC-10	7402	CENT7402_FLT	Centrifuge 2		Fault	ETHDI			
ACP-7410	PLC-10	7402	CENT7402_ON	Centrifuge 2		On	ETHDI			
ACP-7410	PLC-10	7402	CENT7402_GENL	Centrifuge 2		Alarm	ETHDI			
ACP-7410	PLC-10	7402	CENT7402_STRT	Centrifuge 2	Stop	Start	ETHDO			
ACP-7410	PLC-10	7402	CENT7402_FLOW	Centrifuge 2			ETHAI			
ACP-7410	PLC-10	7402	CENT7402_SPAO	Centrifuge 2			ETHAO			
ACP-7410	PLC-10	7452	FV7452_CLSD	Centrifuge Discharge Conveyor 2 Drain Valve		Closed	DI			
ACP-7410	PLC-10	7452	FV7452_OPND	Centrifuge Discharge Conveyor 2 Drain Valve		Opened	DI			
ACP-7410	PLC-10	7452	FV7452_REM	Centrifuge Discharge Conveyor 2 Drain Valve	Local	Remote	DI			
ACP-7410	PLC-10	7452	FV7452_CLSE	Centrifuge Discharge Conveyor 2 Drain Valve		Close	DO			
ACP-7410	PLC-10	7452	FV7452_OPEN	Centrifuge Discharge Conveyor 2 Drain Valve		Open	DO			
ACP-7410	PLC-10	7432	CON7432_ESTP	Centrifuge Transfer Conveyor 2		Estop	DI			
ACP-7410	PLC-10	7432	CON7432_REM	Centrifuge Transfer Conveyor 2	Local	Remote	DI			
ACP-7410	PLC-10	7432	CON7432_RUN	Centrifuge Transfer Conveyor 2		Running	DI			
ACP-7410	PLC-10	7432	CON7432_ZSPD	Centrifuge Transfer Conveyor 2		Zero Speed	DI			
ACP-7410	PLC-10	7432	CON7432_OVLD	Centrifuge Transfer Conveyor 2		Overload	DI			

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ACP-7410	PLC-10	7432	CON7432_STRT	Centrifuge Transfer Conveyor 2	Stop	Start	DO			
ACP-7410	PLC-10	7472	FV7472_CLSD	Non Potable Water Centrate Deaerator 2 Inlet Valve		Closed	DI			
ACP-7410	PLC-10	7472	FV7472_OPND	Non Potable Water Centrate Deaerator 2 Inlet Valve		Opened	DI			
ACP-7410	PLC-10	7472	FV7472_REM	Non Potable Water Centrate Deaerator 2 Inlet Valve	Local	Remote	DI			
ACP-7410	PLC-10	7472	FV7472_CLSE	Non Potable Water Centrate Deaerator 2 Inlet Valve		Close	DO			
ACP-7410	PLC-10	7472	FV7472_OPEN	Non Potable Water Centrate Deaerator 2 Inlet Valve		Open	DO			
ACP-7410	PLC-10	8912A	LT8912A_LVL	Dump Truck Loading 1 Level			AI			
ACP-7410	PLC-10	8912A	LT8912A_HIGH	Dump Truck Loading 1 Level		Alarm High	DO			
ACP-7410	PLC-10	8912B	LT8912B_LVL	Dump Truck Loading 2 Level			AI			
ACP-7410	PLC-10	8912B	LT8912B_HIGH	Dump Truck Loading 2 Level		Alarm High	DO			
ACP-7410	PLC-10	8912C	LT8912C_LVL	Dump Truck Loading 3 Level			AI			
ACP-7410	PLC-10	8912C	LT8912C_HIGH	Dump Truck Loading 3 Level		Alarm High	DO			
ACP-7410	PLC-10	8912D	LT8912D_LVL	Dump Truck Loading 4 Level			AI			
ACP-7410	PLC-10A	8912D	LT8912D_HIGH	Dump Truck Loading 4 Level		Alarm High	DO			
ACP-7410	PLC-10	8912	LCP8912_SIL	Dump Truck Loading Level		Silence	DI			
ACP-7410	PLC-10	8912	LCP8912_HORN	Dump Truck Loading Level		Horn	DO			
ACP-7410-2	PLC-10A	7631	LAH7631_HIGH	Thickening Polymer Tank Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7631	LAL7631_LOW	Thickening Polymer Tank Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7631	LCP7631_HORN	Thickening Polymer Tank Level		Horn	DO			
ACP-7410-2	PLC-10A	7631	LIT7631_LVL	Thickening Polymer Tank Level			AI			
ACP-7410-2	PLC-10A	7611	PMP7611_REM	Thickening Polymer Recirculation Pump	Local	Remote	DI			
ACP-7410-2	PLC-10A	7611	PMP7611_RUN	Thickening Polymer Recirculation Pump		Running	DI			
ACP-7410-2	PLC-10A	7611	PMP7611_FLT	Thickening Polymer Recirculation Pump		Fault	DI			
ACP-7410-2	PLC-10A	7611	PMP7611_TAH	Thickening Polymer Recirculation Pump		High Temperature	DI			
ACP-7410-2	PLC-10A	7611	PMP7611_PSH	Thickening Polymer Recirculation Pump		High Pressure	DI			
ACP-7410-2	PLC-10A	7611	PMP7611_STRT	Thickening Polymer Recirculation Pump	Stop	Start	DO			
ACP-7410-2	PLC-10A	7601	BLND7601_REM	Thickening Polymer Blending Unit 1		Remote	ETHDI			
ACP-7410-2	PLC-10A	7601	BLND7601_RUN	Thickening Polymer Blending Unit 1		Running	ETHDI			
ACP-7410-2	PLC-10A	7601	BLND7601_GENL	Thickening Polymer Blending Unit 1		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7601	BLND7601_STRT	Thickening Polymer Blending Unit 1	Stop	Start	ETHDO			
ACP-7410-2	PLC-10A	7601	BLND7601_FLOW	Thickening Polymer Blending Unit 1			ETHAI			
ACP-7410-2	PLC-10A	7601	BLND7601_SPAO	Thickening Polymer Blending Unit 1			ETHAO			
ACP-7410-2	PLC-10A	7602	BLND7602_REM	Thickening Polymer Blending Unit 2		Remote	ETHDI			
ACP-7410-2	PLC-10A	7602	BLND7602_RUN	Thickening Polymer Blending Unit 2		Running	ETHDI			
ACP-7410-2	PLC-10A	7602	BLND7602_GENL	Thickening Polymer Blending Unit 2		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7602	BLND7602_STRT	Thickening Polymer Blending Unit 2	Stop	Start	ETHDO			

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ACP-7410-2	PLC-10A	7602	BLND7602_FLOW	Thickening Polymer Blending Unit 2			ETHAI			
ACP-7410-2	PLC-10A	7602	BLND7602_SPAO	Thickening Polymer Blending Unit 2			ETHAO			
ACP-7410-2	PLC-10A	7603	BLND7603_REM	Thickening Polymer Blending Unit 3		Remote	ETHDI			
ACP-7410-2	PLC-10A	7603	BLND7603_RUN	Thickening Polymer Blending Unit 3		Running	ETHDI			
ACP-7410-2	PLC-10A	7603	BLND7603_GENL	Thickening Polymer Blending Unit 3		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7603	BLND7603_STRT	Thickening Polymer Blending Unit 3	Stop	Start	ETHDO			
ACP-7410-2	PLC-10A	7603	BLND7603_FLOW	Thickening Polymer Blending Unit 3			ETHAI			
ACP-7410-2	PLC-10A	7603	BLND7603_SPAO	Thickening Polymer Blending Unit 3			ETHAO			
ACP-7410-2	PLC-10A	7530	LCP7530_SIL	Dewatering Polymer Tank 1 and 2 Level		Silence	DI			
ACP-7410-2	PLC-10A	7532	LAH7532_HIGH	Dewatering Polymer Tank 1 Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7532	LAL7532_LOW	Dewatering Polymer Tank 1 Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7530	LCP7530_HORN	Dewatering Polymer Tank 1 and 2 Level		Horn	DO			
ACP-7410-2	PLC-10A	7532	LIT7532_LVL	Dewatering Polymer Tank 1 Level			AI			
ACP-7410-2	PLC-10A	7536	LAH7536_HIGH	Dewatering Polymer Tank 2 Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7536	LAL7536_LOW	Dewatering Polymer Tank 2 Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7536	LIT7536_LVL	Dewatering Polymer Tank 2 Level			AI			
ACP-7410-2	PLC-10A	7540	LCP7540_SIL	Dewatering Polymer Tank 3 and 4 Level		Silence	DI			
ACP-7410-2	PLC-10A	7542	LCP7542_HIGH	Dewatering Polymer Tank 3 Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7542	LCP7542_LOW	Dewatering Polymer Tank 3 Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7540	LCP7540_HORN	Dewatering Polymer Tank 3 and 4 Level		Horn	DO			
ACP-7410-2	PLC-10A	7542	LCP7542_LVL	Dewatering Polymer Tank 3 Level			AI			
ACP-7410-2	PLC-10A	7546	LAH7546_HIGH	Dewatering Polymer Tank 4 Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7546	LAH7546_LOW	Dewatering Polymer Tank 4 Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7546	LAH7546_LVL	Dewatering Polymer Tank 4 Level			AI			
ACP-7410-2	PLC-10A	7685	LCP7685_SIL	Dewatering Polymer Tank 5 Level		Silence	DI			
ACP-7410-2	PLC-10A	7685	LCP7685_HIGH	Dewatering Polymer Tank 5 Level		Alarm High	DO			
ACP-7410-2	PLC-10A	7685	LCP7685_LOW	Dewatering Polymer Tank 5 Level		Alarm Low	DO			
ACP-7410-2	PLC-10A	7685	LCP7685_HORN	Dewatering Polymer Tank 5 Level		Horn	DO			
ACP-7410-2	PLC-10A	7685	LCP7685_LVL	Dewatering Polymer Tank 5 Level			AI			
ACP-7410-2	PLC-10A	7661	PMP7661_REM	Dewatering Polymer Recirculation Pump 1	Local	Remote	DI			
ACP-7410-2	PLC-10A	7661	PMP7661_RUN	Dewatering Polymer Recirculation Pump 1		Running	DI			
ACP-7410-2	PLC-10A	7661	PMP7661_GENL	Dewatering Polymer Recirculation Pump 1		Fault	DI			
ACP-7410-2	PLC-10A	7661	PMP7661_TAH	Dewatering Polymer Recirculation Pump 1		High Temperature	DI			
ACP-7410-2	PLC-10A	7661	PMP7661_PSH	Dewatering Polymer Recirculation Pump 1		High Pressure	DI			
ACP-7410-2	PLC-10A	7661	PMP7661_STRT	Dewatering Polymer Recirculation Pump 1	Stop	Start	DO			
ACP-7410-2	PLC-10A	7662	PMP7662_REM	Dewatering Polymer Recirculation Pump 2	Local	Remote	DI			

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ACP-7410-2	PLC-10A	7662	PMP7662_RUN	Dewatering Polymer Recirculation Pump 2		Running	DI			
ACP-7410-2	PLC-10A	7662	PMP7662_GENL	Dewatering Polymer Recirculation Pump 2		Fault	DI			
ACP-7410-2	PLC-10A	7662	PMP7662_TAH	Dewatering Polymer Recirculation Pump 2		High Temperature	DI			
ACP-7410-2	PLC-10A	7662	PMP7662_PSH	Dewatering Polymer Recirculation Pump 2		High Pressure	DI			
ACP-7410-2	PLC-10A	7662	PMP7662_STRT	Dewatering Polymer Recirculation Pump 2	Stop	Start	DO			
ACP-7410-2	PLC-10A	7663	PMP7663_REM	Dewatering Polymer Recirculation Pump 3	Local	Remote	DI			
ACP-7410-2	PLC-10A	7663	PMP7663_RUN	Dewatering Polymer Recirculation Pump 3		Running	DI			
ACP-7410-2	PLC-10A	7663	PMP7663_GENL	Dewatering Polymer Recirculation Pump 3		Fault	DI			
ACP-7410-2	PLC-10A	7663	PMP7663_TAH	Dewatering Polymer Recirculation Pump 3		High Temperature	DI			
ACP-7410-2	PLC-10A	7663	PMP7663_PSH	Dewatering Polymer Recirculation Pump 3		High Pressure	DI			
ACP-7410-2	PLC-10A	7663	PMP7663_STRT	Dewatering Polymer Recirculation Pump 3	Stop	Start	DO			
ACP-7410-2	PLC-10A	7531	FCV7531_CLSD	Dewatering Polymer Tank 1 and 2 Three-Way Supply Valve		Closed	DI			
ACP-7410-2	PLC-10A	7531	FCV7531_OPND	Dewatering Polymer Tank 1 and 2 Three-Way Supply Valve		Opened	DI			
ACP-7410-2	PLC-10A	7531	FCV7531_REM	Dewatering Polymer Tank 1 and 2 Three-Way Supply Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7531	FCV7531_CLSE	Dewatering Polymer Tank 1 and 2 Three-Way Supply Valve		Close	DO			
ACP-7410-2	PLC-10A	7531	FCV7531_OPEN	Dewatering Polymer Tank 1 and 2 Three-Way Supply Valve		Open	DO			
ACP-7410-2	PLC-10A	7532A	FV7532A_CLSD	Dewatering Polymer Tank 1 Outlet Valve		Closed	DI			
ACP-7410-2	PLC-10A	7532A	FV7532A_OPND	Dewatering Polymer Tank 1 Outlet Valve		Opened	DI			
ACP-7410-2	PLC-10A	7532A	FV7532A_REM	Dewatering Polymer Tank 1 Outlet Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7532A	FV7532A_CLSE	Dewatering Polymer Tank 1 Outlet Valve		Close	DO			
ACP-7410-2	PLC-10A	7532A	FV7532A_OPEN	Dewatering Polymer Tank 1 Outlet Valve		Open	DO			
ACP-7410-2	PLC-10A	7532B	FV7532B_CLSD	Dewatering Polymer Tank 1 Recirculation Valve		Closed	DI			
ACP-7410-2	PLC-10A	7532B	FV7532B_OPND	Dewatering Polymer Tank 1 Recirculation Valve		Opened	DI			
ACP-7410-2	PLC-10A	7532B	FV7532B_REM	Dewatering Polymer Tank 1 Recirculation Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7532B	FV7532B_CLSE	Dewatering Polymer Tank 1 Recirculation Valve		Close	DO			
ACP-7410-2	PLC-10A	7532B	FV7532B_OPEN	Dewatering Polymer Tank 1 Recirculation Valve		Open	DO			
ACP-7410-2	PLC-10A	7532C	FV7532C_CLSD	Dewatering Polymer Tank 1 Isolation Valve Valve		Closed	DI			
ACP-7410-2	PLC-10A	7532C	FV7532C_OPND	Dewatering Polymer Tank 1 Isolation Valve Valve		Opened	DI			
ACP-7410-2	PLC-10A	7532C	FV7532C_REM	Dewatering Polymer Tank 1 Isolation Valve Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7532C	FV7532C_CLSE	Dewatering Polymer Tank 1 Isolation Valve Valve		Close	DO			
ACP-7410-2	PLC-10A	7532C	FV7532C_OPEN	Dewatering Polymer Tank 1 Isolation Valve Valve		Open	DO			
ACP-7410-2	PLC-10A	7536A	FV7536A_CLSD	Dewatering Polymer Tank 2 Outlet Valve		Closed	DI			
ACP-7410-2	PLC-10A	7536A	FV7536A_OPND	Dewatering Polymer Tank 2 Outlet Valve		Opened	DI			
ACP-7410-2	PLC-10A	7536A	FV7536A_REM	Dewatering Polymer Tank 2 Outlet Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7536A	FV7536A_CLSE	Dewatering Polymer Tank 2 Outlet Valve		Close	DO			
ACP-7410-2	PLC-10A	7536A	FV7536A_OPEN	Dewatering Polymer Tank 2 Outlet Valve		Open	DO			

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ACP-7410-2	PLC-10A	7536B	FV7536B_CLSD	Dewatering Polymer Tank 2 Recirculation Valve		Closed	DI			
ACP-7410-2	PLC-10A	7536B	FV7536B_OPND	Dewatering Polymer Tank 2 Recirculation Valve		Opened	DI			
ACP-7410-2	PLC-10A	7536B	FV7536B_REM	Dewatering Polymer Tank 2 Recirculation Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7536B	FV7536B_CLSE	Dewatering Polymer Tank 2 Recirculation Valve		Close	DO			
ACP-7410-2	PLC-10A	7536B	FV7536B_OPEN	Dewatering Polymer Tank 2 Recirculation Valve		Open	DO			
ACP-7410-2	PLC-10A	7536C	FV7536C_CLSD	Dewatering Polymer Tank 2 Isolation Valve Valve		Closed	DI			
ACP-7410-2	PLC-10A	7536C	FV7536C_OPND	Dewatering Polymer Tank 2 Isolation Valve Valve		Opened	DI			
ACP-7410-2	PLC-10A	7536C	FV7536C_REM	Dewatering Polymer Tank 2 Isolation Valve Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7536C	FV7536C_CLSE	Dewatering Polymer Tank 2 Isolation Valve Valve		Close	DO			
ACP-7410-2	PLC-10A	7536C	FV7536C_OPEN	Dewatering Polymer Tank 2 Isolation Valve Valve		Open	DO			
ACP-7410-2	PLC-10A	7541	FCV7541_CLSD	Dewatering Polymer Tank 3 and 4 Three-Way Supply Valve		Closed	DI			
ACP-7410-2	PLC-10A	7541	FCV7541_OPND	Dewatering Polymer Tank 3 and 4 Three-Way Supply Valve		Opened	DI			
ACP-7410-2	PLC-10A	7541	FCV7541_REM	Dewatering Polymer Tank 3 and 4 Three-Way Supply Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7541	FCV7541_CLSE	Dewatering Polymer Tank 3 and 4 Three-Way Supply Valve		Close	DO			
ACP-7410-2	PLC-10A	7541	FCV7541_OPEN	Dewatering Polymer Tank 3 and 4 Three-Way Supply Valve		Open	DO			
ACP-7410-2	PLC-10A	7542A	FV7542A_CLSD	Dewatering Polymer Tank 3 Outlet Valve		Closed	DI			
ACP-7410-2	PLC-10A	7542A	FV7542A_OPND	Dewatering Polymer Tank 3 Outlet Valve		Opened	DI			
ACP-7410-2	PLC-10A	7542A	FV7542A_REM	Dewatering Polymer Tank 3 Outlet Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7542A	FV7542A_CLSE	Dewatering Polymer Tank 3 Outlet Valve		Close	DO			
ACP-7410-2	PLC-10A	7542A	FV7542A_OPEN	Dewatering Polymer Tank 3 Outlet Valve		Open	DO			
ACP-7410-2	PLC-10A	7542B	FV7542B_CLSD	Dewatering Polymer Tank 3 Recirculation Valve		Closed	DI			
ACP-7410-2	PLC-10A	7542B	FV7542B_OPND	Dewatering Polymer Tank 3 Recirculation Valve		Opened	DI			
ACP-7410-2	PLC-10A	7542B	FV7542B_REM	Dewatering Polymer Tank 3 Recirculation Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7542B	FV7542B_CLSE	Dewatering Polymer Tank 3 Recirculation Valve		Close	DO			
ACP-7410-2	PLC-10A	7542B	FV7542B_OPEN	Dewatering Polymer Tank 3 Recirculation Valve		Open	DO			
ACP-7410-2	PLC-10A	7542C	FV7542C_CLSD	Dewatering Polymer Tank 3 Isolation Valve Valve		Closed	DI			
ACP-7410-2	PLC-10A	7542C	FV7542C_OPND	Dewatering Polymer Tank 3 Isolation Valve Valve		Opened	DI			
ACP-7410-2	PLC-10A	7542C	FV7542C_REM	Dewatering Polymer Tank 3 Isolation Valve Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7542C	FV7542C_CLSE	Dewatering Polymer Tank 3 Isolation Valve Valve		Close	DO			
ACP-7410-2	PLC-10A	7542C	FV7542C_OPEN	Dewatering Polymer Tank 3 Isolation Valve Valve		Open	DO			
ACP-7410-2	PLC-10A	7546A	FV7546A_CLSD	Dewatering Polymer Tank 4 Outlet Valve		Closed	DI			
ACP-7410-2	PLC-10A	7546A	FV7546A_OPND	Dewatering Polymer Tank 4 Outlet Valve		Opened	DI			
ACP-7410-2	PLC-10A	7546A	FV7546A_REM	Dewatering Polymer Tank 4 Outlet Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7546A	FV7546A_CLSE	Dewatering Polymer Tank 4 Outlet Valve		Close	DO			
ACP-7410-2	PLC-10A	7546A	FV7546A_OPEN	Dewatering Polymer Tank 4 Outlet Valve		Open	DO			
ACP-7410-2	PLC-10A	7546B	FV7546B_CLSD	Dewatering Polymer Tank 4 Recirculation Valve		Closed	DI			

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ACP-7410-2	PLC-10A	7546B	FV7546B_OPND	Dewatering Polymer Tank 4 Recirculation Valve		Opened	DI			
ACP-7410-2	PLC-10A	7546B	FV7546B_REM	Dewatering Polymer Tank 4 Recirculation Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7546B	FV7546B_CLSE	Dewatering Polymer Tank 4 Recirculation Valve		Close	DO			
ACP-7410-2	PLC-10A	7546B	FV7546B_OPEN	Dewatering Polymer Tank 4 Recirculation Valve		Open	DO			
ACP-7410-2	PLC-10A	7546C	FV7546C_CLSD	Dewatering Polymer Tank 4 Isolation Valve Valve		Closed	DI			
ACP-7410-2	PLC-10A	7546C	FV7546C_OPND	Dewatering Polymer Tank 4 Isolation Valve Valve		Opened	DI			
ACP-7410-2	PLC-10A	7546C	FV7546C_REM	Dewatering Polymer Tank 4 Isolation Valve Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7546C	FV7546C_CLSE	Dewatering Polymer Tank 4 Isolation Valve Valve		Close	DO			
ACP-7410-2	PLC-10A	7546C	FV7546C_OPEN	Dewatering Polymer Tank 4 Isolation Valve Valve		Open	DO			
ACP-7410-2	PLC-10A	7685	FV7685_CLSD	Dewatering Polymer Tank 5 Outlet Valve		Closed	DI			
ACP-7410-2	PLC-10A	7685	FV7685_OPND	Dewatering Polymer Tank 5 Outlet Valve		Opened	DI			
ACP-7410-2	PLC-10A	7685	FV7685_REM	Dewatering Polymer Tank 5 Outlet Valve	Local	Remote	DI			
ACP-7410-2	PLC-10A	7685	FV7685_CLSE	Dewatering Polymer Tank 5 Outlet Valve		Close	DO			
ACP-7410-2	PLC-10A	7685	FV7685_OPEN	Dewatering Polymer Tank 5 Outlet Valve		Open	DO			
ACP-7410-2	PLC-10A	7651	BLND7651_REM	Dewatering Polymer Blending Unit 1		Remote	ETHDI			
ACP-7410-2	PLC-10A	7651	BLND7651_RUN	Dewatering Polymer Blending Unit 1		Running	ETHDI			
ACP-7410-2	PLC-10A	7651	BLND7651_GENL	Dewatering Polymer Blending Unit 1		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7651	BLND7651_STRT	Dewatering Polymer Blending Unit 1	Stop	Start	ETHDO			
ACP-7410-2	PLC-10A	7651	BLND7651_FLOW	Dewatering Polymer Blending Unit 1			ETHAI			
ACP-7410-2	PLC-10A	7651	BLND7651_SPAO	Dewatering Polymer Blending Unit 1			ETHAO			
ACP-7410-2	PLC-10A	7652	BLND7652_REM	Dewatering Polymer Blending Unit 2		Remote	ETHDI			
ACP-7410-2	PLC-10A	7652	BLND7652_RUN	Dewatering Polymer Blending Unit 2		Running	ETHDI			
ACP-7410-2	PLC-10A	7652	BLND7652_GENL	Dewatering Polymer Blending Unit 2		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7652	BLND7652_STRT	Dewatering Polymer Blending Unit 2	Stop	Start	ETHDO			
ACP-7410-2	PLC-10A	7652	BLND7652_FLOW	Dewatering Polymer Blending Unit 2			ATHAI			
ACP-7410-2	PLC-10A	7652	BLND7652_SPAO	Dewatering Polymer Blending Unit 2			ETHAO			
ACP-7410-2	PLC-10A	7653	BLND7653_REM	Dewatering Polymer Blending Unit 3		Remote	ETHDI			
ACP-7410-2	PLC-10A	7653	BLND7653_RUN	Dewatering Polymer Blending Unit 3		Running	ETHDI			
ACP-7410-2	PLC-10A	7653	BLND7653_GENL	Dewatering Polymer Blending Unit 3		Alarm	ETHDI			
ACP-7410-2	PLC-10A	7653	BLND7653_STRT	Dewatering Polymer Blending Unit 3	Stop	Start	ETHDO			
ACP-7410-2	PLC-10A	7653	BLND7653_FLOW	Dewatering Polymer Blending Unit 3			ATHAI			
ACP-7410-2	PLC-10A	7653	BLND7653_SPAO	Dewatering Polymer Blending Unit 3			ETHAO			

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CONTROL PANEL SCHEDULE

Panel No.	Service	Mounting	NEMA	Dimensions H W D	FDT	Space Heater	Serv. Lights, Outlets	Environment	SS
LCP-8912A	Dump Truck Loading Level Indication Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-8912B	Dump Truck Loading Level Indication Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7631	Thickening Polymer Unload Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7685	Thickening Polymer Unload Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7530	Dewatering Polymer Unload Panel	Wall	4X	24 20 10	Yes			Outside	Yes
LCP-7540	Dewatering Polymer Unload Panel	Wall	4X	24 20 10	Yes			Outside	Yes
PLC-10A	Polymer PLC Panel	Freestanding	4X	90 36 24	Yes		Yes	Inside, Air Conditioned	Yes

Column Descriptions:

FDT: Factory Demonstration test required.

Dimensions: Maximum space available for panel.

SS: Stainless Steel.

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JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

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-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

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JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER** **Rev.06.05.92**

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-6-92*
		Tag No.: *AIT-12-6*[pH]

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JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

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-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

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JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

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-20-92 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-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 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-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *30-12*

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CONTROL PANEL SCHEDULE

Panel No.	Service	Mounting	NEMA	Dimensions H W D	FDT	Space Heater	Serv. Lights, Outlets	Environment	SS
LCP-8912A	Dump Truck Loading Level Indication Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-8912B	Dump Truck Loading Level Indication Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7631	Thickening Polymer Unload Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7685	Thickening Polymer Unload Panel	Wall	4X	20 20 10	Yes			Outside	Yes
LCP-7530	Dewatering Polymer Unload Panel	Wall	4X	24 20 10	Yes			Outside	Yes
LCP-7540	Dewatering Polymer Unload Panel	Wall	4X	24 20 10	Yes			Outside	Yes
RIO-10	Polymer RIO Panel	Freestanding	4X	90 36 24	Yes		Yes	Inside, Air Conditioned	Yes

Column Descriptions:

FDT: Factory Demonstration test required.

Dimensions: Maximum space available for panel.

SS: Stainless Steel.

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JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

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-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

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JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER** Rev.06.05.92

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-6-92*
		Tag No.: *AIT-12-6*[pH]

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JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

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-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

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JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

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-20-92 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-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 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-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	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.

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D. 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.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. For air or water service, unless otherwise noted.
2. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
3. Direct-Reading Scale Length: 2-1/2 inches, minimum.
4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
5. Integral inlet needle valves.
6. Integral differential pressure regulators:
   a. For water service.
   b. For air service for level ranges greater than 10 feet of water.
7. Rotameters for water service.
8. Manufacturers and Products:
   a. Fischer & Porter; Series 10A3130.
   b. Brooks; Series DS-1350.

B. Manifold, Three-Valve Equalizing:

1. Type: For isolation and equalization of differential pressure transducers.
2. Materials: Stainless steel.
3. Manufacturers and Products:
   a. Anderson, Greenwood and Co.; Type M1.
   b. Evans.

C. 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.
4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.

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5. Manufacturers and Products:
    a. Ashcroft Utility; Gauge Series 1000.
    b. Reotemp; PT45.

D. 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.

E. ON/OFF Valves:

1. Type: Ball valve.
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; Series 41 through Series 43.
    b. Hoke; Flomite 7100 Series.

F. 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 through 3300 Series.

G. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
3. Manufacturers and Products:
    a. Whitey; Series 41 through Series 43.
    b. Hoke; Selecto-Mite Series.

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H. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
   c. Packing Gland: Teflon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.

I. Spool Valve:

1. Type: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
2. Materials: Aluminum construction with Teflon impregnated aluminum spool, stainless steel spring, and Buna-N O-rings.
3. Port Connection: 1/4-inch outside diameter tube fittings.
4. Manufacturer and Product: Norgren; T71DAOO-TSO-TKO.

J. Solenoid Valve, Two-Way:

1. Type: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
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.

K. 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 psi 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.

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L. 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 psi offset pressure.
3. Manufacturers and Products:
   a. Fisher; Controls Type 95H or 95L.
   b. Masoneilan; Series 17.

M. 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.

N. Copper Tubing and Fittings:

1. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on the Drawings.
3. Manufacturers:
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

O. Plastic Tubing and Fittings:

1. Tubing:
   a. Polyethylene capable of withstanding 190 psig 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.

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P. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on the Drawings.

Q. 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 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

R. Air Set: Consists of a shutoff valve, pressure regulator, discharge pressure gauge, and interconnecting tubing.

S. Purge Set:

1. Parts: Purge rotameter flow element, pressure regulator, pressure gauge, test tap, shutoff valve, spool valve, and interconnecting tubing as shown on the Drawings and as required in this section.
2. Pressure Gauge Scale Range: 150 percent of the process variable.
3. Mounting:
   a. Within consoles, panels, or a separate enclosure as shown.
   b. For separate enclosure mounted purge sets, refer to paragraphs Nonfreestanding Panel Construction and Factory Finishing for enclosure requirements.

T. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer’s recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.

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4. Manufacturers:
   a. Globetray.
   b. Cope.

U. Air Supply Sets:

1. Parts: Integrally Mounted:
   a. Pressure Controls: Automatic START/STOP, factory set at 30 psig to 50 psig.
   b. Valves: Manual drain, manual shutoff, pressure relief, and check valve.
   c. Pressure gauge.
   d. Inlet filter muffler.
   e. Power: 120V ac.
   f. Compressor: Oilless, single cylinder, rated for at least 1 scfm at 50 psig.
   g. Manufacturers and Products:
      1) ITT Pneumotive; GH Series.
      2) Gast.
2. Simplex Air Supply Sets:
   a. Air Receiver: 2 gallons.
   b. Compressors: One.
3. Duplex Air Supply Sets:
   a. Air Receiver: 20 gallons.
   b. Compressors: Two.
   c. Automatic Failover Control: Factory set at 20 psig.

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.

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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.
j. Test Plugs: Soldered connections for 18 AWG wire.
   1) Pin Diameter: 0.079 inch.
   2) Manufacturer and Product: Entrelec; Type FC2.

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.
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.

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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.
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.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

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.

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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.
   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: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
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.

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i. Time Delay Setpoint: As noted or shown.
j. Mode of Operation: As noted or shown.
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, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.
2. Suppressors on 120V ac Power Supply Connections:
   a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
   b. First-Stage Clamping Voltage: 350 volts or less.
   c. Second-Stage Clamping Voltage: 210 volts or less.
   d. Power Supplies for Continuous Operation:
      1) Four-Wire Transmitter or Receiver: Minimum5 amps at 130V ac.
      2) All Other Applications: Minimum 30 amps at 130V ac.
3. Suppressors on Analog Signal Lines:
   a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
   b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
      1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
      2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
      3) Maximum Loop Resistance: 18 ohms per conductor.
4. Manufacturers and Products:
   a. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
   b. 120V ac Lines: Emerson Edco HSP-121.
   c. Field Mounted at Two-Wire Instruments:
      1) Encapsulated in stainless steel pipe nipples.
      2) Emerson Edco SS64 series.

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d. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
   1) Enclosure:
      a) NEMA 4X Type 316 stainless steel with door.
      b) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   2) Emerson Edco; SLAC series.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. 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.
3. 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.
4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. 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.

2.04 INSTRUMENT COMPONENTS

A. L10 Level Transmitter, Pressure:

1. General:
   a. Function: chemical tank level measurement based on gauge pressure.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics.”
   c. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL but does not exceed it.
   b. Accuracy: Plus or minus 0.15 percent of span, unless otherwise noted.

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c. Ambient Operating Temperature: Minus 40 degrees F to plus 185 degrees F, with integral meter.
d. Process Operating Temperature: Minus 40 degrees F to plus 257 degrees F.
e. Humidity: 0 percent to 100 percent relative humidity.
f. Hazardous Location Certifications: Unclassified.

3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Adjustable damping.
   c. Display in engineering units, field configurable.
   d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted. Includes, process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
   f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
   g. Fill Fluid: Silicone, unless otherwise noted.
   h. Bluetooth.
   i. Heartbeat technology:
      1) Continuous self-monitoring of the device without interrupting the process.
      2) Diagnostic messages output.
4. Local Display:
   a. Segment Display:
      1) Measured value (up to 5 digits).
      2) Bar graph proportional to the current output.
      3) Unit of measured value.
   b. Bluetooth wireless technology.
   c. Functions:
      1) Display of measured values and fault and notice messages
      2) Background lighting, which switches from green to red in the event of an error.
      3) The device display can be removed for easer operation.
5. Process Connections:
   a. Line Size: 3 inch.
   b. Connection Type: ANSI Flange.
   c. Compact Diaphragm Seal.
6. Signal Interface:
   a. 4 mA dc to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.

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7. Enclosure:
    a. Type: NEMA 4X/6P.
    b. Dual compartment.
    c. Materials: Coated aluminum, unless otherwise noted.
    d. Electrical Connection: 1/2-inch NPT.
8. Accessories: Tagging stainless steel.
9. Approval: NSF drinking water approval.

B. L29 Level Element and Transmitter, Radar:

1. General:
    a. Function: Continuous liquids level measurement.
    b. Type: Radar, noncontacting.
    c. Loop powered.
    d. Parts: Element/integral transmitter and accessories as noted.
2. Service:
    a. Application: Water, polymer solution, as noted.
    b. Operating Temperature Range:
        1) Ambient: Minus 40 degrees F to plus 176 degrees F.
        2) At Flange (Inside Vessel):
            a) Dependent on antenna type and O-ring materials.
            b) For PTFE rod with PVDF threaded connection, minus 40 degrees F to plus 176 degrees F.
    c. Pressure Rating: Ambient.
3. Performance:
    a. Process Range: As noted.
    b. Zero Reference: As noted.
    c. Frequency: 80-GHz.
    d. Accuracy (Maximum Measurement Error):
        1) Up to 0.8 meter (2.62 feet), plus or minus 4 mm (0.16 inch).
        2) More than 0.8 meter (2.62 feet), plus or minus 1 mm (0.04 inch).
    e. Resolution: 0.04 inch (1 mm.).
    f. Medium Suitability:
        1) Suitable for most liquids with measuring range decreasing for liquids with smaller dielectric constants.
        2) For conductive liquids, (for example, water) maximum possible measuring range is 164 feet.
4. Element/Integral Transmitter:
    a. Display: Integral, unless otherwise noted. Graphic display with touch control plus Bluetooth.
    b. Antenna:
        1) Drip-off.
        2) Size: 2 inch.

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3) Material: PTFE.
4) Beam Angle: 6 degrees.

c. Process Connection:
1) Type: 6-inch ANSI flange, RF.
2) Material: Type 316 stainless steel.
3) Seal: EPDM, unless otherwise noted.

5. Signal and Electrical Interface:
a. Analog:
1) 4 mA dc to 20 mA dc HART.
2) Not furnished when digital interface is noted.

6. Features:
a. Bluetooth.
b. Heartbeat Technology.

7. Enclosure:
a. Transmitter: NEMA 4X/IP65 watertight.
b. Antenna: NEMA 6P/IP68.
c. Dual compartment, aluminum coated.
d. Conduit Entry: 1/2-inch NPT, unless otherwise noted.

8. Accessories:
a. Weather protection cover, if noted.
b. Tagging Stainless Steel

9. Approvals: UL or other NRTL.

C. L50 Level Switch, Tuning Fork:

1. General:
a. Function: Point level switch for liquids.
b. Type: Vibronic.

2. Performance:
a. Measured Error: plus minus 1 mm (0.04 inch) at switch point.
b. Hysteresis: Typically: 2.5 mm (0.1 inch).
c. Non-Repeatability: 0.5 mm (0.02 inch).

3. Process Connections:
a. Type: Male NPT tread.
b. Size: 1 inch.

4. Probe:
a. Length: As noted.
b. Design: Compact.
c. Material: Type 316 stainless steel.

5. Features:
a. Approval: NSF 61.
b. Bluetooth and Heart beat technology.

6. Signal and Electrical Interface:
a. Discrete Output: Relay.
b. Insert Type: FEL64.

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7. Power Supply:
    a. Voltage: 19V ac to 253V ac.
    b. Power Consumption: S less 25 VA, P less 1.3W.
8. Enclosure:
    a. Rating: NEMA Type 4X/6P, 1.83 m H2O for 24 hours.
    b. Cable entry: NPT 1/2 inch.
    c. Type: Single compartment, unless otherwise noted.
    d. Material: Aluminum coated.
9. Environmental:
    a. Ambient Temperature: Minus 40 degrees F to 158 degrees F.
    b. Medium Temperature: Minus 58 degrees F to 302 degrees F.
10. Accessories:
    a. Protective Cover:
        1) Type: For single compartment housing.
        2) Material: Plastic.
    b. Tagging stainless steel.

D. M26 Hand Switch and Light, Corrosion, round:

1. General:
    a. Function: Select, initiate, and display discrete control functions.
    b. Type: Heavy-duty, corrosion-resistant, industrial.
2. General Features:
    a. Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.
    b. Legend Plate: Standard size, square style laminate with white field and black markings, unless otherwise noted. Markings as shown, or as implied by P&IDs.
    c. Configuration: Light, pushbutton, or switch as noted or shown.
3. Light Features:
    a. Lights: 6V ac lamps and integral transformer for operation for operation from 120V ac, unless otherwise noted.
    b. Lens Color: Color as specified, noted, or shown.
    c. Push-to-test, unless otherwise noted.
    d. Additional: As noted.
4. Pushbutton Features:
    a. Operator: Single pushbutton, flush, unless otherwise noted.
    b. Color: Black, unless otherwise noted.
    c. Boot: None, unless otherwise noted.
    d. Contact Arrangement: As required or shown.
    e. Additional: As noted.
5. Selector Switch Features:
    a. Operator: Knob, unless otherwise noted.
    b. Color: Black, unless otherwise noted.
    c. Boot: None, unless otherwise noted.

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d. Positions: As required or shown.
e. Return: Manual, unless otherwise noted.
f. Contact Arrangement: As required or shown.
g. Additional: As noted.

6. Signal Interface:
   a. Contact Block:
      1) Type: Standard, unless otherwise noted.
      2) Materials: Silver amalgam, unless otherwise noted.
      3) Rating: 10 amps continuous at 120V ac, unless otherwise noted.
      4) Sequence: Break-before-make, unless otherwise noted or shown.
      5) Arrangement: Normally open or normally closed as shown, or to perform the functions noted.
7. NEMA Rating: NEMA 4, watertight, dust-tight, and NEMA 4X, corrosion-resistant.
8. Manufacturers and Products:
   a. Allen-Bradley; Bulletin 800H.
   b. Square D Co.; Class 9001, Type SK.
   c. Eaton Corp.; Cutler-Hammer, Type E34.

E. M30 Horn Indoor/Outdoor:

1. General:
   a. Function: Audible alarm. Produces sound by electro-mechanical vibration of a diaphragm.
2. Performance:
   a. Temperature, Operating: Minus 65 degrees F to 150 degrees F.
   b. Sound Output Level: 100 dB nominal at 10 feet (110 dB at 1 meter).
3. Features:
   a. Dimensions: 4-3/8 inches in height and width, and 2.5 inches in depth, for horn and enclosure.
   b. Body: Die-cast zinc.
   c. Diaphragm: Stainless steel.
   d. Projector: None, unless otherwise noted.
   e. Listings: UL, cUL listed, FM, CSA approved.
4. Enclosure:
   a. Type: Cast aluminum with neoprene-gasketed NEMA 4X housing.
   b. Mounting: Surface mount.
5. Power: 120V ac, 50/60-Hz, unless otherwise noted.
6. Manufacturer: Federal Signal Corp.; Model 350WB.

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F. M31 Warning Light Indoor/Outdoor:

1. General:
   a. Function: Visual alarm.
   b. Type: Rotating reflector or flashing bulb.
   c. Parts: Light and spare bulbs.
2. Performance:
   a. Temperature, Operating: Minus 35 degrees F to 190 degrees F.
   b. Flash Rate: Nominally 90 per minute.
3. Features:
   a. Dome: Polycarbonate.
      1) Dome Color: Amber, unless otherwise noted.
      2) Lamp Life: 200 hours.
      3) Lamp: Incandescent/25 watts.
4. Enclosure:
   a. Type: IP65 (NEMA 4X).
   b. Mounting: 1/2-inch pipe, unless otherwise noted.
   c. Listing: UL listed, CSA certified.
5. Power: 120V ac, 50/60-Hz.
6. Spare Bulbs: Provide two for each light.
7. Manufacturers: Federal Signal; Model 225.

G. P04 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Less or equal plus or minus 0.50 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter, unless otherwise noted.
   b. Pointer Vibration Reduction:
      1) Required, unless otherwise noted. Use one of the following methods:
         a) PLUS! Performance.
         b) Liquid filled gauge front, unless otherwise noted.
            (1) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic, unless otherwise noted.

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g. Threaded reinforced polypropylene front ring.
h. Case Type: Solid front with blow-out back.

4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.
   c. Provide block and bleed valve.
5. Weather Protection: NEMA 4X (IP66), unless otherwise noted.
6. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
   b. Two-valve (isolate and vent) instrument manifold:
      1) Material: Type 316 stainless steel.
      2) Connection:
         a) Instrument:
            (1) Size: 1/2 inch.
            (2) Type: Female NPT.
         b) Process:
            (1) Size: 1/2 inch.
            (2) Type: Female NPT.
   c. Tagging stainless steel.

H. P08 Pressure Switch:

1. General:
   a. Function: Monitor pressure.
   b. Type: Diaphragm-type, Snap action switch.
2. Performance:
   a. Setpoint:
      1) As Noted.
      2) Adjustable from 15 percent to 100 percent of range.
      3) Setpoint Repeatability: plus or minus 1 percent of full range.
      4) Setpoint Direction: As Noted.
   b. Range: As Noted.
   c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
   d. Operating Temperature Limit: 170 degrees F.
3. Features:
   a. Diaphragm Material: Buna-N, unless otherwise noted.
   b. Differential (deadband): Fixed.
   c. Reset: Automatic, unless otherwise noted.
   d. Mounting: Surface, unless otherwise noted.
   e. SIL 3 Capable.
   f. Internal setpoint locking screw.

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4. Process Connection:
    a. 1/2-inch NPT Male, 1/4-inch NPT Female (Combination connections), unless otherwise noted.
    b. Materials: Stainless steel, unless otherwise noted.
5. Enclosure:
    a. Type: NEMA 4X, unless otherwise noted.
    b. Material: Epoxy coated aluminum.
6. Signal Interface:
    a. Contact Type:
        1) General purpose, UL/CSA Listed SPDT, unless otherwise noted.
        2) Rated for 15 amps minimum at 125V ac, 6A at 30V dc.
    b. Electrical Termination: 1/2-inch NPT.
7. Accessories: Tagging stainless steel.
8. Manufacturer and Product: Ashcroft, B-Series Pressure Switch.

I. S12 Indicator Field Mount:

1. General:
    a. Function: Digital indication of analog signal.
    b. Type:
        1) Integral enclosure suitable for field mounting.
        2) Loop-powered.
2. Performance:
    a. Accuracy: Plus or minus 0.1 percent of full scale plus or minus one count.
    b. Display Update Rate: 2.5 second minimum.
    c. Operating Temperature Range: Minus 40 degrees C to 80 degrees C.
3. Features:
    a. Display:
        1) LCD.
        2) 3.5-digits.
        3) 0.35 inch minimum.
    b. Input Impedance: 75 ohms maximum.
4. Enclosure:
    a. NEMA 4X, unless otherwise noted.
    b. Mounting: Surface, unless otherwise noted.
5. Loop-powered.
6. Signal Interface: 4 mA to 20 mA dc at 24V dc maximum.
7. Accessories: As required to support the noted options.
8. Manufacturer and Product: Red Lion.

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2.05 I&C COMPONENTS

A. L10 Level Transmitter, Hydrostatic.

B. L29 Level Transmitter, Radar.

C. L50 Level Switch, Tuning Fork.

D. M27 Pushbutton.

E. M30 Horn, Indoor and Outdoor.

F. M31 Warning Light, Indoor and Outdoor.

G. P04 Pressure Gauge.

H. P08 Pressure Switch.

I. S12 Indicator, Field Mount.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. International Society of Automation (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL: 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.

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6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
7. Seismic anchorage and bracing data sheets and drawings 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. Programmable Controller Submittals:
   a. Complete set of user manuals.
   b. Fully documented ladder logic listings.
   c. Function listing for function blocks not fully documented by ladder logic listings.
   d. Cross-reference listing.
3. Manufacturer's list of proposed spares, expendables, and test equipment.
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
2. Light Bulb: 100 percent, two minimum, of each type used.
3. Fuse: 100 percent, five minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 00, Instrumentation and Control for Process Systems.

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2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 mA dc to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 3, two-wire circuits.
3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

1. Power source: Less than 30V dc.

C. Discrete Signals:

1. Two-state logic signals.
2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

D. As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14-gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

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E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and Type 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

J. Lighting: Minimum of one hand switch controlled internal 1,600 lumen LED light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:

1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer’s standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman
2. Saginaw

N. Breather and Drains: Furnish with NEMA 250, Type 4 and Type 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

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2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures shall be UL listed.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
   a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
   b. Branch Circuit Breakers: 15 amps at 250V ac.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main overcurrent protective device with panel door.
   a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
   b. Mount operator controls and indications on front access door.
   c. Complete assembly shall have an overall short circuit rating of 22kA rms symmetrical at 480V.
2. Circuit Breakers:
   a. In accordance with NEMA AB 1.
   b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
   a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
   b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
   c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
   a. Power Control Transformer:
      1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
      2) Limit voltage variation to 15 percent during contact pickup.

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3) Fuse one side of secondary winding and ground the other.
4) Furnish primary winding fuses in ungrounded conductors.

5. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. AC Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 3 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer’s standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

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G. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) 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 funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: One at each end of rail, minimum.
   g. Wire Preparation: Stripping only.
   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.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30-amp.
   c. Wire Size: 22 AWG through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25-inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.
4. Terminal Block, Ground:
   a. Wire Size: 22 AWG through 12 AWG.
   b. Rated Wire Size: 12 AWG.
   c. Color: Green and yellow body.

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d. Spacing: 0.25-inch, maximum.
e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
f. Manufacturer and Product: Entrelec; Type M4/6.P.

5. Terminal Block, Blade Disconnect Switch:
   a. Use: Provide one for each discrete input and output field interface wire.
   b. Rated Voltage: 600V ac.
   c. Rated Current: 10-amp.
   d. Wire Size: 22 through 12 AWG.
   e. Rated Wire Size: 12 AWG.
   f. Color: Gray body, orange switch.
   g. Spacing: 0.25-inch, maximum.
   h. Manufacturer and Product: Entrelec; Type M4/6.SN.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 6.3-amp.
   c. Wire Size: 22 AWG through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32-inch, maximum.
   k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3-amp.
   c. Wire Size: 22 AWG through 12 AWG
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.
   j. Spacing: 0.32-inch, maximum
   k. Manufacturer and Product: Entrelec; Type M4/6.SFL.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

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I. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Provide dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Furnish holddown clips.
2. 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 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.
3. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
4. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified 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 or range.
   i. Time Delay Setpoint: As specified or shown.
   j. Mode of Operation: As specified or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.

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l. Manufacturer and Products: Potter and Brumfield.
   1) Series CB for 0.1-second to 100-minute delay time ranges.
   2) Series CK for 0.1- to 120-second delay time ranges.

J. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 degrees C to 60 degrees C and up to 95 percent humidity, noncondensing.
6. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.
7. Manufacturer: Allen-Bradley CompactLogix.

K. Network Switch:

1. Provide sufficient ports to connect to each device, spare 15 percent ports, and two open ports for a customer connection and a PC connection for maintenance.
2. Provide a managed switch which supports Ethernet IP protocols.
3. Manufacturer: Allen-Bradley.

L. HMI (Human Machine Interface):

1. Color Touchscreen: 14-inch display, minimum.
2. Communications:
   a. Supports Ethernet IP.
   b. One USB Port and one ethernet port, minimum.

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M. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and Type 12 Panels:

1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8-inch and 1/4-inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Eaton/Cutler-Hammer; Model 10250T.
2. Indicating Lights:
   a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
   b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Allen-Bradley; Model 800T
      2) Eaton/Cutler-Hammer; Type 10250T.
      3) General Electric; CR2940U.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Allen-Bradley; Model 800T
      2) Square D; Class 9001, Type K.
      3) Eaton/Cutler-Hammer; Type T.
      4) General Electric; Type CR-2940.
4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16-inch to 1/4-inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Allen-Bradley; Model 800T
      2) Eaton/Cutler-Hammer; Type T.
      3) Square D; Type K.

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f. Manufacturers and Products for Units with up to 12 Selection Positions:
   1) Rundel-Idec; Standard Cam Switch.
   2) Electroswitch; 31.

N. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8-inch and 1/4-inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16-inch to 1/4-inch.

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e. Manufacturer and Products:
   1) Square D; Class 9001, Type SK.
   2) Allen-Bradley; Type 800H.

2.06 INSTRUMENT TAG NUMBERS

A. A shorthand tag number notation is used. For example:

AI-1234

Notation	Explanation
AI	ISA designator for Analysis Indicator
1234	Loop number

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.

1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:

1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16-inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2-inch high.

C. Standard Light Colors and Inscriptions:

1. Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	**Inscription(s)**	**Color**
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green

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Tag	Inscription(s)	Color
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

2. Lettering: Black on white and amber lenses; white on red and green lenses.
3. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in the Instrument List:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

   b. Lettering Color:
      1) Black on white and yellow buttons.
      2) White on black, red, and green buttons.

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2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.

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b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines: Emerson Edco PC-642 or SRA-64 series.
2. 120V ac Lines: Emerson Edco HSP-121.
3. 480-Volt, Three-Phase Power Supplies: Square D Model SDSA3650.
4. Field Mounted at Two-Wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
   a. Enclosure:
      1) NEMA 4X Type 316 stainless steel with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Emerson Edco; SLAC series.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding and Bonding for Electrical Systems, and suppressor manufacturer's requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

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3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer’s recommendations. Replace capsules at Substantial Completion.

3.03 POINT MAPPING

A. Provide point mapping for ethernet IP communications to site SCADA system.

END OF SECTION

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SECTION 41 22 23.19
MONORAIL HOISTS

EQUIPMENT AND COMPONENT NUMBER(S)

CRN-7481: Monorail Hoist 1.
CRN-7482: Monorail Hoist 2.

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI): MH27.1, Underhung Cranes and Monorail Systems.
2. American Society of Mechanical Engineers (ASME):
   a. B30.10, Hooks.
   b. B30.16, Overhead Underhung and Stationary Hoists.
   c. B30.17, Cranes and Monorails (with Underhung Trolley or Bridge.
   d. HST 4M, Performance Standard for Overhead Electric Wire Rope Hoists.
3. National Electrical Manufacturer's Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Occupational Safety and Health Administration (OSHA).
6. UL: 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

A. Monorail System: Specifications for Underhung Cranes and Monorail Systems, ANSI MH27.1 and ASME B30.17.

B. Hoist: ASME B30.17, Hoist Manufacturers' Institute.

C. Trolley: ANSI MH27.1.

D. Wire Rope Hoist Service Class: ASME HST 4M.

E. Hook: ASME 30.10.

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F. Stress and Safety Factors: ANSI MH27.1 and ASME B30.17. Properly select materials of construction for stresses to which subjected.

G. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.17 and OSHA requirements.

H. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01 61 00, Common Product Requirements, and Section 01 88 15, Anchorage and Bracing.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, materials of construction, and specifications on hoist, wheels, gears and bearing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
   c. Dimensioned crane system drawings to indicate the following:
      1) Monorail extents and end stops.
      2) Monorail electrification and connection point.
      3) Pendant connection point and cable length, as applicable.
      4) Hoist hook high and low travel limits relative to trolley runway surface.
      5) Hoist and trolley dimensions and recommended clearances, and dimensions of electrification system to define clearance to structure.
2. Power and control wiring diagrams, including terminals and numbers.
3. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
4. Factory finish system.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Factory Tests, including Factory Functional and Performance Test Reports and Log. Use blank form provided in Section 01 99 90, Standard Forms.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.

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5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
7. Field performance test procedures for load testing.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 91 14, Equipment Testing and Facility Startup. Use blank form located in Section 01 99 90, Standard Forms.
9. Field Functional and Performance Test Reports and Log.
10. Load test report and certifications for hoist use for each hoist.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Indoor Applications:

1. Temperature: Maximum 101 degrees F; minimum 55 degrees F.
2. Humidity: 75 percent.
3. Atmosphere: Mildly corrosive.
4. Ventilation: Six air changes per hour.

1.05 WARRANTY

A. Provide manufacturer's warranty, with Owner named as beneficiary, in writing, to warrant supplied equipment to be free of defects in materials and workmanship for a period of 1-year, with warranty period beginning upon successful completion of Demonstration Testing as specified in Section 01 75 16, Facility Startup.

B. Provide an extended warranty for a period of 1-year beyond the 1-year warranty specified above for a total coverage period of 2 years. Provide separate line-item pricing for the 1-year warranty extension.

1.06 EXTRA MATERIALS

A. Furnish special tools, materials, and supplies required to install, commission, and startup equipment.

B. Submit list of recommended spare parts as part of the Operations and Maintenance (O&M) manual submittal as specified in Section 01 78 23, Operation and Maintenance Data.

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PART 2 PRODUCTS

2.01 GENERAL

A. Materials, equipment, and accessories specified in this section shall be products of:

1. ACCO Wright.
2. “Or-equal.”

B. Hoist and trolley manufacturer to coordinate equipment requirements with steel structures, drive motor, hoisting cable or chain, hook, track, stops, and electrical equipment controls.

C. Where adjustable speed drives or remote-control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

A. See supplements to this section for additional requirements.

2.03 TRACK

A. Monorail track furnished under Section 05 12 00, Structural Steel Framing.

B. Stops: Furnish stops and impact-absorbing bumpers at open track ends.

2.04 TROLLEY

A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Construct to control deflection of trolley assembly while transmitting the carrying load to running surface.

B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.

C. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.

D. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

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E. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single row tapered roller bearings. Bearings prelubricated and sealed or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

F. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.17. Furnish stops on monorail beams.

2.05 WIRE ROPE HOIST

A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on Supplements at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

B. Rope drum and surrounding members constructed to minimize abrasion, crushing, or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.

C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars, or other devices.

D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.06 ELECTRICAL

A. Furnish electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit.

B. Electrical: In accordance with NFPA 70, NEC Article 610.

C. Each monorail hoist assembly that includes factory installed motors, electrical boxes, raceways, and wiring shall have a UL or third party Listing/Labelling Mark per NEC 110.3.

D. Monorail conductor voltage drops from monorail track supply taps shall permit the hoist and trolley motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

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E. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

F. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.07 CONTROLS

A. Hoist and Trolley: Pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

B. Pushbuttons: In accordance with Section 26 05 04, Basic Electrical Materials and Methods, and sized for starting, accelerating, reversing, and stopping duty for specified hoist service class. Housed in NEMA enclosure, type as required per Area Classification and Material Selection Table on the Drawings.

C. Trolley Drives: Soft start controls, 460/230V ac series device, installed between drive motor and motor starter with torque and acceleration rate adjustable, suitable for trolley drive service, and work in conjunction with crane control and pendant system.

D. Pendant Control Stations: Heavy-duty, watertight, corrosion resistant type suspended from trolley, hoist, powered via an integral control power transformer to provide 120V ac power to control station. Pushbutton enclosure supported with wire rope. Control wire cable attached to support wire rope at not more than 6-foot intervals. Furnish control station buttons for control of hoist and trolley ON/OFF main line contactor power switch which removes all power from control station.

E. Control motions indicate direction of resultant monorail motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway monorail situations.

2.08 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

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2.09 FACTORY FINISHING

A. Prepare and prime coat in accordance with Section 09 90 00, Painting and Coating, System No. 5.

2.10 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: No-load run test all equipment furnished.

C. Factory test report shall include Test Data Sheets.

D. Submit completed Manufacturer's Certificate of Factory Tests, including Factory Functional and Performance Test Reports and Log.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Provide lubrication and lubrication fittings.

3.02 FIELD FINISHING

A. Repair and finish equipment as required and in conformance with Section 09 90 00, Painting and Coating.

3.03 FIELD TESTING AND FACILITY STARTUP

A. Field Testing and Facility Startup shall be in accordance with the requirements of Section 01 91 14,Equipment Testing and Facility Startup.

B. Facility startup specifies order and prerequisites for the following tests of equipment:

1. Field functional testing.
2. ORT 1 testing.
3. ORT 2 testing.
4. Performance testing.
5. Demonstration testing.

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C. All Field Testing and Facility Startup shall be performed using a qualified representative provided by manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup; Section 01 43 33, Manufacturer's Field Services, and as elaborated upon in this section.

3.04 FIELD QUALITY CONTROL

A. Field Functional Tests: Conduct on each hoist and monorail system.

1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

B. Field Performance Test Procedures:

1. Proposed load test procedures shall be developed by hoist supplier and submitted to Owner's Representative for review, comment, and approval.
   a. Include description and physical size of test weight(s) and method to transport weights to within hoist hook coverage area.
2. Submit test procedures at least 30 days in advance of specific hoist testing.
3. Testing shall not begin until test procedures have been approved by the Owner's Representative.

C. Field Performance Test:

1. Conduct on each hoist and monorail system.
2. Load tests conducted by crane supplier in compliance with OSHA, ASME B30.17, and ANSI MH27.1.

D. Submit completed Manufacturer's Certificate of Proper Installation.

3.05 MANUFACTURER'S SERVICES

A. Refer to Section 01 43 33, Manufacturer's Field Services.

B. Schedule training after associated equipment is certified by the manufacturer as properly installed and ready for operation using the Manufacturer's Certificate of Proper Installation, and after the equipment is energized.

C. Training shall follow the Master Operation and Maintenance Training Schedule as specified in Section 01 91 14, Equipment Testing and Facility Startup.

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D. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below; travel time excluded:
   a. 2 person-days for installation assistance and inspection.
   b. 2 person-days for functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or Site training. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.
   d. 2 person-days for performance testing.

3.06 SUPPLEMENTS

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

1. Monorail Hoist 1 and Monorail Hoist 2 Data Sheet.
2. Hoist/Monorail Dimension Sheet.

END OF SECTION

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MONORAIL HOIST 1 AND MONORAIL HOIST 2 DATA SHEET

Project: Gresham WWTP BFP Replacement

Manufacturer.: ACCO WRIGHT, "or-equal"

Owner: City of Gresham

Model No.: NER, "or-equal"

Service: Monorail Hoist 1, Monorail Hoist 2

Number of Units: 2

Equip. Tag Number(s): CRN-7481, CRN-7482

Rev/Date/By: _____/_____/_____

GENERAL REQUIREMENTS

Equipment Capacity: 2.0 tons

Method of Control: Pendant

Location of Control: Hoist

Equipment Location:

☒Indoors ☐Outdoors

Factory Testing:

☒Required ☐Not Required

Field Testing: ☐Not required

☒Required, functional and performance

Power Supply:

Voltage: 460

Phase: 3

Frequency: 60

HOIST

Type:

☒Electric, Wire Rope ☐Hand Operated, Chain

Service Class (ANSI):

☒H1 (standby) ☐H2 (light) ☐H3 (standard)

☐H4 (heavy) ☐H5 (severe)

Speed (fpm): 14/2.5

☐Constant Speed ☒Two Speed ☐Variable Speed

Motor hp: 2.4

Hook: See Hoist/Monorail Dimension Sheet

Hook Manufacturer: Manufacturer's Standard

Reeving:

TROLLEY

Type:

☐Top Running ☒Underhung

Service Class (ANSI):

☒A1 (standby) ☐A2 (infrequent) ☐B (light)

☐C (moderate) ☐D (heavy)

Speed (fpm): 40/6.5

☒Constant Speed ☐Variable Speed ☐Hand Operated

Motor hp: 1.7

Electric Conductors:

☐Bus Bar ☒Festoon ☐_____

☐Cable Reel

SPECIAL REQUIREMENTS

Accessories:

☐Central Lubrication System

☒OSHA operating and safety devices

Remote Controls:

☐Infrared, line-of-sight

☐Frequency modulated (FM)

Manufacturer:

☐Extended Grease Fittings

Special Electrical Requirements:

See Hoist/Monorail Dimension Sheet for clearances, lift distances, and details.

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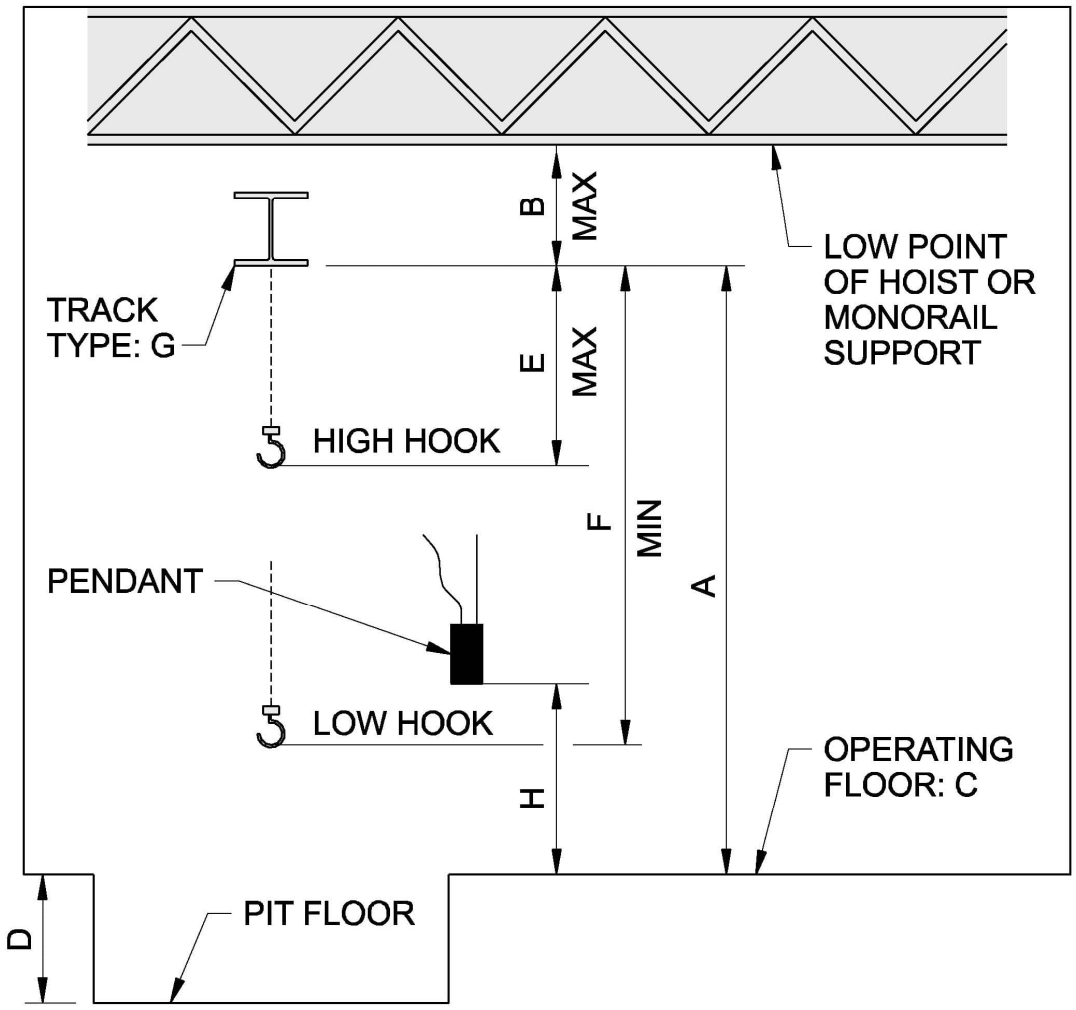
HOIST/MONORAIL DIMENSION SHEET
Building Clearances for Monorail Cranes

Project: Gresham WWTP BFP Replacement

Owner: City of Gresham

Equipment Tag Number(s): CRN-7481, CRN-7482



A: 14′-8″	D: 0′	G: See the Drawings
B: 1′-6″	E: 2′-3″	H: 4′-0″
C: EL 67.00′ First Floor	F: 14′-8″	

Notes:

1. Monorail Track Length: 26′-0″

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SECTION 43 40 02
FIBERGLASS REINFORCED PLASTIC TANK

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. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.
   b. RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.
2. ASTM International (ASTM):
   a. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   b. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   c. D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   d. D3299, Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   e. D4097, Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   g. E1067, Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels.
3. Occupational Safety and Health Act (OSHA): Part 1910.24, Subpart D, Walking-Working Surfaces.

1.02 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.

1.03 DESIGN REQUIREMENTS

A. Design Loads: In accordance with Section 01 61 00, Common Product Requirements.

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B. Design tank, including resin selection (unless specified), wall thickness, methods and locations of support, and stiffener requirements. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction, including complete resin system information.
   b. Letter from resin manufacturer stating that selected resin is suitable for intended service.
   c. Detailed fabrication drawings.
   d. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
   e. Tank capacity chart indicating gallons for every 12 inches of depth and cumulative total from bottom.
   f. Fabricator’s detailed requirements for tank foundations.
   g. Recommended bolt torque for bolted FRP connections.
   h. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.
2. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.

B. Informational Submittals:

1. Complete design calculations for tanks, supports and appropriate accessories stamped by an engineer registered in the State of Oregon.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
3. Fabricator’s Certificate of Compliance with fabrication requirements.
4. Qualifications of Fabricator’s Quality Assurance Supervisor.
5. Copy of fabricator’s Quality Assurance Program.
6. Quality Assurance Inspection:
   a. Qualifications of Independent FRP Quality Assurance Inspector.
   b. Initial QA Inspection Report.
   c. Certification of Factory Testing.
7. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
8. Special shipping, storage and protection, and handling instructions.

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9. Fabricator’s printed installation and tank support instructions.
10. Manufacturer’s Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers’ Field Services.
11. Qualifications of Acoustic Emission Test Agency.

C. Contract Closeout Submittals: Service records for repairs performed during construction.

1.05 WARRANTY

A. Provide manufacturer's warranty, with Owner named as beneficiary, in writing, to warrant the supplied equipment to be free of defects in materials and workmanship for a period of 1-year, with the warranty period beginning upon successful completion of functional tests.

1.06 EXTRA MATERIALS

A. Furnish special tools, materials and supplies required to install, commission and startup equipment.

B. Submit list of recommended spare parts a part of the Operations and Maintenance (O&M) manual submittal as specified in Section 01 78 23, Operations and Maintenance Data.

1.07 QUALITY ASSURANCE

A. Fabricator’s Quality Assurance Supervisor: Minimum of 5 years’ experience in fabrication of fiberglass structures.

B. Designer: Registered professional engineer licensed in state where Project is located.

C. Independent FRP Quality Assurance Inspector:

1. Minimum 5 years’ experience as FRP inspector.
2. Representing a corporately and financially independent organization that can function as an unbiased inspection authority.
3. Professionally independent of manufacturers, suppliers, and installers of systems being inspected.

D. Acoustic Emission Testing Agency: Minimum 5 years’ experience in acoustic emission testing of fiberglass structures.

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1.08 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements. In addition, prepare and protect tank for shipment as follows:

1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside tank.
5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.

1.09 SEQUENCING AND SCHEDULING

A. Do not ship tank from factory until Engineer's review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.02 SERVICE CONDITIONS

A. Operating Pressure: Atmospheric.

B. Operations: Continuous

2.03 MATERIALS

A. Filament-Wound: Fabricate in accordance with ASTM D3299, Type I, Grade 1.

B. Resin:

1. Suitable for intended service.
2. Premium grade and corrosion resistant, such as chlorendic polyester, vinyl ester, or bisphenol A fumarate polyester.
3. Use same resin throughout entire tank shell.

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4. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
5. No dyes, pigments, or colorants.
6. No fillers or thixotropic agents.
7. Additives may be added to achieve fire retardancy. The Flame-Spread Rating of finish laminate shall be less than 25, as determined by ASTM E84. Additives shall not be added to interior layer, unless specifically required.
8. Curing System:
    a. As recommended by resin manufacturer or as specified herein.
    b. Cure products as specified in ASTM D3299.
    c. Measure Barcol hardness according to ASTM D2583.
9. Post-cure tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature. Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.

C. Reinforcements:

1. Surfacing Veil: Chemical surfacing mat, Type C (chemical) glass, 10 mils thick, with a finish and a binder compatible with the lay-up resin.
2. Other Reinforcements: In accordance with ASTM D3299.

D. Laminate:

1. Consists of inner surface (corrosion barrier), interior layer, and exterior layer (structural layer).
2. Meet visual acceptance criteria in ASTM C582.
3. Meet requirements of mechanical properties in ASTM D3299.
4. Reinforce inner surface with resin-rich surfacing veil as specified herein.
5. Apply an Owner preferred color coat after inspection of laminate has been completed.

E. Marking:

1. Identify each tank with fabricator's name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, tank number, tank name, and date of manufacture.
2. Provide permanent marking. Seal decals, labels, etc., into laminate exterior with clear resin.

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F. Nozzles:

1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.
2. Finish flush with inside surface of tank, unless otherwise indicated.
3. Gaskets:
   a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric material having a hardness of Shore A60 plus or minus 5.
   b. Material shall be suitable for intended service.
4. Flanged Nozzles: Rated at 100 pounds per square inch, with other dimensions and bolting corresponding to ASME B16.5 for 150-pound steel flanges.
5. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.

G. Dip-Pipes:

1. Provide inside and outside surfaces of dip-pipes with corrosion barrier.
2. Surfacing veil for this corrosion barrier shall be same as specified for tank.
3. Corrosion barrier shall consist of appropriate surfacing veil, backed by two layers of fiberglass mat.
4. If “ready-made” pipe is used, it shall have an equivalent internal corrosion barrier and shall have specified corrosion barrier applied to outside surface.

2.04 APPURTENANCES

A. Sight Glass (Type 1):

1. Tubular type PVC with 1-inch flanged connection.
2. Furnish with valves, drain cock, Pyrex glass, and stainless steel guard rods.
3. Parts coming in contact with liquid shall be either PVC or glass.
4. Calibrate tank in 100-gallon increments and paint calibrations adjacent to level tube with graduations and boldface figures.
5. Manufacturer and Product: Ernst Flow Industries; Model EFI-PVC.

B. Sight Glass (Type 2):

1. Calibrate in 100-gallon increments.
2. Abrasion and corrosion resistant.
3. Mount using 1/2-inch Tygon tubing, PVC fittings, PVC isolation ball valve, and stainless steel hose clamps.

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C. Supports:

1. Pipe Supports:
   a. Provide for tank overflow pipes, loading pipes and recirculation pipes.
   b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.
   c. As shown on the Drawings, shall allow removal of pipe.
   d. Type 316 stainless steel complete with necessary bolts, nuts, and washers.
2. Level Probe Supports: Stainless steel.

D. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.

E. Anchor Bolts: Type 316 stainless steel bolts, sized by fabricator, and 1/2-inch minimum diameter and as specified in Section 05 50 00, Metal Fabrications.

F. Manway Bolts: Type 316 stainless steel bolts and nuts as specified in Section 05 50 00, Metal Fabrications.

G. Tank Insulation and Heat Tracing: In accordance with Section 40 05 33, Heat Tracing.

2.05 SOURCE QUALITY CONTROL

A. Independent FRP Inspector:

1. To be present at point of manufacture at time fabrication is started, to perform the following:
   a. Observe manufacturing methods, machinery, and techniques to ensure compliance with industry standards and these Specifications.
   b. Observe initial fabrication to verify compliance with these Specifications.
   c. Observe quality control methods for mixing resins and testing of completed equipment.
   d. Generally observe quality of other ongoing fabrication.
   e. Prepare Initial QA Inspection Report.
2. To be present at point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following:
   a. Visual inspection to requirements of ASTM C582.
   b. Barcol Hardness measurements per ASTM D2583.
   c. Acetone sensitivity test for internal secondary bonds.
   d. Glass content by ignition loss on three cutouts per ASTM D2584.

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e. Hydrostatic Leak Test:
   1) Perform on each tank.
   2) Fill to top nozzle; allow to stand for 2 hours with no visible leakage.

3. Prior to beginning repair work, repairs deemed acceptable by Independent FRP Inspector shall be approved by Engineer.

B. Identify and retain cutouts. Engineer may select certain cutouts for testing for physical properties of laminate.

C. Factory Test Reports:

1. Certify results, by signature, of the following:
   a. Inspections.
   b. Results of hydrostatic testing.
   c. Test reports of physical properties of standard laminates.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with fabricator's written instructions.

B. Accurately place anchor bolts using templates furnished by fabricator, and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each tank.
2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER'S FIELD SERVICES

A. Provide fabricator's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup, for installation assistance, inspection and certification of proper installation and startup assistance for specified component, subsystem, equipment, or system.

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3.04 SUPPLEMENTS

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

1. FRP Tank Schedule.
2. Thickening Polymer Storage Tank Data Sheet.
3. Dewatering Polymer Storage Tank Data Sheet.

END OF SECTION

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FRP Tank Schedule			
Name of Tank*	Thickening Polymer Storage Tank	Dewatering Polymer Storage Tank 5	
Equipment Numbers	TNK-7631	TNK-7685	
Filament-wound or Contact-molded	Filament Wound	Filament Wound	
Maximum Capacity Measured to High Solution Level (gallons)	1,169	1,624	
Installation (Vertical/Horizontal)	Vertical	Vertical	
Diameter (feet)	5	6	
Straight Shell Height (feet)	8	8	
Support (saddles, flat pad, legs)	Flat Pad	Flat Pad	
Type of Bottom Head	Flat	Flat	
Type of Top Head	Conical	Conical	
Ladder Required (Yes/No)	No	No	
Tank Location (indoor/outdoor)	Indoor	Indoor	
Ambient Temperature Range (degrees F)	60-104	60-104	
Exterior Loading (psf):			
Personnel Roof Loads			
Platforms			
Mixers			
Pipe Supports			
Operating Contents:			
Temperature (degrees F, not to exceed 180)	60	60	
Chemical Composition	Emulsion Polymer	Emulsion Polymer	
Specific Gravity	0.98 to 1.18	0.98 to 1.18	
Concentration	30-50%	30-50%	
pH Range	2.5-7	2.5-7	
Sight Glass Type (1 or 2)	No	No	
Sight Glass Tube Length	NA	NA	
Insulation/Heat Tracing (Yes/No)	No	No	

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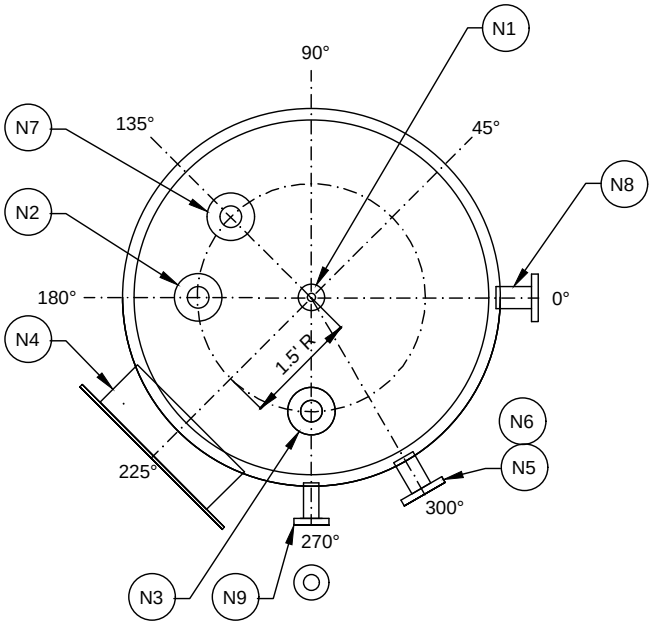
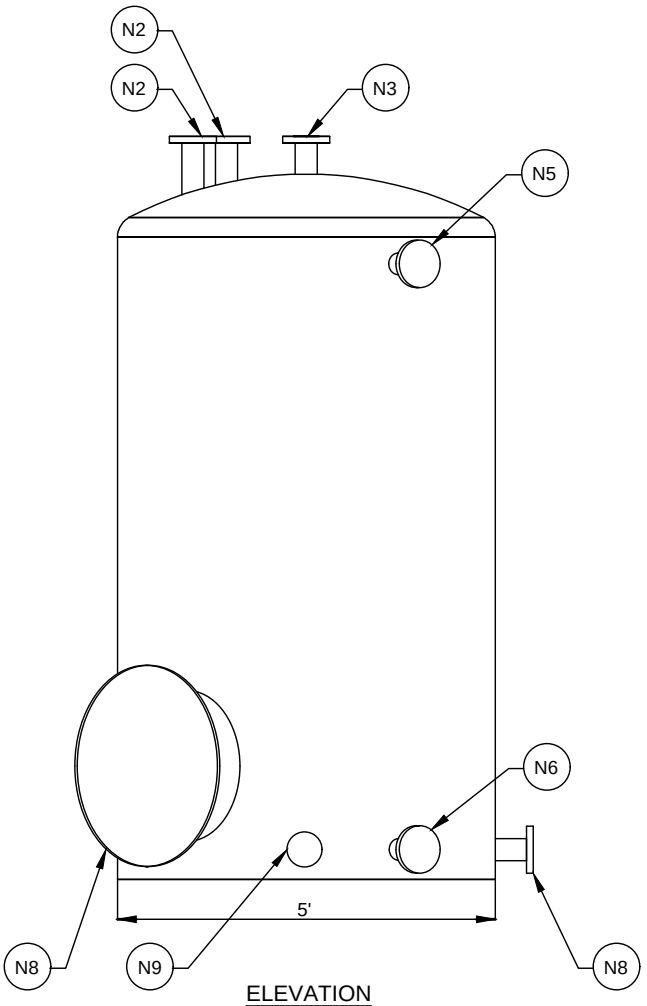


PLAN
NTS



ELEVATION
NTS

GENERAL INFORMATION

EQUIPMENT: THICKENING POLYMER STORAGE TANK (TNK-7631)

SERVICE:	EMULSION POLYMER		No. Reqd 1
Capacity	1,169 GALLONS	Thickness	-
Design code		Roof	DOME
Material	FRP	Shell	
Temperature		Bottom	FLAT

COATING	EXTERNAL	INTERNAL
Surface Prep	AS SPECIFIED	AS SPECIFIED
Primer		
Finish Coat		
Insulation Thk		
Material		
Cladding		

NOZZLE SCHEDULE

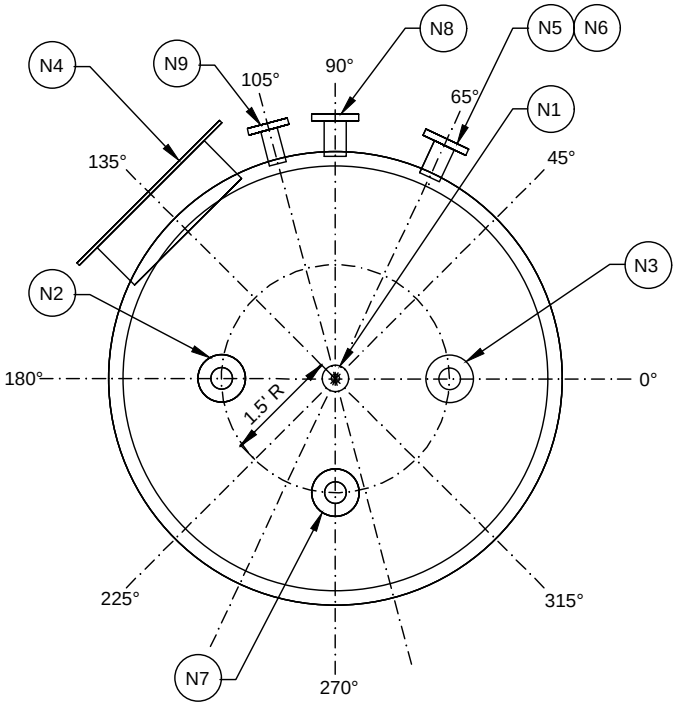
MK	Size/Type	Service	Location	Proj
N1	1"	POL/V	TOP	6"
N2	3"	POL (FILL)	TOP	6"
N3	3"	POL (RECIRCULATION RETURN)	TOP	6"
N4	24"	ACCESSWAY	SIDE	6"
N5	3"	POL/OF	SIDE	6"
N6	3"	POL/D	SIDE	6"
N7	3"	POL/V	TOP	6"
N8	3"	POL (OUTLET)	SIDE	6"
N9	2"	INSTRUMENT MOUNT	SIDE	6"

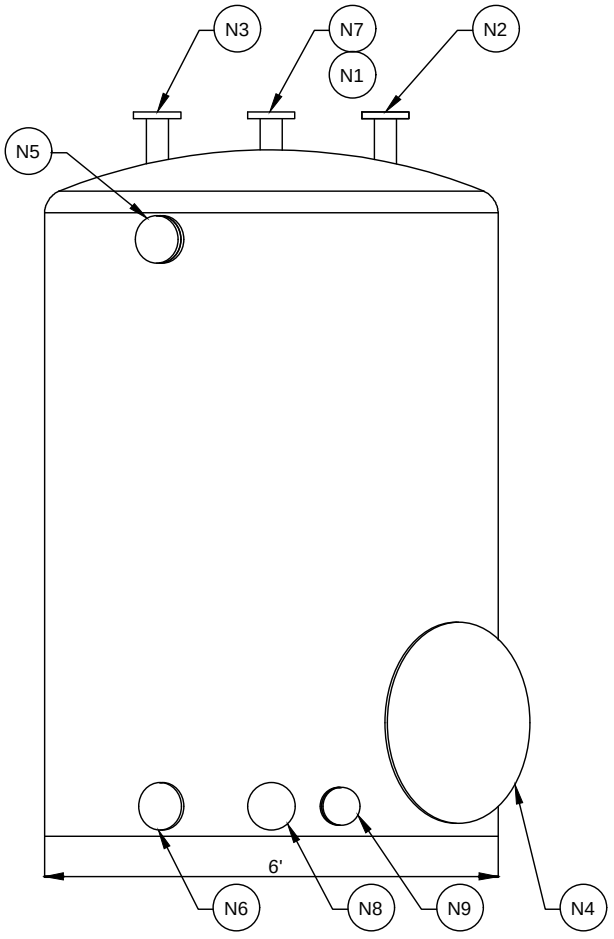
ACCESSORIES

Level Indicator		
Ladder ☐ Int ☐ Ext		
Stairs		
Walkway		
Platform Clips		
Anchor Lugs		
Syphon Drain		
Sump		
Vortex Breaker		
Inlet Baffle		
Lifting Lugs	X	
Thief Hatch		
Access Manway	X	
Down Comer ■ Int ☐ Ext	X	
Heater		
Pressure Vacuum Valve		

NOTES:

Jacobs





ELEVATION
NTS

GENERAL INFORMATION

EQUIPMENT: DEWATERING POLYMER STORAGE TANK 5 (TNK-7685)

SERVICE:	EMULSION POLYMER		No. Reqd 1
Capacity	1,624 GALLONS	Thickness	-
Design code		Roof	DOME
Material	FRP	Shell	
Temperature		Bottom	FLAT

COATING	EXTERNAL	INTERNAL
Surface Prep	AS SPECIFIED	AS SPECIFIED
Primer		
Finish Coat		
Insulation Thk		
Material		
Cladding		

NOZZLE SCHEDULE

MK	Size/Type	Service	Location	Proj
N1	1"	POL/V	TOP	6"
N2	3"	POL (FILL)	TOP	6"
N3	3"	POL (RECIRCULATION RETURN)	TOP	6"
N4	24"	ACCESSWAY	SIDE	6"
N5	3"	POL/OF	SIDE	6"
N6	3"	POL/D	SIDE	6"
N7	3"	POL/V	TOP	6"
N8	3"	POL (OUTLET)	SIDE	6"
N9	2"	INSTRUMENT MOUNT	SIDE	6"

ACCESSORIES

Level Indicator		
Ladder ☐ Int ☐ Ext		
Stairs		
Walkway		
Platform Clips		
Anchor Lugs		
Syphon Drain		
Sump		
Vortex Breaker		
Inlet Baffle		
Lifting Lugs	X	
Thief Hatch		
Access Manway	X	
Down Comer ■ Int ☐ Ext	X	
Heater		
Pressure Vacuum Valve		

NOTES:

Jacobs

SECTION 44 42 56.13
PROGRESSING CAVITY PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

PMP-7611: Recirculation Pump 1 (Thickening Polymer System).
PMP-7661: Dewatering Recirculation Pump 1 (Dewatering Polymer System).
PMP-7662: Dewatering Recirculation Pump 2 (Dewatering Polymer System).
PMP-7663: Dewatering Recirculation Pump 3 (Dewatering Polymer System).

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA).
2. Hydraulic Institute Standards (HIS).
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
   d. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
   e. Power and control wiring diagrams, including terminals and numbers.

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f. Motor data in accordance with requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
g. Factory finish system.
h. Manufacturer's Certification of Compliance that factory finish system is identical to the requirements specified herein.
i. L-10 bearing life calculations per ABMA.
j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory Functional Test Reports and Log.
3. Factory Performance Test Reports and Log.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer's printed installation instructions.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.
9. Field Performance Test Reports and Log.

1.04 WARRANTY

A. Provide manufacturer's warranty, with Owner named as beneficiary, in writing, to warrant supplied equipment to be free of defects in materials and workmanship for a period of 1 year, with warranty period beginning upon successful completion of Demonstration Testing as specified in Section 01 91 14, Equipment Testing and Facility Startup.

1.05 EXTRA MATERIALS

A. Furnish special tools, materials, and supplies required to install, commission, and startup equipment.

B. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Bearings	One complete set
Gaskets and O-ring seals	One complete set

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Item	Quantity
Mechanical seal	One complete set
Pump Stator	One per set of pumps
Pump Rotor	One per set of pumps
Special tools required to maintain or dismantle	One complete set for each different size unit

C. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Characteristics: Progressing cavity pump for mixing of emulsion polymer in storage tanks, with a viscosity of up to 6,000 centipoise.

B. Pumps shall be designed such that they can be installed either horizontal or vertical (on a wall). Provide the necessary supports for this installation.

C. Coordinate pump requirements with motor manufacturer and be responsible for pump and motor requirements.

D. Pumps furnished under this section shall be provided by a single manufacturer.

2.02 ACCESSORIES

A. Stator Thermal Protection:

1. Provide for pumps where indicated in supplements and as specified below:
   a. Stator thermal protection (run dry protection) shall shut pump down before stator damage occurs.
   b. Provide thermowell drilled and tapped into stator and thermocouple for measurement of temperature at pump stator to rotor interface.
   c. Provide temperature controller in NEMA 4X enclosure, with dual display for stator temperature and alarm set-point with adjustable hysteresis to prevent on/off cycling of pump when coming off an alarm.
   d. Provide thermocouple cable between thermocouple and temperature controller.

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e. Provide system operating with external 120-volt power supply.
f. High temperature alarm dry contact rating shall be 5 amps 120V ac. Contact and alarm shall automatically reset when temperature falls below hysteresis value.

B. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

C. Lifting Lugs: Equipment weighing over 100 pounds.

D. OSHA-approved guard for direct coupled or belt driven pumps.

E. Anchor Bolts: PTFE coated Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter.

2.03 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.04 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect for required construction, electrical connection and intended function.

B. Factory Tests and Adjustments: Test all equipment furnished.

C. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.

D. Functional Test: Perform manufacturer’s standard test.

E. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

F. Performance Test:

1. Conduct on each pump.
2. Conduct in accordance with Hydraulic Institute Standards.
3. Perform under simulated operating conditions.
4. Test for a continuous 3-hour period without malfunction.
5. Test Log:
   a. Record the following:
      1) Pump speed.
      2) Flow rate measured by factory instrumentation and storage volumes.
      3) Calculated velocity head at the discharge flange.
      4) Field head.

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5) Driving motor voltage and amperage measured for each phase.

6. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards, if necessary.

G. Submit completed Manufacturer's Certificate of Factory Tests, including Factory Function and Performance Test Reports and Log.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4-inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of the baseplate when anchor bolts are tightened.

C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 30 10, Structural Concrete. Remove wedges after grout is set and pack void with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

G. Pipe pump drain(s) to hub drain or scupper.

3.02 FIELD FINISHING

A. Repair and refinish equipment in accordance with Section 09 90 00, Painting and Coating.

3.03 EQUIPMENT TESTING AND FACILITY STARTUP

A. Equipment testing and facility startup shall be in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.

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B. Facility startup specifies order and prerequisites for the following tests of the equipment:

1. FT 1 testing.
2. Field functional testing.
3. FT 2 testing.
4. Performance testing.
5. Demonstration testing.

C. Field testing and facility startup shall be performed using a qualified representative provided by the manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup, Section 01 43 33, Manufacturer's Field Services, and as specified herein.

3.04 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Verify seal water pressure and flow rates prior to pump operation. Record and include these values on the Manufacturer's Certificate of Proper Installation.
3. Test for a continuous 1-hour period without malfunction.
4. Flow Output: Measured by plant instrumentation and storage volumes.
5. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
6. Verify the following functions of stator thermal protection device:
    a. Stator temperature high setpoint is configured to proper value for pump provided.
    b. Interlock activates when stator temperature reaches high setpoint and inhibits pump form running in all modes.
    c. Interlock resets/releases when stator temperature drops below the hysteresis value.

B. Submit completed Manufacturer's Certificate of Proper Installation.

C. Performance Test:

1. Conduct on each pump as part of Facility Startup.
2. Test for continuous 4-hour period.
3. Operate across specified range of flows, pumping specified media.
4. Record flow rate, suction pressure, discharge pressure, and motor amp draw at approximate 1/2-hour intervals and as needed to record operation over specified range of flows.

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3.05 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturers' Field Services.

B. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation assistance and inspection.
   b. 2 person-days for functional testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for prestartup classroom or Site training. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Owner.
   d. 2 person-days for performance testing and facility startup.

3.06 SUPPLEMENTS

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

1. Thickening Recirculation Pump 1, Dewatering Recirculation Pump 3 Data Sheet.
2. Dewatering Recirculation Pump 1, Dewatering Recirculation Pump 2 Data Sheet.

END OF SECTION

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THICKENING RECIRCULATION PUMP 1, DEWATERING RECIRCULATION PUMP 3 DATA SHEET

Service: Emulsion Polymer (Installed in the vertical)

Pump Name: Thickening Recirculation Pump 1, Dewatering Recirculation Pump 3.

Pump Tag Number(s): PMP-7611, PMP-7663

No. Pumps Required: 2

Pump A Mfr.: Moyno

Model No.: EZ Strip

Pump B Mfr.: "Or-equal"

Model No.:

Liquid Pumped and Service Conditions

Liquid Pumped: Emulsion Polymer

Pumping Temperature (°F):

Normal: 70 Max:100 Min: 60

Specific Gravity @ 60°F: 1.04

Viscosity Range (CP) @ 60°F: 6,000

Vapor Press. @ 60°F (psia):

Liquid pH: 2.5-7

Erosion/Abrasion/Corrosion: ☒Yes ☐No

Caused by:

Scale Buildup: ☐Yes ☒No

Caused by:

Ambient Temp (°F): Max: Min:

Altitude (ft above MSL):

Location: ☒Indoor: ☐Heated ☐Unheated ☐Outdoor

Area Classification:

Performance Requirements

Capacity Rated (U.S. gpm): 10

TDH Rated (ft): 12

Speed Rated Capacity (rpm): 150

☒Constant ☐Adjustable

Speed Range of Rated Speed (%):

Constant Torque: ☐Yes ☐No

Motor (per Section 26 20 00, Low-Voltage AC Induction Motors):

Horsepower: 2

Base Speed (rpm): 1,750

Voltage: 460 Phase: 3 Hz: 60

Service Factor: 1.15

Inverter Duty: ☐Yes ☒No

Enclosure:

☐DIP ☐EXP ☐ODP ☒TEFC ☐TENV

☐CISD-TEFC ☐WPI ☐WPII ☐SUBM

Remarks:

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THICKENING RECIRCULATION PUMP 1, DEWATERING RECIRCULATION PUMP 3 DATA SHEET (Continued)

Pump Design and Materials (Manufacturer to Supply Missing Data)

Connections:
- Suction size (inches): 3
  - ☒ Flanged Type: _____
  - ☐ Open-Throat
  - ☐ Screwed
  - Orientation: Vertical Mounted
- Discharge size (inches): 3
  - ☒ Flanged Type: _____
  - ☐ Screwed

Pump Body:
- Material: Type 304 Stainless Steel

Drive Housing:
- Material: Type 304 Stainless Steel

Pump Stages: 1

Suction Port:
- Material: ANSI 125

Stator:
- Material: Nitrile
- Thermal Protection: ☒ Yes ☐ No

Rotor:
- Material: Type 304 Stainless Steel

Connecting Rod:
- Material: Type 316 Stainless Steel

Drive Shaft:
- Material: Type 316 Stainless Steel

Joint:
- ☐ Gear Type Universal
- ☒ Pin Type Universal
- ☐ Other Type: _____

Shaft Sleeve: ☒ Yes ☐ No:
- Material: Type 316 Stainless Steel

Shaft Seal:
- ☐ Packing Material: _____
- ☐ Lantern Ring Material: _____
- ☒ Mechanical Type: _____
  - Material: Silicon Carbide
- Seal Lubrication: _____

Bearing:
- ABMA B-10 Life (hrs): 100,000
- Lubrication: ☐ Grease ☒ Oil

Coupling:
- ☒ Mfr Standard
- ☐ Falk
- ☐ Fast
- ☐ Gear Type

Baseplate:
- Design: Fabricated
- Material: Painted Steel

Drive Type:
- ☐ Direct-Coupled
- ☐ Belt
- ☒ Close-Coupled Gear Reducer
- ☐ Bearing-Frame Gear Reducer Drive

Arrangement: ☒ In-Line ☐ Piggy Back
- ☐ Horizontal Offset ☐ Vertical "Z"

Pump Coating System:
- Per Section 09 90 00, Painting and Coating

Remarks: Provide a baseplate such that it can be mounted on the wall

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DEWATERING RECIRCULATION PUMP 1, DEWATERING RECIRCULATION PUMP 2 DATA SHEET

Service: Emulsion Polymer

Pump Name: Dewatering Recirculation Pump 1, Dewatering Recirculation Pump 2

Pump Tag Number(s): PMP-7661, PMP-7662

No. Pumps Required: 2

Pump A Mfr.: Moyno

Model No.: EZ Strip

Pump B Mfr.: "Or-Equal"

Model No.: _____

Liquid Pumped and Service Conditions

Liquid Pumped: Emulsion Polymer

Pumping Temperature (°F):

Normal: 70 Max:100 Min: 60

Specific Gravity @ 60°F: 1.04

Viscosity Range (CP) @ 60°F: 6,000

Vapor Press. @ 60°F (psia): _____

Liquid pH: 2.5–7

Erosion/Abrasion/Corrosion: ☒Yes ☐No

Caused by: _____

Scale Buildup: ☐Yes ☒No

Caused by: _____

Ambient Temp (°F): Max: _____ Min: _____

Altitude (ft above MSL): _____

Location: ☒Indoor: ☐Heated ☐Unheated ☐Outdoor

Area Classification: _____

Performance Requirements

Capacity Rated (U.S. gpm): 10

TDH Rated (ft): 12

Speed Rated Capacity (rpm): 150

☒Constant ☐Adjustable

Speed Range of Rated Speed (%): _____

Constant Torque: ☐Yes ☐No

Motor (per Section 26 20 00, Low-Voltage AC Induction Motors):

Horsepower: 2

Base Speed (rpm): 1,750

Voltage: 460 Phase: 3 Hz: 60

Service Factor: 1.15

Inverter Duty: ☐Yes ☒No

Enclosure:

☐DIP ☐EXP ☐ODP ☒TEFC ☐TENV

☐CISD-TEFC ☐WPI ☐WPII ☐SUBM

Remarks: _____

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DEWATERING RECIRCULATION PUMP 1, DEWATERING RECIRCULATION PUMP 2 DATA SHEET (Continued)

Pump Design and Materials (Manufacturer to Supply Missing Data)

Connections:

Suction size (inches): 3

☒ Flanged Type: _____

☐ Open-Throat

☐ Screwed

Orientation: Horizontal

Discharge size (inches): 3

☒ Flanged Type: _____

☐ Screwed

Pump Body:

Material: Type 304 Stainless Steel

Drive Housing:

Material: Type 304 Stainless Steel

Pump Stages: 1

Suction Port: Flanged

Material: ANSI 125

Stator:

Material: Nitrile

Thermal Protection: ☒ Yes ☐ No

Rotor:

Material: Type 304 Stainless Steel

Connecting Rod:

Material: Type 316 Stainless Steel

Drive Shaft:

Material: Type 316 Stainless Steel

Joint:

☐ Gear Type Universal

☒ Pin Type Universal

☐ Other Type: _____

Shaft Sleeve: ☒ Yes ☐ No:

Material: Type 316 Stainless Steel

Shaft Seal:

☐ Packing Material: _____

☐ Lantern Ring Material: _____

☒ Mechanical Type: _____

Material: Silicon Carbide

Seal Lubrication: _____

Bearing:

ABMA B-10 Life (hrs): 100,000

Lubrication: ☐ Grease ☒ Oil

Coupling: ☒ Mfr Standard

☐ Falk

☐ Fast

☐ Gear Type

Baseplate:

Design: Fabricated

Material: Painted Steel

Drive Type: ☐ Direct-Coupled

☐ Belt

☒ Close-Coupled Gear Reducer

☐ Bearing-Frame Gear Reducer Drive

Arrangement: ☒ In-Line ☐ Piggy Back

☐ Horizontal Offset ☐ Vertical "Z"

Pump Coating System:

Per Section 09 90 00, Painting and Coating

Remarks: _____

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SECTION 44 44 63.01
POLYMER FEED SYSTEM, LIQUID

EQUIPMENT AND COMPONENTS

BLND-7601: Thickening Polymer Blending Unit 1.
PMP-7601: Thickening Polymer Blending Unit 1 Metering Pump.
BLND-7602: Thickening Polymer Blending Unit 2.
PMP-7602: Thickening Polymer Blending Unit 2 Metering Pump.
BLND-7603: Thickening Polymer Blending Unit 3.
PMP-7603: Thickening Polymer Blending Unit 3 Metering Pump.
BLND-7651: Dewatering Polymer Blending Unit 1.
PMP-7651: Dewatering Polymer Blending Unit 1 Metering Pump.
BLND-7652: Dewatering Polymer Blending Unit 2.
PMP-7652: Dewatering Polymer Blending Unit 2 Metering Pump.
BLND-7653: Dewatering Polymer Blending Unit 3.
PMP-7653: Dewatering Polymer Blending Unit 3 Metering Pump.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers the work necessary to provide polymer blend units, each including control panel, polymer metering pump, water feed controls, and all appurtenances as specified herein.

1.02 SUBMITTALS

A. Action Submittals-Shop Drawings:

1. Make, model, weight, and horsepower of each equipment item.
2. Schematic of piping layout showing all equipment, valves, and other accessories.
3. Manufacturer’s catalog information, descriptive literature, specifications, and materials of construction.
4. Manufacturer’s catalog information, descriptive literature, specifications, and materials for construction for the liquid polymer metering pump.
5. Detailed mechanical and electrical drawings showing equipment fabrications and interface with other items. Include dimensions, size and locations of connections to other Work.
6. Information on rotameters and mixer chamber shaft seals indicating pressure rating and service requirements specified herein.
7. Retention time and Gt (mean velocity gradient multiplied by retention time) values for polymer mixing chamber.

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8. Motor submittals in conformance with Section 26 20 00, Low-Voltage AC Induction Motors.
9. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
10. Electrical maximum operating current or demand load of each system.
11. Electrical control schematic and wiring diagrams that clearly show alarms, shutdowns, and contact closures for central control system.
12. Interconnection wiring diagrams showing power distribution, control interconnection, instrument connection, wire sizes and quantities, wire identification per control diagrams, and terminal block locations.
13. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.
14. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Information Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory Functional Test Report and log.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 1 year Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
9. Field Functional and Performance Test Report and log.

1.03 SAFETY REQUIREMENTS

A. All equipment furnished shall be designed and manufactured with due regard to safety of operation, accessibility, and durability of parts, and shall comply with all applicable Occupational Health and Safety Act, federal, state, and local safety regulations.

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1.04 QUALITY ASSURANCE

A. The polymer feed systems shall be furnished, coordinated, and tested by one supplier. The system shall be completely shop assembled, skid mounted, and shop tested prior to shipment.

B. All components shall be the standard product of a manufacturer regularly engaged in the production of required materials and equipment.

C. All equipment and material shall be designed and constructed in accordance with applicable standards as indicated.

1.05 SPARE PARTS AND SPECIAL TOOLS

A. Furnish one year supply of lubricants including oil and greases, as recommended by the product manufacturer. The lubricants shall include summer and winter grades along with alternative references to equal products of other manufacturers including specifications such as AGMA numbers, viscosity.

B. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Mechanical seal	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Flanged bearing	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Self-aligning bearing	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Stator (pump)	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Bearing, idler	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Check Valve	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.
Special tools needed for maintenance	One complete set for thickening polymer feed system and one complete set for dewatering polymer feed system.

C. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

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PART 2 PRODUCTS

1.06 GENERAL

A. The polymer feed systems shall be skid mounted assemblies consisting of one metering pump, mixing chamber, and all piping, valves, and controls capable of delivering required minimum and maximum gallons per hour of polymer solution as shown on attached schedule. Included with each polymer feed system shall be a pressure relief valve, back pressure valve, and calibration chamber.

1.07 MANUFACTURERS AND MODELS

A. Velodyne; VeloBlend, VM Series.

B. ProMinent; ProMix, S Series.

C. “Or-equal.”

1.08 SERVICE CONDITIONS

A. Liquid Pumped and Metered: Liquid emulsion cationic polymer, 30 percent to 50 percent activity.

B. Pumping Temperature: 60 degrees F to 100 degrees F.

C. Viscosity (varies with temperature and polymer type): Up to 6,000 centipoise.

D. Dilution Water: Non-potable water at approximately 60 pounds per square inch gauge.

E. All equipment provided shall be designed and rated for exposure to continuous 95 percent relative humidity conditions, for operation in ambient air temperature from 50 degrees F to 104 degrees F, and for exposure to intermittent water or sludge splash and spill conditions.

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1.09 PERFORMANCE REQUIREMENTS

A. General: The polymer system shall be capable of pumping and metering liquid polymer in response to an external signal, metering dilution water, activating polymer with dilution water and delivering activated polymer with dilution water to sludge thickening, dewatering or sludge drying bed equipment. Equipment shall automatically and independently vary both liquid polymer and water flow to produce consistent solution strength at all flow rates.

1. Thickening Polymer System:
   a. Polymer Solution Concentration Range: 0.2 percent to 0.5 percent, based on neat polymer.
   b. Polymer Solution Concentration Design Point: 0.5 percent, based on neat polymer.
   c. Neat Polymer Flow Range: 0.15 gallons to 3 gallons per hour, based on emulsion polymer with 40 percent active content.
   d. Dilution Water Range: 60 gallons per hour to 600 gallons per hour.
   e. Polymer Solution Discharge Pressure: 35 pounds per square inch gauge, minimum.
2. Dewatering Polymer System:
   a. Polymer Solution Concentration Range: 0.2 percent to 0.5 percent, based on neat polymer.
   b. Polymer Solution Concentration Design Point: 0.5 percent, based on neat polymer.
   c. Neat Polymer Flow Range: 0.75 gallons to 15 gallons per hour, based on emulsion polymer with 40 percent active content.
   d. Dilution Water Range: 240 gallons per hour to 2,400 gallons per hour.
   e. Polymer Solution Discharge Pressure: 35 pounds per square inch gauge minimum.

1.10 EQUIPMENT

A. General:

1. Polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. System shall not rely upon a static mixer as the means of polymer activation. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.

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2. Polymer feed system shall include a location within the skid for the installation of a progressing cavity polymer metering pump. The pump shall be driven by a 1/2 Hp, TEFC, ac motor. A controller integral to the system control panel shall provide variable speed capability. Feed system shall provide the capability of pumping emulsion type liquid polymers with 30 percent to 50 percent activity, with maximum apparent viscosities of up to 6,000 centipoise. At no time shall liquid polymer or polymer solution be exposed to excessive shear, so as to degrade the effectiveness of the polymer molecular chains.
3. Provide variable speed controller for pump.
    a. Input Voltage: 120V ac.
    b. Output Voltage: As required for supplied motor.
    c. Hp Rating: 1/8 to 1.
    d. Signal Input 4 mA to 20 mA.
    e. Maximum Output Current: 10 amps.
    f. Adjustable minimum speed, maximum speed, current limit, IR compensation and signal input adjustment.
    g. Speed range 20:1 with 3 percent linearity.
4. Provide variable speed controller for mixer if a variable speed mixer is provided:
    a. Input Voltage: 120V ac.
    b. Output Voltage: As required for supplied motor.
    c. Hp Rating: 1/8 to 1.
    d. Signal Input 4 mA to 20 mA.
    e. Maximum Output Current: 10 amps.
    f. Adjustable minimum speed, maximum speed, current limit, IR compensation and signal input adjustment.
    g. Speed range 20:1 with 3 percent linearity.
5. Each polymer feed system shall be equipped with Type 304 stainless steel side frame and stainless steel base with nonskid feet.
6. The polymer feed system shall be capable of preparing a homogeneous polymer solution based on an operator entered solution concentration setpoint (active basis) and inputted polymer flow rate setpoint from the Plant Control System (PCS).

B. Mixing Requirements:

1. Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion polymers which may vary in specific gravity from 0.98 to 1.18 and vary in viscosity from 80 cp to 6,000 cp.

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2. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy. This design shall include a motor-driven impeller that will create high fluid sheer. Solution shall undergo a tapered mixing intensity slope as it exits the initial sheer zone and pass through a second zone, isolated by a baffle. Polymer activation efficiency shall be consistent over the entire dilution water range. Mixing chamber shall be transparent to allow viewing of mixing intensity.
3. Mixing energy shall be provided by a variable speed, motor-driven impeller. Impeller shall rotate on a stainless steel shaft supported by double sealed ball bearings. Variable speed shall be achieved by variable frequency drive. Impeller shall be adjustable of a range of 900 rpm to 3,450 rpm to ensure complete flexibility in creating mixing energy. Systems not providing means of varying mixing intensities to compensate for different polymers will not be considered.

C. Polymer Metering Pump:

1. Pump Type: Progressing cavity.
2. Pump Rotor, Shaft, and Shaft-Sleeve: Type 316 stainless steel.
3. Stator: Viton; compatible with the full range of high molecular weight cationic emulsion polymers.
4. Joint Type: Pin-type with replaceable bushings and sleeves.
5. Shaft Seal: Mechanical seal with no external flush water.
6. Drive configuration: Close-coupled gear-reducer.
7. Pump Housing, Bearing Housing, and Gearbox Housing: Cast iron.

D. Dilution Water System:

1. Polymer feed system shall have a motorized ball valve for automatic control of dilution water supply. Actuator shall be NEMA 4X and powered at 120V ac. The actuator shall be prewired to the polymer skid control panel.
2. Dilution water system shall contain primary dilution assembly. A post dilution assembly may be provided as applicable to system supplier’s proven design. Dilution system shall have a magnetic flowmeter, digital indicator, and transmitter. Total water flow rate into unit shall be adjusted in order to maintain the operator entered solution concentration setpoint.
3. Water supply pressure will be approximately 60 pounds per square inch gauge. All components in the system shall be designed for at least 120 pounds per square inch gauge working pressure.

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4. Polymer feed system shall have a manufacturer's standard dilution water pressure differential type flow element and low flow switch. Flow switch and element assembly shall be installed as per manufacturer's recommendation. Thermal flow sensors shall not be acceptable.

E. Materials: All metal in contact with polymer or polymer solution shall be Type 304 stainless steel. This shall include miscellaneous hardware including sheet metal screws, hose clamps, etc. All other materials in contact with polymer or polymer solution shall be constructed of plastics or elastomers suitable for service application.

1.11 ELECTRICAL

A. General:

1. Conform to requirements of Section 26 05 02, Basic Electrical Requirements.
2. Provide all necessary electrical components and wiring for a complete, functional system.

B. Wiring: Provide all on skid interconnection wiring including but not limited to wiring between control panel and pumps, motorized ball valves, pressure switches, and instruments. Wiring shall be in conduit.

C. Provide device fusing/circuit breakers as required and a main circuit breaker, housed in each respective the control panel.

D. Power Supply: 120-volt, single-phase, 60-Hz.

E. All on skid equipment including but not limited to the drives, solenoid valves and metering shall be powered from each respective control panel.

1.12 CONTROL SYSTEMS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 90, Package Control Systems.

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B. Panels: Provide a skid mounted control panel for each polymer feed system.

Panel Nos.	Name	NEMA Enclosure	Material
LCP-7601	Thickening Polymer Blending Unit 1 Control Panel	4X	Type 316 Stainless Steel
LCP-7602	Thickening Polymer Blending Unit 2 Control Panel	4X	Type 316 Stainless Steel
LCP-7603	Thickening Polymer Blending Unit 3 Control Panel	4X	Type 316 Stainless Steel
LCP-7651	Dewatering Polymer Blending Unit 1 Control Panel	4X	Type 316 Stainless Steel
LCP-7652	Dewatering Polymer Blending Unit 2 Control Panel	4X	Type 316 Stainless Steel
LCP-7653	Dewatering Polymer Blending Unit 3 Control Panel	4X	Type 316 Stainless Steel

1. Each control panel shall include the following:
   a. A main circuit breaker with a through the door lockable handle.
   b. Controls for polymer metering pump.
   c. Controls for mixer.
   d. Power transformer to supply valves, controls equipment, instruments, and control power.

C. Operator Controls and Indicators:

1. Provide the following panel mounted operator controls and indicators:
   a. Provide the following operator control features through a touch screen operator interface unit (OIU) and menu tree, for each skid:
      1) System mode indication, run, maintenance, calibration.
      2) Polymer makedown concentration (percent), active basis.
      3) Dilution water flow rate.
      4) Polymer metering pump flow rate.
      5) Adjustable polymer metering pump calibration table (for speed versus flow).
      6) Polymer metering pump speed.
   b. LOCAL/OFF/REMOTE selector switch or option in the OIU.

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D. External Interfaces:

1. Analog Input(s): Polymer solution flowrate setpoint.
2. Discrete Input(s): System RUN command.
3. Discrete Output(s):
   a. Loss of water flow alarm.
   b. System ON status.
   c. In REMOTE status.
4. Analog Output(s):
   a. Metering pump flow rate.
   b. Polymer solution flow rate.
   c. Polymer solution concentration setpoint (percent), active basis.

E. Functional Requirements:

1. When in LOCAL, unit runs in response to OIU inputs.
2. When in LOCAL, the water feed follows the polymer flow to maintain a fixed solution concentration set at the OIU. Polymer flow is set manually at the OIU.
3. When in REMOTE, unit runs in response to external System RUN command.
4. When in REMOTE, pump speed is adjusted in response to external polymer solution flowrate setpoint signal. Water feed follows the polymer flow to maintain a fixed solution concentration set at the OIU.
5. Monitor for Low Flow of dilution water. If falling Low Flow is sensed, put the polymer pump in standby. Once dilution water flow resumes (rising Low Flow), restart the polymer pump.
6. Activate loss of water flow alarm if Low Flow of dilution water is sensed for a preset time (initial setting, 15 seconds).

F. The controls for all components of each polymer feed system shall be provided by a dedicated programmable logic controller (PLC), mounted in the skid mounted control panel. The PLC shall provide all control and monitoring functions as required, including, but not limited to, timing, interlocks, startup sequencing, water and polymer flow calculation and adjustments, normal and emergency shutdowns, and permissive functions required for proper operation of each polymer feed system.

1. Provide application software for all digital, programmable components of the polymer feed system.
2. Programming Standards: PLC programming shall not be proprietary in nature.

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3. The PLC I/O signals shall be 24V dc discrete inputs and outputs, and shall be provided with interposing relays as required. Analog inputs and outputs shall be 4 mA dc to 20 mA dc with isolation on the outputs, and surge protection on the inputs.
4. All indicating lights and colors shall be in accordance with Section 40 99 90, Package Control Systems.

G. PLC Manufacturer and Products: Allen-Bradley CompactLogix, or as specified in Section 40 99 90, Package Control Systems.

H. OIU Manufacturer and Product: OIU shall be 12-inch minimum Allen-Bradley PanelView Plus.

1.13 ACCESSORIES

A. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on the equipment in a readily visible location. Plate shall bear 1/4-inch die-stamped equipment identification name indicated in this specification and/or as shown on the Drawings.

B. Lifting Lugs: Equipment over 100 pounds in weight shall be provided with lifting lugs.

C. Graduated cylinder calibration kits complete with necessary control valves, connective tubing and fittings shall be furnished for each polymer feed system. Calibration columns shall be sized (capacity) as recommended by the polymer feed equipment manufacturer.

D. Anchor Bolts: ASTM A193, Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

1.14 FACTORY TESTS

A. All equipment shall be painted with manufacturer’s standard painting system for corrosive service, except for stainless steel components which shall be mill finish.

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PART 3 EXECUTION

1.15 EQUIPMENT INSTALLATION

A. Anchor Bolts: Accurately place using templates furnished by Manufacturer and as specified in Section 05 50 00, Metal Fabrications.

B. Manufacturer of polymer feed equipment shall furnish a qualified representative who shall supervise installation of equipment, check for proper mounting, assembly, mechanical adjustment, lubrication, proper control sequencing, general functioning of equipment, and quality of workmanship. Polymer feed equipment shall be installed in strict conformance with manufacturer's recommendations.

C. Polymer equipment shall meet the requirements of applicable industrial standards or specifications as to design, construction, and performance.

D. Polymer feed system shall be installed to conform to general layout and alignment shown on the Drawings.

E. Connect suction and discharge piping without imposing strain to skid connections.

1.16 PAINTING

A. Contractor shall repair and refinish painted surfaces as required.

1.17 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each polymer feed system.

1. Test complete assembly for proper installation and connection, correction rotation, proper alignment, quiet operation, and absence of vibration.
2. Demonstrate valve operation:
   a. Check operation of OPEN/CLOSED indication lights at OIU and inputs to PLC.
   b. OPEN and CLOSE valves through full range and verify valve operation in manual and automatic modes. In remote mode, demonstrate that valves OPEN and CLOSE in response to a communicated signal.
3. Check Electrical and Operator Controls:
   a. LOCAL/OFF/REMOTE selector switch.
   b. Verify OIU displays.

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c. Unit responds to communicated flow rate signal.
   1) Test unit for a continuous 30-minute period without malfunction under simulated operating conditions. During this operating period, the pump shall obtain suction from the bulk polymer storage tanks and discharge to the polymer batch tanks.
   2) During the test, record neat polymer and dilution water flow rates.

B. Performance Tests: Conduct on each polymer feed system.

1. Test unit for a continuous 30-minute period to demonstrate proper operation as judged by consistent and trouble-free production of a polymer solution without fisheyes and meeting the specified performance requirements.
2. A unit failing the performance test shall be adjusted and retested. If the unit fails the retest, the unit shall be rejected, and the Contractor shall replace it. The Contractor shall provide replacement unit(s) that meet the specified performance requirements.

C. Test equipment as required in Section 01 91 14, Equipment Testing and Facility Startup.

1.18 MANUFACTURERS' SERVICES

A. A manufacturer's representative for equipment specified herein shall be present at Job Site and/or classroom designated by WSSC for the minimum person-days listed for services hereunder, travel time excluded:

1. 2 person-days for installation assistance, inspection, certification of installation, and functional and performance testing.
2. 3 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 2 person-days for prestartup classroom or Site training.
4. 3 person-days for facility startup.
5. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

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 44 46 13.02
DEWATERED SLUDGE INCLINED SCREW CONVEYOR SYSTEM

EQUIPMENT AND COMPONENT NUMBER(S)

CON-7421: Centrifuge Discharge Conveyor 1.
CON-7431: Centrifuge Transfer Conveyor 1.
CON-7422: Centrifuge Discharge Conveyor 2.
CON-7432: Centrifuge Transfer Conveyor 2.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers the Work necessary to supply the dewatered sludge inclined conveyor system. System shall include all associated components, instruments, valves, piping and connecting chutes to the centrifuge discharge chute, and connecting chutes between the conveyors.

B. System shall include all specified instruments and transmitters at a minimum, plus all items required for a complete and operable system.

C. Unit Responsibility: A manufacturer shall be responsible for supplying the inclined conveyor system, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, control panel, adjustable frequency drives, shafting, safety guards, speed reducers, and spare parts) and for the design, assembly, delivery, installation supervision, startup, and testing of the equipment. The manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.

D. The design of the inclined conveyor system as shown on the Drawings is based upon the equipment from the first-named centrifuge manufacturer listed in this Section 46 76 33, Dewatering Centrifuges. The Contractor, if selecting a manufacturer other than the first-named centrifuge manufacturer, shall be responsible for making all necessary changes to the facility design to accommodate the equipment, including but not limited to layout changes and interface connections to other work and equipment which are different than that shown on the Drawings. The Contractor shall be responsible for coordinating this Work and the changes will be at the sole expense of the Contractor. At a minimum these changes may include:

1. Size of motors.

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2. Layout and mounting of the equipment, including concrete equipment pads.
3. Coordination of equipment elevations.
4. Changes in electrical requirements of any kind.
5. Instrumentation and control interface requirement changes.
6. Rerouting of any piping required to meet the manufacturer's system requirements.

E. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

F. Adjustable Frequency Drive Requirements: Conform to the requirements of Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

G. General Requirements: See Division 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

H. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

1.02 REFERENCES

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

1. American Bearing Manufacturers' Association (ABMA): 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA).
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A36A/36M, Standard Specification for Carbon Structural Steel.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A385, Standard Practice for Providing High-Quality Zinc Coatings (Hot Dip).
   e. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
5. Conveyor Equipment Manufacturers Association (CEMA): 300, Screw Conveyor Dimensional Standards.

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6. National Electric Manufacturers Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. UL: 674, Electric Motors and Generators Used in Division 1 Hazardous (Classified) Locations.

1.03 SYSTEM DESCRIPTION

A. Design conveyor system to collect dewatered sludge cake from the dewatering centrifuges and transfer the dewatered cake to the existing belt conveyor system. Configuration of conveyors to be as shown on the Drawings.

B. Centrifuge discharge conveyors shall collect material from the centrifuges and discharge to centrifuge transfer conveyors. Centrifuge discharge conveyors will be inclined and operate in reverse to convey mixed solids/liquids discharged during centrifuge startup and shutdown to plant drain piping via an actuated valve.

C. Centrifuge transfer conveyors shall collect material from the centrifuge discharge conveyors and discharge to the existing belt conveyor system. Centrifuge transfer conveyors will be inclined and operate in forward motion to transfer cake from the discharge conveyors to the existing belt conveyor system.

D. Design conveyors without a center shaft for conveying material with minimal maintenance. Spiral flights shall be designed to be self-guiding and aligning in the trough. Guide bearings shall not be permitted.

E. Provide supports for conveyors, spaced as specified herein, to support the conveyors from the concrete floor.

F. Prior to fabricating the screw conveyors, determine the requirements for and furnish brackets, chutes, and fitments required.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detail drawings and specifications for components of equipment showing all dimensions, parts, construction details, and materials.
   b. Equipment performance specifications.
   c. Equipment process schematics.
   d. Fabricated items, equipment structural supports, platforms, handrails, and associated items.

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e. Design loadings, for load combinations, to be transmitted to foundations or supports.
f. Size, length, and spacing of anchor bolts or attachments to the foundations or supports.
g. Specific details of attachment of bracing members to concrete or steel structures.
h. Instrumentation and control components catalog data and specifications.
i. Power and control wiring diagrams including terminals and members.
j. Motor submittals in accordance with Section 26 20 00, Low-Voltage AC Induction Motors.
k. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Design calculations for items covered by these Shop Drawings. Calculations shall show design stresses in structural members and connections for loading combinations. Design calculations shall be stamped by an engineer registered in the State of Oregon.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Manufacturer's Certificate of Factory Tests, including Factory Functional and Performance Test Reports and Log. Use blank form provided in Section 01 99 90, Standard Forms.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturer's Field Services.
9. Functional Testing Procedure Submittal: Proposal for functional testing procedure. Submit test procedures for review, comment, and approval at least 30 days in advance of the Notice to Conduct the Functional Testing.
10. Performance Testing Procedure Submittal: Proposal for performance test procedure. Submit test procedures for review, comment, and approval at least 30 days in advance of the notice to conduct the performance testing.
11. Performance Test Report: Submit summary of actual procedures used, monitoring methods, performance testing results, and all equipment and setpoint modifications made.

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1.05 WARRANTY

A. Provide manufacturer's warranty, with Owner named as beneficiary, in writing, to warrant the supplied equipment to be free of defects in materials and workmanship for a period of 1-year, with the warranty period beginning upon successful completion of Demonstration Testing as specified in Section 01 91 14, Equipment Testing and Facility Startup.

B. Provide an extended warranty for a period of 1-year beyond the 1-year warranty specified above for a total warranty coverage period of 2 years. Provide separate line item pricing for the 1-year warranty extension.

1.06 EXTRA MATERIALS

A. Furnish special tools, materials, and supplies required to install, commission, and startup equipment.

B. Submit list of recommended spare parts as part of the Operations and Maintenance (O&M) manual submittal as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 SERVICE CONDITIONS

A. Material Conveyed: Dewatered sludge cake consisting of anaerobically digested sludge from a municipal wastewater treatment plant.

B. Material Density: 55 pounds to 70 pounds per cubic foot.

C. Solids, Percent by Weight: 16 percent to 20 percent.

D. Temperature: 70 degrees F to 90 degrees F.

E. Screw Diameter: Nominal diameters listed in below table, to be adjusted to meet the Performance Requirements specified herein.

F. Hours of Operation: 24 hours per day.

G. Environment: Indoors.

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2.02 PERFORMANCE REQUIREMENTS

A. Screw Speed: Maximum of 20 rpm.

B. Capacity:

1. The greater of the following:
   a. Volumetric capacity as specified below.
   b. Mass capacity based on volumetric capacity specified below conveying material with maximum material density specified above.

C. Conveyor shall be sized based on the larger of the following criteria:

1. Sized such that the specified capacity is less than 60 percent of the conveyor's performance capacity; or
2. Conveyor has a maximum trough fill of 40 percent when operated at the specified capacity.

D. Each conveyor drive unit shall be designed for 100 percent of rated capacity:

	Specified Capacity (ft^3/hr)	**Nominal Screw Diameter (in)**	**Nominal Conveyor Length* (ft)**	**Incline* (degrees)**	**Horsepower (hp)**
Centrifuge Discharge Conveyor 1	145	12	12	20	1.5
Centrifuge Discharge Conveyor 2	145	12	12	20	1.5
Centrifuge Transfer Conveyor 1	145	12	14	25	2.0
Centrifuge Transfer Conveyor 2	145	12	14	25	2.0
*Confirm dimensions as shown on Mechanical Drawings.					

2.03 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. SPIRAC, Inc.
2. Jim Myers and Sons, Inc (JMS).

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2.04 COMPONENTS

A. Materials:

1. Steelplate and Shapes: ASTM A167, Type 304 stainless steel.
2. Chutes: ASTM A167, Type 304 stainless steel.
3. Spiral Flights: Cold-formed spring steel, minimum hardness 200 Brinell with ability to transmit 32,000 inch-pounds of input torque.
4. Drive Shaft: 17-4 precipitation hardened stainless steel, of uniform diameter.
5. Wear Liner: UHMW polyethylene, 4 feet long sections, 1/2-inch minimum thickness installed on maximum 12-inch centers and a maximum of 2 inches from the liner top edge. Wear liner bars are not acceptable.
6. Fasteners for Conveyor Supports: Galvanized, ASTM A153/A153M or zinc-plated, ASTM A385.
7. Fasteners in Contact with Sludge: ASTM A193, Type 316 stainless steel.

B. Chute(s):

1. Provide all drop chutes required for connections between centrifuges and conveyors, and between conveyors.
2. Minimum 1/4-inch ASTM A167, Type 304 stainless steel.
3. Openings shall be flanged and bolted. Flanges shall be 1/4-inch by 2-3/4-inch.
4. Inlet drop chute (transition chute) shall align with the dewatering centrifuge solids discharge.
5. Provide inspection doors in the cake discharge chutes, 12-inch square minimum, for visual inspection of the inside of the chutes. The inspection door shall be hinged on one side with latches on the opposite side and shall be constructed of the same material as the chute.
6. Rigidly supported following manufacturer’s recommendations.

C. Trough:

1. Fabricated from 1/4-inch, ASTM A167, Type 304 stainless steel.
2. 2-inch drain tap for the Centrifuge Transfer Conveyor 1 and Conveyor 2.
3. 6-inch drain connection for the Centrifuge Discharge Conveyor 1 and Conveyor 2.
4. Flange fittings for inlet and discharge chutes.
5. Troughs shall conform to the dimensional standards of CEMA 300 and enclosure Classification IIIE.

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D. Spiral Flighting: Design spiral flights with the stability to prevent distortion and jumping in the trough.

1. At its torsional rating, the stress in the spiral flighting shall not exceed 30 percent of the Fy value in the extreme fiber of the flight material.
2. Brake Horsepower: Produce less torque than the spiral flighting is rated for.
3. At 250 percent torque of the motor nameplate horsepower rating, the drive train shall not produce more torque than 250 percent of the spiral flighting's torsional rating.

E. Bearings:

1. ABMA 11, high capacity roller bearings located in the reducing drive housing with an L-10 life rating of 100,000 hours.
2. Designed to support thrust loads and provide angular alignment with the trough.
3. When recommended by the manufacturer, furnish tail and end bearings. If deflection of the spiral flights in the vertical direction exceeds 1-inch, furnish end bearings.
4. End Bearings: Double pillow block or flange and pillow block type mounted outside the trough; completely serviceable from outside the conveyor.

F. Seals: Compression packing gland between the drive shaft and sleeve.

G. Cover:

1. Provide quick release cover over trough for portions not covered by a filling chute to contain odors, to act as a protective guard, and prevent splashes.
2. Minimum 12-gauge ASTM A167, Type 304 stainless steel.
3. Gaskets between trough and cover: Neoprene, 50 Durometer, full-face gaskets shall be provided. Access covers shall be gasketed with the same materials as the trough covers.
4. Conform to Screw Conveyor Standards CEMA 300.
5. Provide inspection doors in the trough covers, 12-inch square minimum, for visual inspection of the inside area of the conveyors. Each inspection door shall be hinged on one side with latches on the opposite side, provided with bolt-in expanded metal safety screen, and shall be constructed of the same material as the cover. Provide inspection doors in the following locations:
   a. Over discharge point.
   b. Adjacent to each inlet point.

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6. Provide 2-inch diameter flanged Type 304 stainless steel pipe nozzle welded to conveyor cover at points shown on the Drawings, to receive pipe flushing appurtenances (provided by others).
7. Provide 6-inch diameter flanged Type 304 stainless steel pipe nozzle welded to conveyor, located as shown on the Drawings, for connection to foul air piping.

H. Gear Reducing Drive:

1. Design for full thrust loads from spiral flights.
2. Bearings: Operating life of L-10 100,000 hours.
3. Air-cooled, no auxiliary cooling allowed.
4. Close coupled with drive motor.
5. Applied Torque: Adequate to start the screw conveyor when fully loaded.
6. Each screw drive shall consist of a right-angle geared speed reducer with integral motor and thrust bearing. The drive shall be separated from the conveyed material by a trough end seal. Drives shall be suitable for AGMA Class II operation with full rated torque and thrust capacity in forward and reverse rotation.
7. Reducer shall be parallel or concentric shaft type. Reducer selection shall be based on continuous operation with minimum 1.9 mechanical and 1.0 thermal service factors as applied to the motor nameplate horsepower. Thermal horsepower rating strength to be based on maximum ambient temperature specified herein. Gearing strength rating to catalog rating ratio shall be 1.75 minimum and based on all applicable AGMA standards. Bearings shall be oil lubricated antifriction type. Integral thrust bearing shall be tapered roller type capable of resisting the thrust developed by the fully loaded screw. Minimum B-10 bearing lift of 100,000 hours shall be based on readily accepted bearing manufacturers rating practices. In the case of tapered roller bearings, they shall be selected per the Timken rating method. Reducer shall be capable of reversing operation where identified hereinbefore.
8. Reducer features shall include shielded grease purge seal cage to protect dual lip oil seals from the environment and accidental damage, breather assembly to prevent pressure build-up inside the unit, removable drive shaft assembly without removing unit from screw trough end, all steel fabricated drive mount which shall bolt directly to the screw drive reducer. Reducer housing shall be 30,000 pounds per square inch cast iron.
9. Screw Drive Manufacturers:
    a. Flender Corporation.
    b. Eurodrive.
    c. Nord.

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I. Drive Motors:

1. Provide squirrel-cage ac induction motors meeting the requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Centrifuge Discharge Conveyor and Centrifuge Transfer Conveyor motors shall meet the following specific requirements:
   a. Motor Horsepower: 1.5 hp minimum for Centrifuge Discharge Conveyors, and 2 hp minimum for Centrifuge Transfer Conveyors, adjusted as necessary to meet the Performance Requirements specified herein.
   b. Synchronous Speed: 1,800 rpm.
   c. Voltage Rating: 460-volt, three-phase.
   d. Enclosure Type: TEFC.

J. Conveyor Supports:

1. Supports for the conveyor system, including chutes, and appurtenance shall be designed and provided by the system supplier. Supports shall meet all specified design requirements and shall be coordinated for proper connection to the building structure and platforms.
2. No attempt has been made to show all required support locations. The absence of defined support locations or support details on any Drawings shall not relieve the system supplier and Contractor of the responsibility of providing all required conveyor system supports throughout the facility.
3. Minimum 1/4-inch rectangular ASTM A167, Type 304 stainless steel shapes and plates.
4. Ratio of unbraced length to least radius of gyration shall not exceed 240 for tensile members and 120 for compression members.
5. Designed to not exceed 1/3 of AISC allowable stresses when loaded to twice the running torque of the motor.
6. Support Loads: Based on completely filled trough, weight of the conveyor, and dynamic loading when operating.
7. Coordinate support locations with facility structure. Supports shall not restrict access to other process systems.

K. Motion Detector:

1. Detect underspeed or zero speed.
2. Noncontacting motion sensing unit.
3. Adjustable time delay for startup.
4. Operate on 120V ac, 60-Hz.
5. DPDT contacts rated 10 amps at 120V ac.

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6. Remote mounted NEMA 250, Type 4X, electronics unit, UL Listed. Provide sensor cable to connect to electronic unit. Mount motor detector sensor on conveyor and adjust position as required for proper operation.
7. Manufacturer and Product: Siemens; Milltronics MFA-4P Switch with MSP series sensor.

L. Emergency Stop:

1. Provide pull cable emergency stops running the full length of all conveyors on both sides of each conveyor.
2. Emergency stop shall disrupt power to the drive and provide dry contact for alarming at the plant control system.
3. Cables shall be orange-colored, plastic-covered steel aircraft cable.
4. Provide all cable end fittings and intermediate cable support eyes. Maximum spacing for support eyes is 10 feet.
5. Switches shall require manual reset after actuation and shall provide visual indication of operation.
6. Provide switches as required to limit the required actuating force to comply with OSHA guidelines, with the following minimum number of switches:
   a. Centrifuge Discharge Conveyors: Two per conveyor, one on each side.
   b. Centrifuge Transfer Conveyors: Two per conveyor, one on each side.

2.05 ACCESSORIES

A. Anchor Bolts: ASTM A193, Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type enamel filled equipment identification number and letters.

D. Furnish lubricants required for startup, initial operation, and testing of the equipment until final acceptance by the Owner.

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2.06 SOURCE QUALITY CONTROL

A. Performance Tests: Completely shop assemble prior to shipment and run for a minimum of 2 hours to ensure proper operation.

B. Factory Tests and Adjustments: Inspect equipment and test for proper alignment, quiet operation, proper connection, and satisfactory performance of components and controls by means of a functional test conducted using material approved by the Engineer.

2.07 FIELD TESTING AND FACILITY STARTUP

A. Field Testing and Facility Startup shall be in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Facility startup specifies the order and prerequisites for the following tests of the equipment:

1. Field functional testing.
2. FT 1 testing.
3. FT 2 testing.
4. Performance testing.
5. Demonstration testing.

C. All field testing and facility startup shall be performed using a qualified representative provided by the manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup; Section 01 43 33, Manufacturers' Field Services, and as elaborated upon in this section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Anchor Bolts: Accurately place using templates furnished by conveyor manufacturer and as specified in Section 05 50 00, Metal Fabrications.

B. Install in accordance with manufacturer's recommendations.

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3.02 FIELD QUALITY CONTROL

A. Functional Testing:

1. Prior to system startup, all equipment shall be inspected and certified for proper alignment, quiet operation, proper connection and satisfactory operation by means of a functional test conducted by the system supplier, assisted by the installing Contractor and Owner, and as approved by the Engineer.
2. Proposed test procedures shall be developed by the system supplier and submitted to the Engineer for review, comment and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
3. Complete and sign Manufacturer's Certificate of Proper Installation.
4. Complete successful functional testing prior to performance testing.
5. Submit completed Manufacturer's Certificate of Proper Installation.

B. Performance Testing:

1. Conduct on:
   a. Each conveyor as part of facility startup prior to successful completion of the Demonstration Testing Period.
   b. Each centrifuge transfer conveyor with one centrifuge in operation for a period of 4 hours.
2. Test for continuous 4-hour period. Proposed test procedures shall be developed by the system supplier and submitted to the Engineer for review, comment, and approved by the Engineer.
3. Operate at performance capacity or at a cubic feet per hour approved by Engineer, conveying the specified media.
4. Record flow in terms of cubic feet per hour.
5. Record motor amp draw at approximately 1/2-hour intervals and as needed to record values operated over the specified range of flows.
6. During system operation, examination for leakage shall be made at all seams, joints, and connections.

3.03 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Manufacturer's Field Services.

B. Schedule training after associated equipment is certified by the manufacturer as properly installed and ready for operation using the MCOPI, and after the equipment is energized and the controlling software is sufficiently complete to run the equipment for which training is being conducted.

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C. Training shall follow the Master Operation and Maintenance Training Schedule as specified in Section 01 91 14, Equipment Testing and Facility Startup.

D. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 1 person-day for installation assistance and inspection.
   b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1 person-day for facility startup.
   d. 1 person-day for training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed Engineer.

E. 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 46 76 33
DEWATERING CENTRIFUGES

EQUIPMENT AND COMPONENT NUMBER(S)

CENT-7401: Centrifuge 1.
CENT-7402: Centrifuge 2.
LCP-7401: Centrifuge 1 Local Control Panel 1.
LCP-7402: Centrifuge 2 Local Control Panel 1.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers the work necessary to provide two dewatering centrifuges, two centrifuge control panels, and all appurtenances as specified herein.

1.02 GENERAL

A. Unit Responsibility: A single centrifuge manufacturer shall be responsible for supplying the dewatering centrifuges, complete with all accessories and appurtenances (including, but not necessarily limited to, electric motors, variable frequency drives (VFDs), control panels, shafting, safety guards, speed reducers, and spare parts) and for the design, assembly, delivery, installation supervision, startup, and testing of the centrifuges. The centrifuge manufacturer shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions. The centrifuges shall be produced and assembled by the manufacturer at a facility owned and operated by the manufacturer and under the direct supervision and control of the manufacturer.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer to achieve standardization for operation, maintenance, spare parts, and manufacturers' services.

C. General Requirements: See Division 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

D. AC Induction Motor Requirements: Conform to the requirements of Section 26 20 00, Low-Voltage AC Induction Motors.

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E. Variable Frequency Drive Requirements: Conform to the requirements of Section 26 29 23, Low-Voltage Variable Frequency Drive System.

F. Electrical and Control Panels: Conform to the requirements of Section 26 27 16, Cabinets and Enclosures.

G. Control System Requirements: Conform to the requirements of Section 40 99 90, Package Control Systems.

H. The control functions contained and described herein are intended to provide proposed minimum performance requirements. They do not necessarily identify each and every control function, connection, communications, or equipment to achieve the requirements. Additional specificity and details shall be coordinated at time of submittals.

1.03 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA).
2. American Gear Manufacturers Association (AGMA).
3. American National Standards Institute (ANSI).
4. American Society of Mechanical Engineers (ASME): PTC-36, Measurement of Industrial Sound.
5. American Welding Society (AWS).
6. ASTM International (ASTM): G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests.
7. British Standards Institute (BSI): BS 5490.
8. German Industrial Standards (DIN).
9. Institute of Electrical and Electronics Engineers (IEEE).
10. Instrument Society of American (ISA).
11. National Electric Code (NEC).
12. National Electrical Manufacturers Association (NEMA): MG-Motors and Generators.
13. Occupational Safety and Health Act (OSHA).
14. Society of Protective Coatings (SSPC).
15. UL.

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1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Document modifications to manufacturer's standard design to meet specified requirements and identify elements of manufacturer's standard design that do not comply with performance, features, functions, and materials of construction specified herein.
   b. Make, model, weight, and horsepower of each equipment assembly.
   c. Manufacturers:
      1) Catalog information, descriptive literature, specifications.
      2) Identification of materials of construction for centrifuge, drive motor, backdrive motor, variable speed drives, control panel, power supply, lubrication system, and flexible connectors.
         a) Listing of materials of construction to confirm compliance with requirements of Article Materials.
   d. Performance data documenting units' ability to meet criteria specified, including back drive gear box rated torque capacity and torque capacity required to meet performance requirements.
   e. Detailed mechanical drawings showing equipment fabrications and external interfaces. Include:
      1) Dimensions, size, and locations of connections to other work, and weights of equipment.
      2) Foundation drawings showing anchor bolt layouts and locations.
      3) Recommended anchor bolt sizes.
      4) Weights of individual pieces of equipment and live (dynamic loads) created by the total weight of each centrifuge and ancillary equipment.
      5) Scroll hard surfacing materials and coverage.
      6) Sizes and locations of space for incoming and outgoing conduits.
      7) Minimum clearance distances around equipment required to access equipment for service/repair/removal and high hook elevation necessary for hoisting equipment.
      8) Control panel drawings showing panel size and sizes and locations of raceway connections.
   f. Bill of materials listing major system components, special tools, and spare parts.
   g. Required pressure for sludge and polymer at unit's feed connection.

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h. Outside utility requirements such as air, water, power, drain, etc., for each component.
i. Calculated AFBMA L-10 bearing life and type of lubrication recommended for all equipment.
j. Design data for the following:
    1) Main drive motor sizing.
    2) Backdrive motor sizing.
    3) Variable frequency drive sizing.
    4) Main bearings.
    5) Maximum measured sound power levels at 3 feet, all sides of equipment.
    6) Heat transfer to room from centrifuge control panel.
k. Instrumentation and Control Submittals: In conformance with Section 40 99 90, Package Control Systems.
l. Motor submittals in conformance with Section 26 20 00, Low-Voltage AC Induction Motors.
m. VFD submittals in conformance with Section 26 29 23, Low-Voltage Variable Frequency Drive System.
n. Letter verifying compatibility and coordination of VFDs with the motor and centrifuge application, including sizing justification.
o. Control panel submittals in conformance with Section 26 27 16, Electrical and Control Cabinets and Enclosures.
p. Certificate(s) demonstrating that the centrifuge production and assembly facilities are ISO 9001 certified.
q. Functional description of internal and external instrumentation and controls to be supplied.
    1) Include list of parameters monitored, controlled, or alarmed.
r. Sequential description of operation under various modes of control including:
    1) Complete control circuit and equipment operation and logic.
    2) Interlocks and permissives.
s. Description of all automatic shutdown features and interfaces with the plant instrumentation and control systems, in both word and schematic form.
    1) Standard Instrument Society of America symbols shall be used on all schematics.
t. Control Panel interconnection diagrams showing wiring interconnections between all centrifuge system components and remote components provided by others.
u. Control Panel elevation drawings showing construction and placement of operator interface devices and other elements.
v. Power and control wiring diagrams including terminals and numbers.

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w. Shop and field painting systems proposed:
1) Include Manufacturer's descriptive technical catalog literature and specifications, and hazardous communication data sheets.
2) Where system proposed is different from that specified or where, in the manufacturer's opinion, the coating system(s) exceed(s) the requirements specified, submit complete technical literature of the proposed system(s) to the Engineer for review.

2. Samples:
a. Submit the following items with the Shop Drawings:
1) Scroll abrasive resistant tile, quantity of two.

3. Equipment Testing Procedure Submittals:
a. Submit test procedures for review, comment, and approval 30 days in advance of the notice to conduct the following testing:
1) Functional Testing.
2) Pre-Performance Testing.
3) Performance Testing.
4) Optimization.

B. Informational Submittals:

1. Factory Quality Control Submittals:
a. Obtain Engineer's review and approval of information listed below prior to equipment shipment.
b. Manufacturer's Certificate of Compliance.
c. Factory test results, reports, and certifications. Include:
1) Functional Test Reports and Certificates.
2) Vibration Test Reports and Certificates.
3) Noise Test Reports and Certificates.
4) For each ac motor, provide a certified copy of a test report for an identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B.
a) Report shall show full-load efficiency and power factor meeting or exceeding the specified minimum guaranteed values.
b) Motors not as specified will be rejected.
5) Certified Scratch Abrasion Test results for the abrasion protection tiles batch where the tiles used for the centrifuges of this Project came from.
d. Test results of the control panels for proper operation, construction, electrical connection, and function.
2. Anchorage and bracing calculations.
3. Shipping, storage, protection, and handling instructions.

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4. Manufacturer's written/printed installation instructions.
5. Routine maintenance requirements prior to plant startup.
6. Operation and Maintenance Manual with Maintenance Summary Form in accordance with Section 01 78 23, Operation and Maintenance Data, and the following requirements:
    a. Operation, maintenance, recommended spare parts, and renewal parts information for all equipment furnished under this section.
    b. Set of complete as-reviewed Shop Drawing submittals.
    c. As-built electric and instrumentation and control wiring diagrams and equipment drawings.
    d. Index of all equipment suppliers listing current names, addresses, telephone numbers, and e-mail of those who should be contacted for service, information, and assistance.
    e. Detailed operational procedures including step-by-step startup, normal operation, shutdown, and troubleshooting procedures.
    f. Detailed preventative maintenance requirements and recommended schedule.
7. Field Quality Control Submittals:
    a. Submit the following prior to Project Completion:
        1) Submit test reports within 20 days after completing field testing.
    b. Field test results, reports, and certifications. Include:
        1) Functional Test Report and Certificates.
        2) Manufacturer's Certificate of Equipment Installation Services.
        3) Pre-Performance Test Report and Certificates.
        4) Performance Test Report and Certificates.
        5) Vibration Test Certificates.

1.05 EXTRA MATERIALS

A. Spare Parts and Special Tools: Manufacturer to provide a spare parts recommended list for the City.

B. Tools and Accessories:

1. Provide manufacturer's recommended special tools and accessories required to assemble and disassemble installed centrifuges as follows:
    a. Bowl lifter, including spreader beam, shackles, and ratchet straps, suitable for bowl removal using the overhead bridge crane.
    b. Conveyor lifter.
    c. Tools for removal/installation of conveyor and thrust bearings.
    d. Tools for plate dam adjustment/replacement.
    e. Lifting eyes for hoisting of main drive pillow block bearings.

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C. Bowl Cart: Provide one bowl cart.

D. Lubricants:

1. Manufacturer’s Services Include:
   a. Provide lubricants for initial centrifuge equipment startup.
   b. Provide and change lubricants and filters as frequently as required during the period between successfully completed functional testing and equipment acceptance, up to a maximum period of 12 months.
   c. Furnish and install new lubricants and filters at Substantial Completion.
   d. After acceptance and substantial completion, Owner will be responsible for changing the lubricants according to the schedule provided by manufacturer in the Operations and Maintenance Manual.

E. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

1.06 SAFETY REQUIREMENTS

A. Design and manufacture equipment with due regard to safety of operation, accessibility, and durability of parts.

B. Comply with all applicable Occupational Health and Safety Act, federal, state, and local safety regulations.

1.07 WARRANTY

A. Provide manufacturer’s warranty, with Owner named as beneficiary, in writing, to warrant the supplied equipment to be free of defects in materials and workmanship for a period of 1 year, with the warranty period beginning upon successful completion of Demonstration Testing as specified in Section 01 91 14, Equipment Testing and Facility Startup.

B. Provide an extended warranty for a period of 2 years beyond the 1-year warranty specified above for a total warranty coverage period of 3 years. Provide separate line item pricing for the 2-year warranty extension. Warranty period shall in no case exceed a period of 4 years from date of equipment delivery to the Project Site.

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1.08 SPARE ROTATING ASSEMBLY

A. The manufacturer shall supply one complete spare rotating assembly, including bowl, scroll, gearbox, and all associated bearings, seals, and fasteners, fully assembled and dynamically balanced as a unit. This spare assembly shall be identical in material, specification, and performance to the primary rotating assembly supplied with the centrifuge. It shall be supplied in a protective crate, ready for installation, and accompanied by detailed installation instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Each centrifuge shall be of the solid bowl horizontal, continuous feed, scroll conveyor type specifically configured for dewatering only applications and intended to produce a dewatered cake with a higher solids content than produced with conventional centrifuges. No disc type or nozzle bowl type or basket type centrifuges will be allowed. The centrifuge design shall limit air leakage from the body of the centrifuges by providing gaskets on the casing flange and labyrinth-type seals on both hub ends. The centrifuge equipment shall be designed and built to operate continuously. A variable frequency drive (VFD) main drive system shall be provided to drive the centrifuge rotating assembly. A VFD backdrive system shall be supplied with the centrifuge to provide speed variation between the scroll conveyor and the centrifuge bowl. The centrifuge shall be designed to be mounted on a steel frame allowing discharge into discharge chutes directly beneath the centrifuge bowl.

B. Each centrifuge system shall be equipped with:

1. Variable frequency electric main drive motor assembly.
2. Variable frequency drive electric backdrive motor assembly.
3. Belt guards.
4. Automatic lubrication system for the rotating assembly’s main bearings.
5. Vibration isolators.
6. Flexible connectors.
7. Main drive and backdrive variable frequency drives.
8. Control panel, fully functional.

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2.02 MANUFACTURER

A. Centrifuge Manufacturer:

1. Minimum 10 years' experience in the design, application, and supply of centrifuges for dewatering of wastewater sludge from municipal wastewater treatment plants.
2. Production and assembly facilities shall be ISO 9001 certified.

B. Modifications to Standard Equipment Model Offerings:

1. Manufacturer listing does not indicate that manufacturer's standard centrifuge model offering meets specifications or is acceptable without modification.
2. Provide listed Manufacturer's equipment, modified as necessary, to conform to the performance, functions, features, and materials of construction specified.

C. Provide centrifuges from one of the following listed manufacturers:

1. Andritz Separation, Inc.
2. Alfa-Laval, Inc.
3. Flottweg, Inc.

2.03 SERVICE CONDITIONS

A. The centrifuges, motors, auxiliary equipment, and appurtenances shall be suitable for exposure to continuous 95 percent relative humidity conditions, for operation in ambient air temperature from 55 degrees F to 104 degrees F, and for exposure to intermittent water or sludge splash and spill conditions.

B. The centrifuge control panels and appurtenances will be located in the centrifuge process space and shall be suitable for exposure to continuous 95 percent relative humidity conditions, for continuous operation in ambient temperature from 55 degrees F to 104 degrees F, and for exposure to intermittent water or sludge splash and spill conditions.

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C. The material to be dewatered will be digested sludge resulting from anaerobic digestion of thickened waste activated sludge (WAS) and primary sludge (PS) resulting from biological treatment of municipal wastewater preceded by primary clarification. Performance requirements to be confirmed via the field performance testing specified herein shall be conducted on the following sludge stream:

Parameter	Digested Sludge
Nominal Sludge Composition, Total Dry Solids Weight Basis	20% PS / 80% WAS to, 40% PS / 60% WAS
Sludge Feed Concentration, % Total Dry Solids Exclusive of Polymer	2.0% to 3.0%
Sludge Volatile Solids Concentration, % Volatile Solids Dry Weight Basis	59% to 77%

2.04 PERFORMANCE REQUIREMENTS

A. The centrifuge shall continuously receive, condition, and dewater the feed sludge specified herein, and continuously discharge the dewatered solids into a screw conveyor (provided by others). Each unit shall be able to operate continuously on demand; shall be suitable for dewatering the specified sludge continuously for up to 24 hours per day, 7 days per week; and shall operate without spillage of sludge beyond the nominal solids discharge chute and piping envelope or spillage of centrate beyond the liquid (centrate) discharge chute and piping envelope.

B. Manufacturer shall guarantee that the centrifuges shall be capable of the minimum performance requirements specified below, to be confirmed via the field performance testing specified herein. Feed hydraulic loading rates for sludge dry solids concentrations between points specified will be linearly interpolated between the points specified (i.e., maintaining the specified feed dry solids loading rates).

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C. Performance Requirements:

Parameter	Digested Sludge Guaranteed Performance Normal Operation	Machine Sizing Throughput Criteria
Feed Solids Loading Rate, lbs/hr., Total Dry Solids (DS) Basis	975	1,500
Feed Hydraulic Loading Rates(1), gpm	97 at 2.0% TS 78 at 2.5% TS 65 at 3.0% TS	120 at 2.5%TS 100 at 3.0%TS 86 at 3.5%TS
Minimum Dewatered Cake Concentration(2), % Total Dry Solids	17	Range 16 to 19
Minimum Total Solids Capture(3), %	95	Range 90 to 98
Maximum Polymer Dose(4), lbs. Active per Dry Ton of Feed Solids	60	Range 55 to 65

Notes:

(1) The range of feed hydraulic loading rates are calculated based on the total dry solids dry mass loading rate at the expected range of total dry solids concentrations and are exclusive of polymer solution.

(2) Performance testing results shall be no greater than a 5% deviation from the value specified above (i.e., less than the minimum), with the average of test results rounded to one decimal place.

(3) Performance Testing results shall be no greater than a 2.5% deviation from the value specified above (i.e., less than the minimum), with average of test results rounded to one decimal place.

(4) Performance Testing results shall be no greater than a 5% deviation from the value specified above (i.e., greater than the maximum), with average of test results rounded to one decimal place.

D. The goal of the specified optimization assistance is to minimize polymer dose and electrical use and maximize cake solids and solids capture efficiency of the centrifuge. This will reduce the Owner's operating cost of sludge.

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E. Solids Capture:

$$\%\,\text{Capture: } \frac{T}{F} \times \frac{F-C}{T-C} \times 100$$

Where: T = Cake total solids concentration (mg/L).
F = Feed sludge total solids concentration, excluding any dilution due to polymer solution addition (mg/L).
C = Centrate total suspended solids concentration, excluding any dilution due to polymer solution addition and centrifuge purge water (mg/L).

F. Polymer: Make-down of a polymer solution will be from only bulk emulsion, high molecular weight cationic polymers. Centrifuge manufacturer shall be responsible for polymer selection, in coordination with Owner and Owner's contracted polymer supplier. The centrifuge manufacturer is advised that successful bench-scale dewatering tests, that demonstrated acceptable results, were conducted for this project using Emulsion Polymer C-6266 (Polydyne) and Emulsion Polymer C-6268 (Polydyne). The centrifuge manufacturer shall consider these results and verify the compatibility and expected performance of their proposed centrifuge system with these or similar emulsion-type polymers.

2.05 MATERIALS

A. Unless otherwise specified, materials of Construction:

1. Conform to the following:
   a. Bowl: ANSI SC-2205 duplex stainless steel or ANSI SC2304 duplex stainless steel centrifugal castings.
   b. Bowl Wear Strips: Stainless steel, Type 316, minimum 3 mm thickness, or longitudinal grooves.
   c. Scroll Conveyor: Type 316 stainless steel, ANSI SC-2205 duplex stainless steel or ANSI SC-2304 duplex stainless steel.
   d. Scroll Conveyor Tips: Sintered Tungsten Carbide tiles from the second flight beyond the feed zone towards the liquids discharge end through to the solids discharge end.
   e. Feed Tube: Stainless steel, Type 316.
   f. Base: Fabricated carbon steel or cast steel, with all surfaces in contact with process material coated with epoxy or Type 316 stainless liner.
   g. Upper Case: Stainless steel, Type 316, or fiberglass reinforced plastic (FRP).
   h. Main Centrifuge Bearings: Lubricated with grease or forced oil, or air-oil mist, L-10 life of 100,000 hours minimum.

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i. Scroll Conveyor Bearings: Grease lubricated, L-10 life of 100,000 hours minimum.
j. Feed Compartment: Stainless steel, Type 316 with feed compartment liner or breaker.
   1) Feed Compartment Liner: Either constructed of corrosion resistant, hardened material or equipped with field replaceable Adiprene, ceramic or Urethane liner or Flame Sprayed Coast 53C, or Deycon paste, including axial walls.
   2) Feed Compartment Breaker: Stainless Steel, Type 316.
k. Sludge Feed Nozzles and Solids Discharge Nozzles:
   1) Replaceable Solid Sintered Tungsten Carbide: Test sintered tungsten carbide abrasion resistant materials in accordance with ASTM G65, Procedure A, Standard Practice for Conducting Dry Sand/Rubber Wheel Abrasion Tests with volume loss less than 3 cubic millimetres.
l. Case Protection, Solids Discharge End: Field Replaceable Adiprene, Urethane, or Type 316 stainless steel liner, “or-equal.”
m. Fasteners (Wetted): Minimum Type 316 stainless steel.

2.06 BOWL

A. The bowl shall be designed to withstand, with an adequate factor of safety, all forces encountered during operation. The bowl shall be supported on each end by pillow block bearings.

1. Bowl Inside Diameter: Minimum 16.9 inches, maximum 18.5 inches.
2. Bowl Length to Diameter Ratio: Minimum 4.0:1.
3. Normal Operating Speed: Minimum 3,200 rpm to maximum 3,600 rpm.
4. Bowl wall thickness, and bowl conical and cylindrical sections thickness shall be determined by centrifuge manufacturer. Examine surfaces for cracks, shrinkage, porosity, or other defects by means of a liquid penetrant test.
5. Pool depth level must be readily adjustable via weir plates (dams) located at the large diameter end of the bowl where liquid is discharged.
6. Centrate discharges shall be provided with deflector plates, nozzles, power plates, or tube weirs to redirect and assist in turning the bowl to reduce overall centrifuge electrical power consumption.
7. Solids shall be conveyed through a conical section of the bowl and discharged from the small diameter end of the bowl through multiple solids discharge ports spaced evenly around the bowl end. Solids discharge ports shall be protected against abrasion by field replaceable and weight balanced, mechanically attached and replaceable wear saddles manufactured of sintered tungsten carbide or chilled cast bushing liners.

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8. Centrifugally cast bowls shall be 100 percent dye penetrant inspected. Casting certificates for each component will be required. Rolled and welded or statically cast bowls are not allowed.
9. Bowl shall be provided with a replaceable ribbed stainless steel liner from two wraps beyond the feed zone (toward the liquids end), or a minimum of eight evenly spaced longitudinal bowl strips the entire length of the bowl, or longitudinal grooves the entire length of the bowl, to trap solids and form a layer to protect the bowl from wear.
10. Material to be processed shall be introduced to the bowl through a compartment that evenly distributes the feed. The feed compartment shall be protected against abrasion.

2.07 SCROLL CONVEYOR

A. Centrifuge shall include a horizontal cylindrical-conical scroll conveyor supported by anti-friction bearings and equipped with helical flights independently mounted concentrically within the centrifuge bowl.

B. Conveyor shall include solids feed ports protected against abrasion by field replaceable, weight balanced, mechanically attached wear nozzles.

C. The conveyor edge and face of the flights shall be protected against abrasion by a series of welded-on sintered tungsten carbide tile assemblies from two wraps beyond the feed zone towards the liquids discharge end through to the solids discharge end. Each tile assembly shall be weight correct and consist of a solid sintered tungsten carbide wear part attached to a stainless steel backup holder. Spray hard surfacing applied to a backup plate is not allowed. Each assembly shall be individually replaceable and shall include the ability to monitor wear by means of visual inspection. The tile assemblies shall extend a minimum of 0.3 inch beyond the radial edge of the conveyor flight.

D. The remaining scroll conveyor edge and face shall be protected from abrasion by flame sprayed hard surfacing containing a minimum of 40 percent tungsten carbide particles.

E. All sintered tungsten carbide tiles shall be able to meet ASTM G65 Test Procedure A with a volume loss.

F. One full turn of the conveyor flight in front of the baffle disc will be additionally stiffened. If any flight deflection is observed during the extended warranty period, the flights will be restraightened, additional stiffeners added, and the conveyor rebalanced at no cost to the City.

G. The scroll conveyor shall be dynamically independently balanced to allow for the exchange of one scroll conveyor to another.

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H. The scroll beach cone angle shall be a minimum of 10 degrees and a maximum of 15 degrees.

2.08 CASE

A. Centrifuge shall be enclosed in a fabricated case, the purpose of which shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard, and to provide complete enclosure for noise reduction and odor control. Case shall be protected at the solids discharge end with field replaceable liner. Upper case shall be specifically designed for rigidity and noise reduction. The case top shall be bolted in place. Lifting eyes shall be provided for lifting of the case top or provided with a spring loaded to facilitate lifting to one side.

B. A flanged and gasketed seal shall be provided between the upper- and lower-case components.

2.09 FRAME

A. The centrifuge shall be supported by a fabricated carbon steel or combination cast iron and steel base which shall in turn be mounted on vibration isolators.

B. Vibration Isolators:

1. Vibration isolators shall be capable of dampening vibration in all directions and shall be a combination of metal springs, or rubber dampeners and/or viscous dampening fluid.
2. Quantity, capacity, and vibration constant of isolators as selected by manufacturer for the load and impact resulting from operation of the centrifuge provided.
3. Isolators shall be designed to limit dynamic loads imparted to foundation to 10 percent of the static load of empty machine in the vertical direction and 5 percent of the static load of empty machine in the horizontal direction.

C. The bottom portion of the frame shall be provided with machined outlets for the attachment of the solids and centrate flexible connectors.

D. Lifting eyes or solid lifting bars shall be provided for lifting the frame.

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2.10 MAIN DRIVE SYSTEM

A. The bowl drive system shall consist of an electric main drive motor with variable frequency drive and V-belt drive system complete with necessary vibration isolators for the individual support of the motor and centrifuge. The belt drive system shall consist of multiple V-belts as required to provide full load capacity and to withstand the full starting torque of the system.

B. Main Drive Motor:

1. Provide squirrel-cage AC induction motor meeting the requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein. Motor shall be sized to satisfy all operational conditions and as specified.
2. Motor shall meet the following specific requirements:
    a. Motor Horsepower: 40 minimum; 50 maximum.
    b. Nominal Speed: 1,800 rpm.
    c. Voltage Rating: 460V, three-phase.
    d. Enclosure Type: TEFC.
    e. Mounting: Horizontal.
    f. Inverter duty rated motor.
3. Provide motor modifications as follows:
    a. With the motor at ambient temperature (COLD), it shall be capable of making two complete starts in succession with coasting to rest between starts within a 1-hour time period. With the motor running (HOT), it shall be capable of at least one restart within 1 hour after any shutdown. The motor insulation temperature classification shall not be exceeded.
    b. The motor shall be of the quiet type design. The noise level shall not exceed 85 dBA sound pressure measured at 3 feet from the motor in all directions.
    c. Provide bi-metallic thermostat for thermal protection.

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2.11 BACKDRIVE SYSTEMS

A. Provide a variable frequency drive (VFD) backdrive system for each centrifuge.

B. Gear Box for Electric Motor Based Backdrive Systems: Either 1) a two-gear conveyor drive system consisting of a primary cyclo gear and a secondary cyclo gear; or 2) a one-stage cyclo reducer; or 3) a two-stage, three-stage, or four-stage planetary gear unit shall maintain a differential speed between the conveyor and bowl. Each of the above devices shall be suitable for 24 hours per day continuous service. The gear box shall have a torque capacity to meet the specified service conditions and performance requirements with the design required torque not to exceed 80 percent of the gear box full rated torque capacity. Gear boxes shall be capable of withstanding a 200 percent momentary overload and 150 percent intermittent overload. A torque overload control shall be provided to initiate centrifuge shutdown in the event of conveyor overload. Manufacturer shall select the reduction gear ratio as required for the solids to be handled and to be consistent with satisfactory operation. The gear unit shall be grease lubricated with its housing serving as a lubricant reservoir.

C. Variable Frequency Drive Backdrive System: An inverter duty backdrive motor shall be supplied and connected to the pinion shaft of the differential gear box. Backdrive system shall provide stepwise or infinite speed variation between the conveyor and the bowl shell of the centrifuge.

1. Centrifuge Backdrive Motor:
    a. Provide squirrel-cage AC induction motor meeting the requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein. Motor shall be sized to satisfy all operational conditions and as specified.
    b. Motor shall meet the following specific requirements:
        1) Motor Horsepower: 10 minimum; 20 maximum.
        2) Nominal Speed: 1,800 rpm.
        3) Voltage Rating: 460V, three-phase.
        4) Enclosure Type: TEFC.
        5) Mounting: Horizontal.
        6) Inverter duty rated motor.
    c. Provide motor modifications as follows:
        1) Provide bi-metallic thermostat for thermal protection.
2. Attach the motor to the pinion shaft of the differential gearbox.

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D. The backdrive system shall be capable of operating in a DIFFERENTIAL or TORQUE control mode that provides for operation at specific adjustable scroll/bowl differential speeds or backdrive torque values. In the DIFFERENTIAL control mode, the backdrive system shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque. In the TORQUE control mode, the backdrive system shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. Backdrive torque controller shall incorporate an auto-tuning feature to automatically adjust the proportional, integral, and derivative constants to automatically adjust to sludge and scroll conveyor torque feedback changes.

E. Torque shall be measured as a function of input in the drive unit. In the event that torque exceeds the normal operating range, monitoring instrumentation shall detect this condition and stop the sludge feed to allow the machine to clear itself. The torque monitoring system shall automatically reset when the torque approaches the normal operating range. In the event that the torque approaches the limit of the backdrive, the centrifuge's controller shall initiate centrifuge shutdown and initiate stop of both sludge and polymer feeds yet maintain torque for the entire shutdown so that the machine clears itself while under reduced G-force thus allowing the centrifuge to be clean when coming to a complete stop.

2.12 BEARINGS

A. The entire rotating assembly of each centrifuge shall be supported by two main bearings. Each main bearing shall be lubricated ball or cylindrical roller type bearings. Main bearings shall be housed in one-piece pillow blocks with dowel pins for proper alignment. Provide each pillow block bearing with a threaded female connection to permit the use of a lifting eye to facilitate inspection and maintenance.

B. Bearing temperature monitors shall be provided on each main bearing pillow block, with a 4 mA to 20 mA analog output signal sent to the control panel for display and monitoring. Provide 100 ohm two-wire or three-wire platinum resistance temperature detectors (RTDs). Bring the RTD leads out to a terminal junction box.

C. Scroll conveyor bearings shall be anti-friction ball or roller type bearings sealed from process contamination. Bearings shall have external grease fitting for lubrication.

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D. Bearings shall have an ABMA L-10 life or DIN ISO 281 L-10 life of 100,000 hours minimum at machine rated operating speed and machine sizing solids loading rate specified in Article Performance Requirements.

2.13 MAIN BEARING LUBRICATION SYSTEM

A. Lubrication of centrifuge main bearings shall be provided by means of an automatic feed system. Lubrication feed system shall be one of the following types, and include, at a minimum but not limited to:

1. Oil/Air Mist Type:
   a. Oil reservoir with sight level gauge.
   b. Oil reservoir level switch.
   c. Air/oil feed solenoid valve.
   d. Oil feed adjustment valves.
   e. Air compressor, compressed air supply isolation valve, regulator, and filter.
   f. Low air pressure switches.
2. Forced Oil Type:
   a. Oil reservoir with sight level gauge, temperature gauge, and drain leg and plug valve.
   b. Oil pump of adequate capacity with motor sized by centrifuge manufacturer.
   c. Oil pump motor starter located in centrifuge electrical panel.
   d. Oil to water heat exchanger, Type 316 stainless steel.
   e. Pressure gauge.
   f. Water in oil detector.
   g. Temperature regulating valve on cooling water supply.
   h. Solenoid valve on cooling water supply, automatically controlled from the centrifuge control panel, fail open.
   i. Cooling water strainer, 100 mesh.
   j. Two oil return flow-indicator switches, one for each pillow block bearing.
   k. Resistance temperature detector in oil supply line.
   l. Pressure relief valve.
   m. Oil filter.
   n. Oil filter high pressure loss switch, to indicate required filter change.
   o. Oil temperature indicator and regulator.
   p. System shall be skid-mounted and supplied fully assembled. All lube oil piping internal to the lube oil skid and on the centrifuge itself shall be Type 316 stainless steel. Piping between the lube oil skid and the centrifuge shall be flexible rubber hose. Fittings shall be compression type.

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q. Forced oil lubrication oil heat exchanger shall meet its cooling requirement using not more than 15 gpm of cooling water supplied at a temperature of 80 degrees F when ambient temperature is 104 degrees F. Provide self-contained regulating valve to automatically control cooling water flow rate as required to maintain lubrication oil temperature. Cooling water supplied with be plant effluent reclaimed water. Heat exchanger shall be tube-in-tube.

3. Grease Type:
   a. Grease reservoir with sight level gauge per bearing.
   b. Grease reservoir low level switch per bearing.
   c. Grease feed solenoid valve per bearing.
   d. Grease feed adjustment valves.

B. Oil system shall be skid-mounted and supplied fully assembled. All lube oil piping internal to the lube oil skid and on the centrifuge itself shall be Type 316 stainless steel. Piping between the lube oil skid and the centrifuge shall be flexible rubber hose. Fittings shall be compression type.

C. Lubrication oil shall be synthetic type.

D. All lubrication system signals shall be wired to a common junction box for connection to the external control panel.

2.14 GUARDS

A. Fabricated guards shall be provided for all gear boxes, pulleys, and belt drives.

1. Guards shall be 16-gauge minimum thickness Type 304 stainless steel.
2. The guards shall meet OSHA standards and completely enclose the rotating parts of drive system and shall be designed to minimize vibration and noise.
3. Guards shall include expanded metal sections, with holes coincident with the shafts and belting of all equipment to facilitate the use of a strobe light for inspection and maintenance of the shafts and belts.
4. Fasteners shall be externally accessible.

2.15 CENTRIFUGE FEED

A. Sludge shall be fed to the centrifuge by means of a removable feed tube suitable to minimize turbulence. The feed connection to the centrifuge shall be a 2-inch minimum, 150-pound ASME flanged connection. The maximum available inlet pressure required at the centrifuge inlet flange shall be 7.5 pounds per square inch gauge at 120 gpm (when based on water with the viscosity of 1-centipoise).

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B. The supplied feed pipe tree shall provide connections for sludge, polymer and CIP feed piping with a singular flexible connector between it and the feed tube connection at the centrifuge. Length and material of the flexible connector shall be selected by the Manufacturer to perform within all operating ranges of the centrifuges conveying the specified liquids.

2.16 FLEXIBLE CONNECTIONS

A. All mechanical and electrical connections to the centrifuge, including, but not necessarily limited to, the feed sludge, polymer, centrate and dewatered cake connections, compressed air piping, cooling water supply and return piping, sample line, vents, and electrical raceways shall be equipped with flexible connections.

B. All flexible connections shall isolate centrifuge vibrations from fixed, rigid external connections. No exterior loads shall be transferred to a centrifuge by external connections to the machine.

C. Centrate and dewatered cake flexible connections shall be flanged and fabricated from neoprene, with Type 316 stainless steel bolts with Type 316 stainless steel retainer plates at each end.

D. Piping flexible connectors shall be metal reinforced elastomer with flanged connections. Tubing flexible connectors shall be metal reinforced hose with Type 316 stainless steel hose clamps.

E. Flexible electrical connections shall be made with liquid-tight conduit.

2.17 CHUTES

A. Solids discharge chutes to the conveyors and centrate chutes shall be provided by others.

2.18 NOISE

A. Centrifuge shall be designed such that when running at the normal operating speed, the average free-field noise level measured at 3 feet around the periphery of the complete centrifuge assembly shall not exceed 85 dBA, when tested at the manufacturing facility, without feed and with inlet and discharge connections sealed.

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2.19 VIBRATION MONITORING SYSTEM

A. A vibration monitoring system shall be provided for each centrifuge to perform the following functions:

1. Convert vibration into velocity.
2. Sound a warning and initiate stop of sludge feed if the velocity reaches a certain preset level (HIGH).
3. Sound a warning and shut the centrifuge down if the velocity reaches a separate preset level (HIGH HIGH).
4. Provide an adjustable time delay during centrifuge startup to account for initial acceleration and feed induced vibration.
5. Provide an adjustable time delay, not to exceed 5 seconds, during operation to account for momentary excursions due to process changes.

B. Provide two sensors installed on each centrifuge and wired to a common terminal junction box. Sensors shall be rigidly attached to each of the two main bearings, positioned to measure both horizontal and vertical displacement.

C. The centrifuge, when running at the normal operating speed, shall not produce vibration velocities greater than 4.5 mm per second at the main bearings when tested at the manufacturing facility without feed.

D. Wires shall be labeled in accordance with Section 40 99 90, Package Control Systems.

2.20 ANCHOR BOLTS AND FASTENERS

A. Anchor Bolts, Nuts, and Washers: Type 316 stainless steel shall be sized by centrifuge manufacturer and provided by Contractor.

B. Fasteners: All internal fasteners furnished with the centrifuges which are subject to contact with sludge, centrate, or vapors of wash water and wastewater shall be a minimum Type 316 stainless steel.

2.21 ELECTRICAL

A. General:

1. Provide all necessary electrical components and wiring for a complete, functional system.
2. All variable frequency drives for the centrifuge system shall be provided in the control panels provided as part of this section.

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3. Control and electrical panel and interior components shall be rated for continuous operation in the environment conditions specified in Section 40 99 90, Packaged Control Systems, for indoor, air conditioned.

B. Wiring: Size conductors and conduits for power circuits to the main and backdrive motors. Factory prewire (size, furnish, install, and connect) all skid mounted equipment control conductors and instrumentation cables to skid mounted terminal junction boxes for connection to the control and electrical panels. All conductors shall be stranded copper, and all wiring shall meet the requirements of NFPA 70, the 2023 National Electrical Code. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in 600-volt twisted shielded pair cable. Analog and power circuits shall not be run in the same conduits. Connections from skid mounted junction boxes to the control and electrical panels will be by others.

C. Electrical Raceways: All conductors and cables not subject to vibration between prewired devices and skid-mounted terminal junction boxes shall be installed in PVC coated rigid galvanized steel conduits. Flexible, nonmetallic, liquid-tight conduits shall be provided where flexible conduits are required.

D. Terminal Junction Boxes:

1. All centrifuge-mounted devices, except for motor leads, shall be pre-wired to centrifuge-mounted terminal junction boxes (TJBs). Separate TJBs shall be provided for:
   a. 120V ac power and control, and
   b. 24V dc 4 mA to 20 mA analog and discrete signals.
   c. Size, furnish, and install NEMA 4X, Type 316 stainless steel TJBs on the centrifuge skid.

E. Main Drive VFD: Main drive motor shall be controlled by a variable frequency drive provided in the Centrifuge Control Panel.

1. The drive and system shall be sized in accordance with manufacturer’s design requirements and shall be as specified in Section 26 29 23, Low Voltage Adjustable Frequency Drive System.
2. The motor shall be capable of delivering full load torque across a 10:1 turndown ratio.
3. Drive system shall be capable of flying restart.

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F. Backdrive VFD: Backdrive motor shall be controlled by a variable frequency drive provided in the Centrifuge Control Panel.

1. The backdrive system shall provide infinite speed variation between the scroll conveyor and bowl shell of the centrifuge.
2. The drive and system shall be sized in accordance with manufacturer's design requirements and shall be as specified in Section 26 29 23, Low Voltage Adjustable Frequency Drive System.
3. The motor shall be capable of delivering full load torque across a 10:1 turndown ratio.
4. Drive systems shall be capable of flying restart.
5. Centrifuges with a hydraulic backdrive shall provide a soft start or VFD. Comply with Division 26, Electrical. Manufacturer shall provide inrush current on loaded startup.

G. Centrifuge Emergency Stop: Provide a Mushroom E-stop pushbutton by each centrifuge, and at each Centrifuge Control Panel.

1. Provide all other power transformers as required by the system, such as 24V dc power supplies.

H. Power Monitoring: The existing electrical system, as represented by connected load, can only support a 40 hp Main drive with a 10 hp backdrive. If a larger system is required to meet design parameters, a 30-day power monitoring device shall be installed, per NEC 220.87, at the sourced MCC bus.

1. Submit device settings and initial report data after 1-hour to insure accurate readings.
2. Submit final report data for evaluation with packaged system's overall power requirements.

2.22 CONTROLS

A. General:

1. Provide controls in accordance with the requirements specified in Section 40 99 90, Package Control Systems, and related sections.
2. Provide centrifuge controls equipment in a dedicated local control panel as specified herein.

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3. The controls for all components of each centrifuge shall be provided by a dedicated programmable logic controller (PLC), mounted in the Centrifuge Control Panel. The PLC shall provide all control and monitoring functions required for the operation and monitoring of the centrifuge including, but not limited to, timing, interlocks, startup sequencing, normal and emergency shutdowns, and permissive functions required for safe operation of each centrifuge. Refer to Section 40 99 90, Package Control Systems, for PLC manufacturer and products. Provide a Rockwell Automation CompactLogix programmable logic controller as required in Section 40 99 90, Package Control Systems.
4. The PLC I/O signal types and voltages are specified in Section 40 99 90, Package Control Systems.
5. Each Centrifuge Control Panel shall be equipped with an Operator Interface Terminal (OIT). Refer to Section 40 99 90, Package Control Systems, for OIT manufacturer and products.
6. All indicating lights shall be in accordance with Section 40 99 00, Package Control Systems.
7. Provide uninterruptible power supply (UPS) backup power for all PLC control panels as specified in Section 40 99 90, Package Control Systems and Section 26 33 53, Uninterruptable Power Supply.
8. Provide Application software for all digital, programmable components of the centrifuge systems, including submittals, documentation, communication, and testing as specified in Section 40 99 90, Package Control Systems.
9. Each control panel shall communicate with the plant Supervisory Control and Data Acquisition (SCADA) system via Ethernet TCP/IP links. All alarm, status and control points addresses shall be documented in O&M literature for interface with the plant SCADA system. Provide Ethernet switch in each control panel as specified in Section 40 99 90, Package Control Systems.

B. Centrifuge Control Panels:

1. Provide a Control Panel for Each Centrifuge:

Name	NEMA Enclosure	Material
Centrifuge Control Panels	NEMA 4X	Type 304 SST

2. Each control panel shall be freestanding enclosure, located in the Centrifuge Room. The location will be nonhazardous.
   a. Provide an arc flash barrier for segregation of 480V components from 120V and lower components. 120V side of the cabinet shall be openable with Centrifuge main disconnect in the CLOSED position (energized).

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3. Each control panel shall contain the following:
    a. A main overcurrent protective device with a through-the-door lockable handle.
        1) Disconnect position shall be physically interlocked with cabinet door, to prevent opening while energized. Interlock to be defeatable.
        2) Complete assembly shall have an overall short circuit rating of 42kA rms symmetrical at 480V.
    b. Programmable logic controller.
    c. I/O modules.
    d. Panel mount Operator interface terminal (OIT). Refer to the general control requirements herein.
    e. Ethernet switch for connecting the package PLC, VFDs, and OIT and for connection to the plant SCADA system.
    f. Mushroom E-stop pushbutton.
    g. Pilot light to indicate “Power On” – white LED.
    h. LED strobe beacon, amber, to visually indicate alarm conditions.
    i. Main Drive VFD:
        1) VFD controls for main drive motor.
        2) VFDs shall share a common bus on the line side of the VFD main disconnect.
    j. Back Drive VFD:
        1) VFD controls for back drive motor.
        2) VFDs shall share a common bus on the line side of the VFD main disconnect.
    k. Starter for lube oil pump, air compressor, and grease pump (if provided).
    l. Control power transformer to supply 120V ac control power to the associated centrifuge control components and instruments.
    m. Provide all other power transformers as required by the system, such as 24V dc power supplies.
4. Power Supply: 480-volt, three-phase, three-wire, 60-Hz.
5. Ventilation Requirements: Ventilation and filters for centrifuge control panels shall be installed at the enclosure front doors, not from the sides.
6. Dimensional Requirements: Each centrifuge local PLC/HMI control panel shall have a maximum footprint of 72 inches wide by 24 inches deep by 90 inches high.
    a. Interior-mounted PLC racks shall be less than 75 inches from bottom of enclosure.
    b. Door-mounted devices (exemption – alarm beacon) shall be less than 65 inches from bottom of enclosure.

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C. Control Panel Functions:

1. Operator Interface Terminal (OIT):
   a. The OIT for each centrifuge shall provide the primary method for an operator to monitor the status of the centrifuge and to affect its operation by command or directive entry. The plant SCADA system shall provide the secondary method for an operator to monitor and control the centrifuge. The OIT shall provide the graphics-based interface between the operator and the centrifuge controller. The graphics and their layout/presentation shall be manufacturer's standard.
   b. The OIT and Plant SCADA shall provide all displays and control screens needed to safely and efficiently monitor and control the dewatering centrifuge.
   c. The OIT and Plant SCADA shall provide for selection of the following:
      1) Centrifuge Control Mode: LOCAL/REMOTE.
      2) Backdrive Control Mode: TORQUE/DIFFERENTIAL.
      3) Centrifuge START.
      4) Centrifuge STOP.
      5) Centrifuge Clean-in-Place (CIP) initiation.
   d. Display (at a minimum):
      1) Alarms.
      2) Status and control of each system component.
      3) Bowl speed.
      4) Backdrive speed.
      5) Main drive motor amperage (rms value).
      6) Differential Speed: Scroll versus bowl.
      7) Bearing temperatures.
      8) Backdrive torque.
      9) Vibration.
      10) Centrifuge Control Mode: LOCAL/REMOTE.
      11) Backdrive Control Mode: TORQUE/DIFFERENTIAL.
      12) The specific shutdown condition.
      13) Sludge and polymer flow rates.
      14) All inputs from and outputs to the plant SCADA system.
   e. Manufacturer and Product Information:
      1) Allen Bradley; Panel View Plus or Optix 15" HMI.
      2) Ethernet TCP/IP communications.
      3) Minimum 10-inch screen.
2. Controller Sequencing: The centrifuge PLC shall contain all programming necessary to safely start and stop the centrifuge, in either the LOCAL or REMOTE mode. The following minimum sequences and control shall be provided.

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a. LOCAL/REMOTE: In the LOCAL mode, centrifuge control shall only be available through the centrifuge control panel. All outputs to the Plant SCADA System shall be available. In the REMOTE mode, START, STOP, BACKDRIVE control mode selection, torque set point entry, differential set point entry, and other specified centrifuge controls shall be from the Plant SCADA System.

b. Start: The start of the centrifuges will be initiated from the plant SCADA system HMI or the local OIT. The start command shall instruct the centrifuge control system to begin its start sequence. The centrifuge shall not be allowed to start more than the stated number of times per hour (two if cold, one if hot). The centrifuge control system shall confirm the successful initiation and/or completion of each step in the startup sequence before continuing with the next step in the sequence.
    1) The start sequence can only begin when the centrifuge sludge feed pump and polymer feed pump are not running (OFF status from plant SCADA system).
    2) Provided all interlocks are in the normal state, the centrifuge control system shall bring the bowl and scroll up to speed and signal when proper conditions have been attained to begin feeding polymer and sludge.
    3) Initiate conveyor start alarm and strobe.
    4) Initiate start of the inclined screw conveyor in REVERSE, to conveyor mixed solids/liquids discharge to the centrate piping system.
    5) Initiate start of the polymer feed pump.
    6) Initiate start of the centrifuge sludge feed pump (after a preset time delay).
    7) Initiate the screw conveyor flush water valve OPEN.
    8) Upon reaching an operator entered torque set point, initiate stop of the screw conveyor, initiate conveyor start alarm and strobe, and then initiate start of the conveyor in FORWARD after a preset time delay (to allow the conveyor to come to a complete stop). Initiate the screw conveyor flush water valve CLOSE.
    9) Once the polymer feed pump is confirmed on (ON feedback from plan SCADA system), initiate a preset timer.

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10) If the start sequence is interrupted for any reason, including, but not limited to equipment failure, interlock failure, or manual (operator initiated) interrupt, the centrifuge controller shall generate a time delayed FAIL TO START alarm, with an operator adjustable delay from 0-minute to 5 minutes. Stop the centrifuge feed pump and polymer feed pumps (request to plant SCADA system) and allow the machine to coast to a standstill.
11) If the start sequence is successful, continue monitoring interlock status of polymer feed pump, and centrifuge sludge feed pump.

c. Normal Stop: This command shall instruct the centrifuge control system to begin its normal stop sequence. The centrifuge control system shall confirm the successful initiation and/or completion of each step in the stop sequence. If any step in the sequence fails, the centrifuge controller shall generate an alarm specifying the failed step.
1) Stop the centrifuge sludge feed pump and polymer feed pump (disable ENABLE commands).
2) Maintain a preset differential speed to clear the remaining solids from the bowl.
3) After a set adjustable time for removal of resident solids or upon reaching an operator entered falling backdrive torque set point, initiate opening the centrifuge flush water valve, stop the centrifuge discharge conveyor, initiate conveyor start alarm and strobe, and then start the conveyor in REVERSE after a preset time delay (to allow the conveyor to come to a complete stop).
4) After a predetermined (adjustable) time period, initiate closing of the centrifuge flush water valve and stop the centrifuge discharge conveyor. Initiate the screw conveyor flush water valve CLOSE. The centrifuge shall then coast to a standstill.

d. The control system shall cause a “Controlled Shutdown” of the centrifuge and alarm this condition in the event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:
1) Backdrive controller malfunction.
2) Left/right bearing HIGH HIGH temperature alarms.
3) Backdrive malfunction.
4) HIGH HIGH torque.
5) HIGH HIGH vibration.

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e. The control system shall cause an automatic NORMAL STOP sequence shutdown of the centrifuge and alarm this condition in the event that any of the following interlocks are triggered. These automatic shutdown interlocks shall include, but are not limited to:
   1) Backdrive HIGH temperature alarm.
   2) Drive motor over temperature.
   3) Drive motor overload.

f. During normal operation an excessive solids build-up shall be detected by the centrifuge control system as a higher than normal torque requirement or by sensing excessive vibration. Should the torque or vibration exceed a preset point, the HIGH torque or vibration switch shall close, sending a signal to the centrifuge control system which shall initiate shutdown of the sludge and polymer feeds. This action will normally result in a reduction of torque and vibration as the buildup is removed from the bowl. When the torque or vibration falls to an acceptable limit, reinitiate start of sludge and polymer feeds. The high torque control shall be not more than twice the normal operating torque or pressure. The controls shall also allow operation at a set differential speed allowed to vary within the normal operating limits. Controls shall include adjustable timers and or a count of HIGH torque or vibration events in order to initiate an automatic NORMAL STOP in the event of repeated torque or vibration excursions.

g. In the event that the above clearing action fails to remedy the high torque or vibration situation, and the torque or vibration continues to increase, the centrifuge control system shall respond by issuing a torque or vibration HIGH HIGH alarm at the control panel and similar signal to the Plant SCADA System in addition to initiating a CONTROLLED SHUTDOWN.

h. Controlled Shutdown: Controlled Shutdown shall require reset action at the centrifuge control panel before the unit can be restarted.
   1) This command shall de-energize the centrifuge main drive motor. The centrifuge shall be allowed to coast to a standstill. If available, the backdrive shall remain active until the bowl has coasted to a standstill, controlled to clear as much solids as possible from the bowl.
   2) Initiate stop of the centrifuge feed pump and polymer feed pump.
   3) Initiate the centrifuge flush water valve open for flushing and subsequently initiate close after an adjustable time period.

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i. Emergency Stop: Emergency Stop initiated via E-STOP pushbutton at the centrifuge control panel shall stop the centrifuge and all associated equipment instantaneously with no flush water.
   1) This command shall de-energize the centrifuge system.
   2) Initiate stop of the centrifuge feed pump and polymer feed pump.

j. Conveyor Emergency Stop: Activation of the safety pullwire shall stop operation of the conveyor, stop the centrifuge sludge feed pump feed, polymer feed pump feed and place the centrifuge in pause mode (centrifuge conveyor and bowl shall reach the same speed).

k. Provide clean-in-place (CIP) function to clean solids out of the bowl. In a CIP cycle a CIP START pushbutton is pressed, the centrifuge flush water valve OPEN is initiated, the backdrive energized and begin to rotate in the reverse (if required by the manufacturer's particular design) direction at a low speed for a predetermined time. At the end of the set time, the backdrive shall toggle direction, causing a water "sloshing" effect within the centrifuge bowl and conveyor. The process shall continue until the predetermined overall times ends, a CIP STOP key is depressed, or a fault occurs. Any shutdown fault shall terminate the CIP cycle.

3. Controller Interface (Data Exchange with Plant SCADA System): Provide provisions to make available and receive in contiguous registers the following data to and from the Plant SCADA system. Coordinate configuration and testing of controller interface to the Plant SCADA System with the CITY. Refer to Section 40 99 90, Package Control Systems, for additional requirements.
   a. Outputs to the Plant SCADA System:
      1) Emergency STOP.
      2) Conveyor Emergency STOP.
      3) System Energized (power on) IN SERVICE status. Centrifuge START command.
      4) Centrifuge NORMAL STOP command.
      5) Centrifuge CIP START command.
      6) Centrifuge ON status.
      7) Centrifuge READY status.
      8) Centrifuge FAILED TO START status.
      9) Centrifuge FAILED TO STOP status.
      10) Centrifuge control mode REMOTE status.
      11) Backdrive control mode status.
      12) Clean mode status.
      13) Bowl speed.
      14) Scroll drive gear shaft speed, if gearbox is supplied.
      15) Bowl/scroll differential speed.

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16) Backdrive torque.
17) Main drive motor amperage (rms value).
18) Centrifuge system power consumption (kW).
19) Drive-end main bearing temperature.
20) Idle-end main bearing temperature.
21) Drive-end main bearing vibration value.
22) Idle-end main bearing vibration value.
23) Vibration warning (HIGH) alarm.
24) Vibration shutdown (HIGH HIGH) alarms.
25) Motor faults.
26) High torque alarm.
27) Torque overload (HIGH HIGH) alarm.
28) Drive-end/idle-end main bearing HIGH temperature alarm.
29) Drive motor HIGH temperature alarm.
30) Backdrive motor HIGH temperature alarm.
31) Backdrive controller (VFD) malfunction alarm.
32) Main drive controller (VFD) malfunction alarm.
33) Centrifuge feed pump ENABLE signal.
34) Centrifuge feed pump flowrate setpoint (in LOCAL mode).
35) Polymer feed pump ENABLE signal.
36) Polymer feed pump flowrate setpoint (in LOCAL mode).
37) Centrifuge flush water valve OPEN command.
38) Centrifuge flush water valve CLOSE command.
39) Discharge screw conveyor flush water valve OPEN command.
40) Screw conveyor FORWARD ENABLE signal.
41) Screw conveyor REVERSE ENABLE signal.
42) Discharge screw conveyor flush water valve CLOSE command.

b. Inputs from the Plant SCADA System:
1) NORMAL STOP (centrifuge or conveyor).
2) Backdrive control mode (TORQUE/DIFFERENTIAL).
3) Backdrive torque set point (TORQUE control mode).
4) Differential speed set point (DIFFERENTIAL control mode).
5) Centrifuge sludge feed pump ON status.
6) Polymer feed pump ON status.
7) Sludge feed flow rate.
8) Polymer feed flow rate.
9) Screw conveyor FORWARD status.
10) Screw conveyor REVERSE status.

c. Any other data or status considered by manufacturer as essential to safe operation.

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d. Centrifuge feed pump START/STOP, and flow control loop will be controlled by the Plant SCADA System. The centrifuge PLC shall communicate ENABLE (start) signal for the centrifuge feed pump as specified for centrifuge startup and shutdown functions.

e. Polymer feed pump START/STOP and flow control loop will be controlled by the Plant SCADA System. The centrifuge PLC shall communicate ENABLE (start) signal for the polymer feed pump as specified for centrifuge startup and shutdown functions.

D. The lubrication system shall be interlocked with the centrifuge main drive motor such that low pressure, low flow, and/or low level will de-energize the centrifuge main drive motor. In all cases, the starter for oil gear pump, or the air compressor, or grease pump motor controls shall be interlocked with the main drive motor so that bearings are lubricated whenever the centrifuge is running and a delayed trip so that bearings continue to be lubricated while the centrifuge coasts to a stop. The oil gear pump, or air compressor, or grease pump shall also be independently operable.

E. All lubrication system signals shall be wired to a common junction box for connection to the external control panel. All wires shall be labeled in accordance with Section 40 99 90, Package Control Systems.

2.23 ACCESSORIES

A. Equipment Identification Plates: Provide a 16-gauge stainless steel identification plate for all equipment, valves, appurtenances, and instruments with equipment/component numbers, securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification numbers.

B. Lifting Lugs: Equipment and each component thereof weighing over 50 pounds shall be provided with lifting lugs for easy handling.

2.24 PAINTING

A. The paint system shall be a catalyzed epoxy primer with a top coating of aliphatic acrylic urethane in accordance with manufacturer’s typical paint specifications.

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B. All carbon steel and cast iron shall be properly prepared and cleaned in accordance with the best standard practices. Minimum surface preparation shall include solvent cleaning, SSPC SP-1 followed by abrasive blasting to near white metal, SSPC SP-10 or other surface preparation methods will be considered, provided that the method results in the minimum surface profile required by the paint manufacturer. Apply 3 mils minimum dry film thickness of lead-free catalyzed epoxy polyamide metal primer and one finish coat of aliphatic acrylic polyurethane, 3 mils minimum dry film thickness. Prepare all surfaces and apply all paint in accordance with the paint manufacturer's written directions. The color shall be the manufacturer's standard. Provide 1-gallon of touch-up paint.

2.25 CENTRIFUGE FACTORY ACCEPTANCE TESTING

A. Perform Factory Acceptance Testing.

B. The City has the option to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuge and associated equipment. City's travel expenses will be borne by the City.

C. Notify the City of the schedule for centrifuge factory testing not less than 45 days in advance and City will travel to the factory and witness the centrifuge factory testing.

D. Perform manufacturer's functional tests on the centrifuges as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Dye penetrant test bowl component centrifugal castings.
3. Manufacturer's Test Representative shall certify test results.
4. Perform tests on all components actually furnished. Use of factory control panels and factory motors are acceptable.
5. Vibration measurement with bowl empty.
6. Vibration measurement with bowl filled with water.
7. Operation of machine for minimum of 4 hours with water.
    a. Note: The wet testing specified herein is voluntary and shall occur onsite during commissioning activities. Any delays associated with leakage occurring during onsite wet testing with manufacturers that do not perform the specified functional voluntary wet testing at the factory, shall be borne by the manufacturer.
8. Motor starting amperage.
9. Obtain acceptance of test reports from Engineer prior to shipment of equipment.

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E. Noise Test: Measure free field sound pressure levels of centrifuge running at the normal operating speed with bowl filled with water and/or with water feed.

F. Motor Tests: See Section 26 20 00, Low-Voltage AC Induction Motors.

G. Scratch Abrasion Test:

1. The sintered tungsten carbide tiles to be used on the wearing face of the conveyor shall be subjected to a dry sand rubber wheel abrasion test. This test shall be conducted in accordance with the current ASTM G65, Procedure A. The test shall be conducted with the following requirements:
   a. Wheel Load: 30 pounds.
   b. Grit: AFS 50/70.
   c. Grit Flow Rate: 250 grams per minute to 350 grams per minute.
   d. Shape of Sand Curtain: Streamlined.
   e. Test Duration: 6,000 revolutions.
   f. Rubber Wheel: Chlorobutyl rubber with a Durometer A of 58 to 62.
   g. Wheel Speed: 200 rpm (plus or minus 10 rpm).
   h. Wheel Diameter: 8.5 inches to 9 inches.
   i. Linear Abrasion Distance: 14,138 feet.
   j. Sand Nozzle: Special fabricated design.
2. Test one tile from each lot of tiles used in manufacturing the centrifuges, or four tiles total, whichever requires the greater number of tiles to be tested. The following laboratories are equipped to conduct these tests in accordance with the ASTM Standards and can provide certification of the results:
   a. Colorado School of Mines, Golden, Colorado 80401.
   b. Falex Corp., Aurora, Illinois 60505.
3. The volume loss of the proposed wear resistant material shall not exceed 3 cubic millimeters per tile during the 30-minute test period. Any material that exceeds 3 cubic millimeters loss in 30 minutes will not be allowed.

2.26 CONTROL PANEL FACTORY ACCEPTANCE TESTING

A. Perform Factory Acceptance Testing.

B. The City has the option to inspect the fabrication procedures at any time during the fabrication stage(s) of the centrifuge control panels and associated equipment. City’s travel expenses will be borne by the City.

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C. Notify the City of the schedule for panel factory testing not less than 45 days in advance and City will travel to the factory and witness the panel factory testing.

D. Perform manufacturer's functional tests on each centrifuge control panel as follows:

1. Gather and furnish test information necessary to show conformance to specified requirements.
2. Manufacturer's Test Representative shall certify test results.
3. Perform tests on centrifuge control and electrical panel actually furnished.
4. Test panel for proper construction, electrical connection, and function.
5. Test all PLC inputs and outputs for proper connection and function.
6. Check all alarms, shutdown conditions, and automatic sequences to verify proper function.
7. Simulate interlocks and signals from other connected equipment in order to demonstrate specified operator interface functions and controls.
8. Obtain acceptance of test reports from Engineer prior to shipment of equipment.
9. Refer to Section 40 99 90, Package Control Systems, for additional requirements.

PART 3 EXECUTION

3.01 INSTALLATION, PREPARATION AND CHECKOUT AND COMMISSIONING

A. Contractor shall install equipment in conformance with the manufacturer's written instructions, with supervision and inspection performed by manufacturer's representative.

3.02 PRE-INSTALLATION CONFERENCE

A. Centrifuge manufacturer service technician and centrifuge manufacturer's local equipment representative shall attend pre-installation conference with City and installing Contractor to coordinate. Conference shall be held at the plant.

3.03 FIELD TESTING

A. The timing and scheduling for testing shall be coordinated with and be dependent upon the City's schedule and quantity of sludge available for testing.

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B. Contractor shall notify the City in writing 60 days prior to when the Pre-Performance Test will occur. Contractor shall include in the notification the type of polymer recommended by the centrifuge manufacturer for the Pre-Performance and Performance testing.

C. Functional Test:

1. Perform equipment startup and checkout.
2. Prior to startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance of all components by means of a functional test conducted by the manufacturer's representative, assisted by the installing contractor and City, and as approved by the Engineer.
3. Field Motor Tests: At the time of equipment delivery to the Job Site and after installation prior to startup, the Contractor shall megger test (500-volt megger) each motor phase-to-phase and phase-to-ground in the presence of the Engineer. The Engineer will make a record of these values and provide the data to the centrifuge manufacturer. Values of resistance less than 1 megohm will not be acceptable. Refer to Section 40 99 90, Package Control Systems, for additional requirements.
4. Perform on each completed centrifuge system without sludge feed prior to startup.
5. Each unit shall be submitted to complete normal start, normal stop, and controlled shutdown cycles. The unit shall then be submitted to a 2-hour running test. At the beginning and end of the test, and at periodic intervals between, all temperature monitoring devices shall be observed and recorded. The belt tension shall be adjusted at the start of the test, checked and readjusted, if necessary, at the end of the test. All safety devices and the differential speed control for the backdrive unit shall be checked for satisfactory operation. Instrumentation and control systems shall be checked for conformance with the specifications.
6. As part of the test, each centrifuge shall be operated with water feed for a minimum of 30 minutes. At the beginning and end of the 30-minute water test, observe and record all thermometer, pressure gauges, and flow indicator readings.
7. After approximately 1 hour of runtime, the centrifuge shall be measured for proper vibration. Vibration velocities shall not exceed 7 mm per second RMS, with water feed, at the main bearings. If units exhibit vibration in excess of the limits specified, manufacturer shall adjust or modify the unit as necessary. After adjustment and/or modification, unit shall be retested to prove conformance.
8. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.

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9. Submit test log to Engineer upon completion of each test.
10. Complete successful functional testing prior to pre-performance test.

D. Pre-Performance Test:

1. During the pre-performance testing, the centrifuge manufacturer must ensure the equipment is fully optimized and configured in its final intended operational state. This includes verifying all settings, calibrations, and conditions required to pass the formal performance testing. The purpose is to confirm readiness and identify any necessary adjustments prior to the official performance test execution. Passing the formal performance test remains the definitive acceptance criterion.
2. Manufacturer's representative, assisted by the installing contractor and City, shall conduct testing to demonstrate continuous, reliable operation, not performance, while dewatering the sludge stream specified for durations a minimum of 5 days.
3. Contractor shall coordinate with centrifuge manufacturer representative and notify the City in writing at least 14 days prior to when the Pre-Performance Test will occur. Prior to any testing, the centrifuge manufacturer shall have provided complete Operation and Maintenance Manuals and conducted Pre-Startup classroom training on the dewatering centrifuges. Field training may occur during the Pre-Performance Test. The Functional Test shall be successful before the Pre-Performance Test may be conducted.
4. Pre-Performance Test shall include operation of each dewatering centrifuge for a period of 5 working days (one 5-day, 8-hour workday week) without shutdown due to equipment or system failures. No more than one centrifuge shall be operated simultaneously.
5. Stoppages due to any failure of provided equipment and instrumentation, such as the centrifuge control and electrical panels, shall not exceed 30 minutes, and such stoppages shall not number more than five over the 5-day test period. A greater number of stoppages or a stoppage longer than 30 minutes shall be deemed a failure of the Pre-Performance Test, and the test will stop. Stoppages caused by the City may occur without causing failure of the test.
6. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
7. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.

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8. If, in the opinion of the Engineer, the Pre-Performance Test is successful and meets the requirements specified herein, the Engineer will recommend to the City, by letter, the acceptance of the Pre-Performance Test and that the dewatering centrifuge may begin the Performance Test, providing other requirements for the Performance Test to begin are satisfied.
9. Should the dewatering centrifuges be unable to achieve the Pre-Performance Test requirements, the centrifuge manufacturer shall perform whatever equipment modifications are deemed necessary such that the equipment can achieve the performance specified. All modifications shall be documented and submitted to the Engineer. Following completion of the equipment modifications, the Pre-Performance Test shall be run again in its entirety. For any Pre-Performance Test after the first Pre-Performance Test, the centrifuge manufacturer shall pay for the City and Engineer to observe the Pre-Performance Test.
10. If, in the opinion of the Engineer, any one centrifuge did not meet the pre-performance requirements specified herein after a second pre-performance test, then the equipment shall be subject to rejection.
11. For the first and second (if required) Pre-Performance Tests, the cost and responsibility for supplying polymer shall be the responsibility of the City. The costs for power, feed sludge, centrate disposal, and dewatered cake disposal shall be borne by the City. Centrifuge manufacturer shall be responsible for recommending the emulsion polymer to use and centrifuge operational settings.

E. Performance Test:

1. General:
   a. Performance testing shall be done to demonstrate the actual system operating conditions and verify that each dewatering centrifuge meets or exceeds the minimum performance requirements specified in Article Performance Requirements while dewatering the sludge stream specified in Article Service Conditions. Performance testing shall be performed at the solids loading rates specified in Article Performance Requirements.
   b. The centrifuge manufacturer shall notify the City in writing at least 14 days prior to when the Performance Test will occur. Performance Test shall not proceed until after the Pre-Performance Test is successfully concluded.

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c. The cost of all laboratory tests necessary to confirm the sludge characteristics for the initial performance test on a centrifuge will be borne by the City. All laboratory tests for performance testing shall be performed by the City in conformance with the applicable portions of standard methods. If retesting is required, the centrifuge manufacturer shall pay the City for all laboratory tests subsequent to the initial test. Payment rate for City performed laboratory testing shall be as documented by City and agreed prior to testing. If desired by the centrifuge manufacturer for initial performance test and/or retesting, centrifuge manufacturer may take duplicate samples and have laboratory tests performed by an independent laboratory at centrifuge manufacturer's expense.

d. Polymer used shall be as recommended by the centrifuge manufacturer. The cost and responsibility for supplying polymer shall be the responsibility of the City until the equipment is accepted.

e. The cost of power, water, and feed sludge shall be borne by the City.

f. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.

2. Performance Test Procedures:

a. Manufacturer's representative, assisted by the City, shall startup and operate each centrifuge system on the digested sludge dewatering scenario specified herein, for a period of 2 working days, with 8 hours per day, once stable operation is achieved, with no interruptions allowed during each 8-hour period. All centrifuge operations and associated manufacturer's field services required to adjust machine settings shall be performed prior to and exclusive of the above specified performance test duration. No more than one centrifuge shall be operated simultaneously.

b. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment and approval. Testing shall not begin until the test procedures have been approved by the Engineer.

c. A qualified representative of the manufacturer shall supervise each test, analyze data, and certify the centrifuge's performance during the test.

d. Steady state operation at the specified sludge feed solids rates shall be maintained throughout the test and all hourly quantities shall be the average during the test period. The centrifuge shall maintain acceptable performance while dewatering feed sludge with properties within plus or minus 10 percent of the specified criteria listed in Article Service Conditions.

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e. Centrifuge manufacturer shall verify accuracy of instrumentation used to confirm performance prior to conducting the Performance Test.

f. During each performance test, take measurements and collect all required samples for analysis in order to make the following determinations:
   1) Sludge Feed Concentration: The total dry solids concentration of the feed sludge entering the centrifuge (percent TS), taken by sample.
   2) Dewatered Cake Concentration: The total dry solids concentration of the dewatered cake discharged from the centrifuge (percent TS), taken by sample. Take two duplicate samples per sample interval.
   3) Centrate Concentration: The total suspended solids concentration of the centrate discharged from the centrifuge (percent TSS), taken by sample.
   4) Solids Capture: Percent, by calculation specified herein.
   5) Feed Hydraulic Loading Rate (Exclusive of Polymer): gpm, as measured by sludge feed flowmeter.
   6) Feed Solids Loading Rate (Exclusive of Polymer): Pounds per hour of total dry solids, by calculation.
   7) Polymer Feed Rate: gpm, as measured by polymer feed flowmeter.
   8) Polymer Dose: Pounds active per dry ton of feed solids, by calculation.

g. Collect samples at approximate 1-hour intervals for a minimum of eight samples for each test period. Additional sampling may be made at centrifuge manufacturer's option.

h. Performance evaluation will be based upon the arithmetic average of the test results obtained during the test period, with the average rounded to one decimal place. The City reserves the right to discard obviously high or low erroneous test results. As specified below, laboratory testing will be performed by the City. Turnaround time for dewatered cake concentration samples are approximately 24 hours. For more immediate dewatered cake results, centrifuge manufacturer may supply their own instrumentation. Performance results shall be based on the laboratory standard methods results.

i. Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, polymer dose, and solids capture. Submit final report to the Engineer within 20 days after completion of the test.

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3. Performance Test Acceptance Procedures:
    a. If, in the opinion of the Engineer, the Performance Test is successful and meets the requirements specified herein, the Engineer will recommend to the City, by letter, the acceptance of the Performance Test.
    b. If, in the opinion of the Engineer, the centrifuge does not meet the minimum performance requirements specified in Article Performance Requirements, the representative of the manufacturer shall make such changes in the equipment and methods of operation as deemed necessary and as approved by the Engineer. The necessary adjustments shall be made as soon as practical, but within a period not to exceed 30 days.
    c. Following the adjustments, centrifuge manufacturer and shall repeat the Performance Test ("retest"). Prepare a formal test report including all laboratory analysis reports, all measured flows, the mass balance calculations, polymer dose, and solids capture. Submit the final report to the Engineer within 20 days after completion of the retest.
    d. If, in the opinion of the Engineer, the retest Performance Test is successful and meets the requirements specified herein, the Engineer will recommend to the City, by letter, the acceptance of the Performance Test.
    e. If, in the opinion of the Engineer, the centrifuge did not meet the minimum performance requirements specified in Article Performance Requirements during the retest, then the equipment shall be subject to rejection.
4. Equipment Rejection: Equipment subject to rejection shall be removed by the centrifuge manufacturer, at centrifuge manufacturer's expense, as defined in the Contract Documents.
5. Liquidated Damages for Nonacceptable Performance: The Performance Test is conducted to ensure the centrifuge performance. Liquidated damages shall be assessed for lesser performance of the centrifuge if the Engineer and Owner agree on nonacceptable performance. $100,000 shall be retained from the centrifuge equipment payment until the performance tests meet specification. Failure of performance of the centrifuge shall result in the Owner retaining the $100,000.

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F. Optimization Test:

1. Optimization Testing shall not begin until a minimum of 6 weeks after successful completion of the Performance Test, with timing to be selected by the City.
2. A qualified representative of the manufacturer, assisted by the City, shall operate the centrifuges to optimize machine settings to maximize cake dryness and solids capture efficiency and minimize polymer and electrical power consumption. Optimization period shall be 2 working days.
3. Proposed test procedures shall be developed by the centrifuge manufacturer and submitted to the Engineer for review, comment, and approval. Testing shall not begin until the test procedures have been approved by the Engineer.
4. A qualified representative of the manufacturer shall supervise the testing, analyze data, and provide a report summarizing trials, measured performance, and recommendations.
5. During optimization testing, take measurements as specified for performance testing, collecting samples at approximately 2-hour intervals, or when operation has stabilized at each trial condition.
6. The cost of all laboratory tests will be borne by the City. All laboratory tests for performance testing shall be performed by the Owner in conformance with the applicable portions of standard methods.
7. Emulsion polymer used shall be as recommended by the centrifuge manufacturer. Polymer costs shall be borne by the City.
8. The cost of power, water, feed sludge, centrate disposal, and cake disposal shall be borne by the City.

G. Manufacturer’s Field Services:

1. Provide manufacturer’s services necessary to provide a Manufacturer’s Certificate of Proper Installation per Section 01 43 33, Manufacturers’ Field Services.
    a. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Subcontractor’s assembly, erection, installation or application procedures.
    b. Inspection, checking, testing, 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.
    c. Providing, on a daily basis, copies of manufacturers’ representatives field notes and data to Engineer.
    d. Revisiting Site as required to correct problems and until installation and operation are acceptable to Engineer.

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e. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
f. Assistance during functional and performance testing, and facility startup and evaluation.
g. Training of City's personnel in operation and maintenance of respective product as required.

H. The manufacturer is required to be onsite for all of the functions listed above for the minimum person-days listed below, travel time excluded:

1. 6 person-days total, one trip, for installation assistance, inspection, and certification of installation.
2. 10 person-days total, two trips, for functional testing.
3. 2 person-days total, one trip, for prestartup classroom or Job Site training.
4. 10 person-days total, two trips, for pre-performance testing.
5. 4 person-days total, two trips, for performance testing and operator training during facility startup.
6. 2 person-days total, one trip, for optimization assistance consisting of the following activities:
   a. 1/2 person-day for supplemental classroom training.
   b. 1/2 person-day for supplemental hands-on training.
   c. 1 person day for performance optimization.
7. 2 person-days, one trip, for post-startup training within 1-year of initial startup.
8. The periods stated above are minimums only and the manufacturer is required to be onsite for all of the functions listed above to the extent that is required to complete those functions to the satisfaction of the Owner and Engineer. Owner shall pay manufacturer for additional service trips and labor hours, if trips and labor hours exceed the periods specified above due to fault of the Owner.

I. For additional field services regarding the VFDs, see Section 26 29 23, Low Voltage Adjustable Frequency Drive System.

END OF SECTION

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PART 2

DRAWINGS
(BOUND SEPARATELY)